J. Robert Welsh Power Plant

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

CCR Unit – Primary Bottom Ash Pond

As required by 40 CFR 257.103(f)(2)(viii), this is a notification that on November 30, 2020 J. Robert Welsh Power Plant (Welsh 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 Welsh Plant's operating record and posted to the CCR Rule Compliance Data and Information website.

AMERICAN
ELECTRIC
POWER
BOUNDLESS ENERGY

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
Welsh Power Plant Alternative Closure Demonstration

Dear Administrator Wheeler,

Southwestern Electric Power Company (SWEPCO) Welsh Power Plant (Welsh 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 Primary Bottom Ash Pond (PBAP) located at the Welsh Plant near Pittsburgh, Texas. Welsh Plant is requesting an extension pursuant to 40 C.F.R. § 257.103(f)(2) to allow the PBAP 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

J. Robert Welsh Power Plant

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

Prepared by:

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

and

Burns & McDonnell Engineering Inc.
9400 Ward Parkway
Kansas City, MO 64114

Submitted

11/25/2020

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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
112498

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 J. Robert Welsh Power Plant (Welsh Plant) (1187 County Road 4865 (Titus County) in Pittsburg, 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 two remaining coal-fired generating units at Welsh Plant will cease combusting coal in March 2028 and the CCR surface impoundments will be closed in order to comply with EPA's recently revised CCR regulations. Closure of the Primary Bottom Ash Pond (PBAP) impoundment will be completed no later than October 17, 2028, while the Bottom Ash Storage Pond (BASP) will cease receipt of CCR and non-CCR wastestreams no later than April 11, 2021 and initiate closure. 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 CFR §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 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 CFR § 257.103(f)(2)). To qualify for this 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 WELSH PLANT AND AFFECTED CCR UNITS

The Welsh Plant began operations in 1977 as a coal-fired electric generating power plant. The Welsh Plant had three coal-fired generating units, each capable of producing approximately 528 megawatts (MW) of power. Welsh Unit 2 retired in 2015. The remaining units produce bottom ash, economizer ash, and flyash, all of which are classified as coal combustion residuals (CCR). Bottom ash and economizer ash are sluiced from the operating generating units to the Primary Bottom Ash Pond (PBAP), along with other non-CCR wastewaters. The PBAP was constructed with the generating units in the 1970s and is approximately 65 acres in size. Solids settle and CCR material is dredged from the PBAP to the BASP. The BASP was constructed in 2000, and a portion of the CCR material is dewatered and sold for beneficial uses from this area. The remainder is taken to the on-site Welsh Plant Landfill (LF) for final disposal. The locations of the CCR surface impoundments are shown on Figure 1.

The BASP is a 22-acre impoundment located in a topographically high area of Welsh Plant. The BASP was constructed with a 60-mil high-density polyethylene (HDPE) liner at the base of the BASP at an elevation of 340 feet amsl which extends along the base of the BASP sidewalls and is keyed into the top of the BASP earthen embankment at an elevation of 360 feet amsl. The BASP embankments are approximately 20 feet in height and are constructed of sandy clays and clayey sands on a 3:1 slope. The southeast corner of the BASP contains an approximate ¼-acre clear water pond with a base elevation of 347 feet amsl. The clear water pond's elevation is maintained so that surface water flows through the drainpipe at invert elevation 350.5 feet amsl or weir set at a crest elevation of 355 feet amsl. The water that flows from the BASP's ¼ acre clear water pond discharges through a 30-inch-diameter pipe into the PBAP. The BASP meets the location restriction requirements including the minimum aquifer separation, but does not meet the liner requirements of the CCR regulation. A groundwater monitoring system was developed for the BASP in 2017 and Detection Monitoring was initiated in January of 2018. There have been no statistically significant increases over Appendix III background levels for any constituent at any monitoring well in the BASP groundwater monitoring network.

The PBAP is located in a topographically low area that had been an unnamed intermittent tributary of Swauano Creek prior to development of the Site. The PBAP resides in a drainage area that is approximately 450 acres in size. The PBAP is bounded by natural ground surface (topographically higher areas) to the north, south, and west, and an embankment dike to the east. The embankment dike is constructed of compacted sandy clay and clayey sand and is approximately 40 feet in height. The water level in the PBAP is controlled by a weir box which discharges into a drainage canal that receives treated wastewater from the PBAP and has an emergency spillway with a crest elevation at approximately 334 feet amsl. Assessment monitoring identified an exceedance of the ground water protection standard for lithium, but an alternate source demonstration was completed showing higher upgradient lithium concentrations, and widespread correlation of higher iron and lithium concentrations in native soils in the surrounding area, demonstrating that the PBAP was not the source of the lithium detected. However, the PBAP does not meet either the aquifer separation distance or the liner requirements of the CCR regulation and is therefore subject to the closure requirements in 40 CFR §257.101(a)(1) and (b)(1)(i), but eligible for an alternative closure deadline in accordance with 40 CFR §257.101(b)(4) and (f)(2). The most recent groundwater monitoring report with the alternate source demonstrations, structural stability assessment, and safety factor assessment for the PBAP are included in Appendices C, D, and E, respectively.

The treated wastewater in the drainage canal flows east and thence discharges into the facility's Clearwater Pond (a 4.5-acre, non-CCR impoundment). Water in the Clearwater Pond discharges through a weir box into a 36-inch-diameter pipe, and then into the Welsh Reservoir via Outfall #001 under Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0001811000. The Clearwater Pond is designed as a final polishing pond for the plant's wastestreams prior to discharging to the outfall.

These CCR surface impoundments are subject to closure in order to comply with EPA's recently revised CCR regulations. Therefore, the boilers associated with generating Units 1 and 3 will cease combusting coal and closure of the PBAP impoundment will be completed no later than October 17, 2028, while the BASP will cease receipt of CCR and non-CCR wastestreams no later than April 11, 2021 and initiate closure.

SATIFACTION OF THE CRITERIA IN 40 CFR §257.101(f)(2) FOR THE PBAP

NO ALTERNATIVE DISPOSAL CAPACITY

From the regulatory text

> 40 CFR §*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.*
>
> 40 CFR §*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 40 CFR §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 that Welsh Plant seeks to continue using the PBAP for 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 criterion. 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 40 CFR § 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 waste stream.

<u>CCR Wastestreams:</u>

The PBAP receives approximately 0.63 million gallons a day (MGD) of sluiced flows containing economizer and bottom ash.

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

Table 1. Welsh Plant CCR Wastestreams

CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Bottom Ash	630,000	Bottom ash is currently sluiced to the PBAP.	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 cease combusting coal in 2028.
Economizer Ash	Included with Bottom Ash flows	Sluiced to the existing PBAP 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 cease combusting coal in 2028.
Pyrites (non-CCR but handled with CCR wastestreams)	Included with Bottom Ash flows	Sluiced to the existing PBAP 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 cease combusting coal in 2028.

Welsh 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 Welsh Plant can cease sluicing CCR and placing non-CCR wastestreams into the PBAP. A new CCR compliant impoundment approximately 10 acres in size would be required to treat the CCR and non-CCR wastestreams, with the exception of the coal pile runoff flow, in order to meet the TPDES permit limits. A new non-CCR impoundment approximately 5 acres in size with chemical treatment would be required to treat the coal pile runoff flow. Since Welsh Plant has elected to pursue the option to permanently cease the use of the coal fired boilers by a date certain, developing alternative disposal capacity is "illogical" as stated by EPA, and also 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 75 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 (630,000 gallons) divided by the frac tank capacity (21,000 gallons) and doubling it to account for the 24 hours settling time requirement which resulted in 60 frac tanks. Because approximately 10 of these frac tanks would need to be rotated out of service each day for solids removal and disposal in the Welsh landfill, an allowance, or emergency margin, of 15 frac tanks was added to this value, which resulted in a total of 75 tanks being required. These tanks would require significant amounts of interconnecting piping which could create an unacceptable potential for significant leaks or spills.

For off-site disposal, 630,000gpd on average would require approximately 84 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 not feasible 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 Welsh Plant CCR material.

As a result, the conditions at Welsh 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) Welsh Plant must continue to use the PBAP due to the absence of alternative disposal capacity both on and off-site of the facility.

<u>Non-CCR Wastestreams:</u>

Approximately 12 MGD of various non-CCR wastestreams are sent to the PBAP. These wastewater streams include coal pile runoff, wash down of the electrostatic precipitator area, hydrovactor vacuum system discharges, boiler blowdown, water treatment waste (ultrafiltration, reverse osmosis, demineralizer), plant drains and sumps, contact and non-contact storm water runoff as well as contact storm water runoff from and through the ash landfill.

AEP evaluated each non-CCR wastestream placed in the PBAP at Welsh Plant. For the reasons discussed below and in Table 2, each of the following non-CCR wastestreams must continue to be placed in the PBAP due to lack of alternative capacity both on and off-site.

Table 2. Welsh Plant non-CCR Wastestreams

Non-CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Hydrovactor Flows	11,800,000	Pumped to the existing PBAP, using the existing bottom ash pumps and piping	No	The PBAP provides treatment for these non-CCR wastestreams (primarily solids settling) to allow them to meet the TPDES discharge limits and no on-site alternative capacity exists for treatment. Significant physical alterations would be required to treat the flows as noted in the discussion above. Off-site disposal of these flows is not practical as noted in the discussion below.
Coal Pile Runoff	260,000	Gravity flows to the existing PBAP	No	
Ecology Pit flows	668,000	Collects flow from multiple sources including plant drains, coolers and sumps pumped to the PBAP	No	
Washdowns of Electrostatic Precipitator Area	36,000	Flows to the existing PBAP through sump and exiting plumbing	No	
Water Treatment Waste	692,000	Wastewater from demineralizer regenerant, reverse osmosis and ultrafilter. Flows to the existing PBAP through sump and exiting plumbing	No	
Lab Drains & Boiler Blowdown	132,000	Flow to the existing PBAP	No	
Ash Landfill Stormwater Runoff	180,000	Flow is directed to the existing PBAP through a system of ditches	No	

Non-CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Non-contact stormwater runoff	Intermittent	Flow is directed to the existing PBAP through a system of ditches	No	

Welsh Plant does not have an existing alternate impoundment on-site that can be utilized for the non-CCR wastestreams as discussed above.

Relative to off-site disposal capacity for the non-CCR streams; the sheer volume which would need to be handled on a daily basis makes this impractical. 12 MGD on average would require approximately 1600 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. Collection of the flows would require the installation of significant infrastructure (sumps, piping, loading facilities) that currently does not exist at the plant for most of the non-CCR wastrestreams. Furthermore, the 12 MGD flow rate is an average flow rate. Several of the non-CCR wastestreams (coal pile runoff, landfill runoff, etc) are mostly a result of rain events which are not predictable and could result in daily flows that significantly exceeds the 12 MGD average flowrate. 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 non-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.

Consequently, there are no feasible offsite-disposal options for the non-CCR wastestreams at Welsh Plant. 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. For the reasons discussed above, each of the remaining non-CCR wastestreams must continue to be placed in the PBAP due to lack of alternative capacity both on and off-site. Consequently, in order to continue to operate and generate electricity, Welsh Plant must continue to use the PBAP to manage the non-CCR wastestreams discussed above.

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

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

Impact to Plant Operations if Alternative Capacity Not Obtained

If the Welsh Plant were required to immediately cease the placement of CCR and non-CCR wastestreams into the PBAP, which is necessary for handling more than 12.6 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 Welsh Plant. Idling or closure of the Welsh Plant would stop the production of CCR wastestreams and some non-CCR wastestreams, but would not eliminate the need for handling other non-CCR wastestreams, such as coal pile runoff and low volume wastewater from various water collection sumps from around the plant. The PBAP is integral in receiving and treating these flows as required to meet the TPDES discharge limits. Therefore, the need for uninterrupted non-CCR wastestream capacity in the PBAP will be necessary for a significant amount of time until alternate capacity from the new wastewater ponds is available. Put simply, the PBAP will be unable to immediately cease operation even if the Welsh Plant immediately discontinued the combustion of coal and production of CCR wastestreams.

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

From the regulatory text

40 CFR §*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).

Currently, the plant applies chemical additives to the PBAP to help settle bottom ash and economizer ash. There is a pH control system in place for the effluent from the Clearwater Pond into the Welsh Reservoir as necessary to meet the current NPDES permit limits.

The plant could take physical precautionary measure of minimizing the volume of CCR stored in the PBAP. This will include periodic removal of the CCR. 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 liner material.

Additionally, to prevent future groundwater contamination from entering the Welsh Reservoir, east of the PBAP, 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 PBAP.

Another potential physical measure that could be implement, if necessary, is the installation of a hydraulic barrier within the reservoir. These mitigation measures would promptly address any contaminate migrating toward the reservoir.

> *(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 CCR Units is accomplished using a PE-certified groundwater monitoring network composed of three upgradient wells shared by all CCR Units and three downgradient monitoring wells distinctive for each CCR Unit. The certified Groundwater Monitoring Well Evaluation Report is included in Appendix D.

Groundwater at the PBAP 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 lithium, but alternate source demonstrations have been completed showing higher upgradient lithium concentrations, and widespread correlation of higher iron and lithium concentrations in native soils in the surrounding area, demonstrating that the PBAP was not the source of the 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 at a minimum 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 PBAP 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 are presented in the Groundwater Monitoring and Corrective Action Reports in Appendix C.

Plume

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

Nearby receptors and mitigation

There are no private water wells located within a 0.5 mile radius from Welsh Plant, see Figure 6. Therefore the only reasonable receptor would be the Welsh Reservoir. The Welsh Reservoir was constructed primarily to provide the plant with a source of water for generating steam and for cooling, with most of these waters returned to the reservoir. There are no surface water intakes within the reservoir for any other water supply.

The PBAP is located directly west of the Welsh Reservoir. The PBAP normal operating water level is near the weir box which has a bottom elevation of 325 feet amsl. The surface water elevation of the Welsh Reservoir is maintained at approximately 320 feet amsl. The Welsh Reservoir is likely a gaining surface water feature and groundwater elevations at the impoundments are approximately 324 feet amsl, which are higher than the normal stage elevation of the Welsh Reservoir. To prevent future groundwater contamination from entering the Welsh Reservoir, east of the PBAP, 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 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, a hydraulic barrier (cutoff wall) could be implemented within 4 to 6 months after the identification of a release from the PBAP. 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.

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. A slurry wall, which is constructed with low permeable material such as bentonite, would be applicable to the Welsh 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 density of the subsurface materials are very consolidated, the depths may even be less.

Vertical cutoff walls (a type of hydraulic barrier) are used to control and/or isolate impacted groundwater. Low permeability cutoff walls can be used to prevent horizontal off-site migration of potentially impacted 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.

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 with pitless adapters 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.

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

From the regulatory text

40 CFR §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 Welsh 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 Welsh Plants CCR units are maintaining compliance with all requirements of Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments found at 40 CFR §257 Subpart D. 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 Welsh Plant CCR units is accomplished using PE-certified groundwater monitoring networks comprised of three upgradient wells shared by all CCR Units and three downgradient wells distinctive for each CCR Unit. The complete Groundwater Monitoring and Network Evaluation Reports are provided in Appendix D and include:

- A map showing the location of the monitoring wells relative to the CCR units
- Boring logs and well construction diagrams
- Maps that characterize the direction of groundwater flow accounting for seasonal variations

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 C).

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

The Groundwater Monitoring Well Network Evaluation Reports, included in Appendix D, provide a description of the site hydrogeology and stratigraphic cross-sections of the site.

Based on the soil borings completed at Welsh Plant, native soils consist primarily of stiff to hard lean clay (CL) and fat clay (CH) with intermittent layers of medium dense to very dense clayey sand (SC) and silty sand (SM). Atterberg Plasticity Indices of the tested soils ranged from 9 to 44. These features are further illustrated on five lines of cross section that were prepared through the CCR units at Welsh Plant, 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 and the lines of cross section are included as Figures 4 - 8 in the Groundwater Monitoring Well Network Evaluation Reports in Appendix D.

Welsh Plant is less than one-half mile from Swauano Creek, which was dammed near the southern end of the Welsh Plant during plant development to form the Welsh Reservoir. Groundwater flow direction at Welsh Plant is generally from west to east, following surface topography towards the Welsh Reservoir. The Welsh Reservoir is likely a gaining surface water feature, and groundwater elevations on site are higher than the normal stage elevation of the Welsh Reservoir (approximately 320 feet amsl). The PBAP's normal operating level is near the weir box which has a bottom elevation of 325 feet amsl. Figures 2 through 5 represent the seasonal potentiometric surfaces. As shown on these figures, the groundwater flow direction in the upper most aquifer is easterly toward the Welsh Reservoir.

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

The Welsh 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 Welsh Plant CCR units have not entered Assessment of Corrective Measures, therefore no progress reports on remedy selection and design and reports 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 assessment required at 40 CFR§ 257.73(d) for the PBAP and BASP can be found in Appendix E. 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 assessment required at 40 CFR § 257.73(e) for the PBAP and BASP can be found in Appendix F. 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

40 CFR §257.103(f)(2)(v)(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 combusting coal; and the sequence construction activities. Welsh Plant will conduct periodic removal of CCR material from the PBAP for placement into the landfill. AEP will plan to operate the PBAP at the lowest practical operating level to minimize the amount of free water stored.

The following are the planned activities that will be necessary to meet the closure date of October 17, 2028 for the PBAP (greater than 40 acres):

Engineering, Design and Permitting
The conceptual design of the PBAP pond closure and retrofit has been completed. A geotechnical investigation is being performed to verify current CCR material depths at certain locations and provide information to support the conceptual design and projected construction efforts. The detailed design of the closure for the PBAP will begin in early 2025 to support closure by October 2028. The closure engineering and design is to support submitting and obtaining revisions to the Welsh Plant TPDES discharge permit and construction environmental permits. The current plan is based on permit revision and construction permit submittal and review being 12 to 15 months, based on past site experience.

Contractor Selection
During permit review and approval, construction bid packages with detailed design will be issued for bid to support starting construction once permits have been received. 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 closure of the PBAP requires specific sequencing in order to complete the work while continuing to meet the TPDES discharge permit requirements throughout construction. The PBAP is located at the low point of a drainage area that is approximately 450 acres in size. The continuous flows from stormwater runoff create a difficult environment for removing CCR material from the pond. The means and methods of excavating or removing the CCR material from the pond will be decided by the construction contractor with approval by the engineer and AEP. Mechanical excavation and dredging of the material are viable options. The construction sequence and duration described herein assumes that the area will be dewatered and CCR material removed by excavation. It is feasible that during execution of the project the selected construction contractor may submit a plan that utilizes dredging that can support the same or better schedule which would be evaluated by AEP and the engineer.

In order to facilitate the work to be completed in the PBAP, AEP has chosen to separate the construction into two phases.

Phase 1 - Construction will start immediately after the award of the construction contract and after receipt of the necessary permits which is forecasted for and by February 2027. The first phase will consist of rerouting the non-CCR wastewater, stormwater drainage, and the sluiced CCR material around the primary working area of the pond in temporary diversion ditches or berm sections of the pond. Following completion of the diversion channel, a diversion berm to segregate the pond area will be constructed. The rerouting of flows and segregation berm will allow for the working area to be dewatered. Bottom ash and economizer ash sluice water along with most non-CCR flows will be routed in a ditch along the east and south perimeter of the pond. Stormwater from the west and coal pile runoff flows will be routed in a berm section and/or ditch on the west side of the pond. Solids will be managed in these ditches by the addition of chemicals and regular cleaning to allow for the discharge to meet the TPDES limits at the Clearwater Pond discharge. This phase will involve CCR removal in the western area of the PBAP (approx. 310,000 CY). CCR material will be disposed of in the on-site landfill. Phase 1 is expected to take approximately 6 months to complete. When the excavation of the PBAP has reached the pre-construction contours (verified by comparing the excavated contours to the original contours when the plant was constructed), the contractor will remove an additional one foot of material (approx. 44,000 CY) and confirm removal of CCR material. Additionally, an engineer will perform quality assurance/quality control (QAQC) services to independently verify that all CCR materials are removed.

Phase 2 - Construction will start immediately after the facility ceases combustion of coal which is planned for March 2028. The second phase of work will include removal of the remaining CCR material from the PBAP (approx. 200,000 CY) that was not removed in Phase 1. CCR removal is expected to take 4 months based on removal rates from similar projects. An additional one foot of material (approx. 20,000 CY) will be removed to confirm removal of CCR material and an engineer will perform quality assurance/quality control to verify all CCR materials are removed. Though the additional one foot of material will take 3 months to remove, the work will be performed concurrently with CCR material removal.

After completion of Phase 2, site regrading of the area will be performed to ensure proper drainage and temporary construction facilities, laydown areas, and erosion controls will be removed. Completion of Phase 2 will be the completion of closure and will be by October 17, 2028

Table below summarizes the major tasks and durations associated with closing the PBAP.

Initiate PBAP Closure	January 2025
Closure Planning and Engineering	6 months
Environmental and Construction Permits	15 months
Spec, bid, and Award construction contracts	6 months
Commence CCR Closure Phase 1 Construction no later than	February 2027
Dewatering and Wastewater/Stormwater Diversion	3 months
Pond Segregation Berm	2 months
Phase 1 CCR Removal	6 months
Phase 1 Impacted Soil Removal	4 months
Cease Coal Combustion; Start of Phase 2	March 2028
Phase 2 Dewatering	2 months
Phase 2 CCR material removal in remaining PBAP	4 months
Phase 2 Impacted soil removal	3 months
Site Regrading and Restoration	4 months
Complete closure by	October 17, 2028

The closure plan for the PBAP required by 40 CFR §257.102(b) can be found in Appendix B.

CONCLUSION

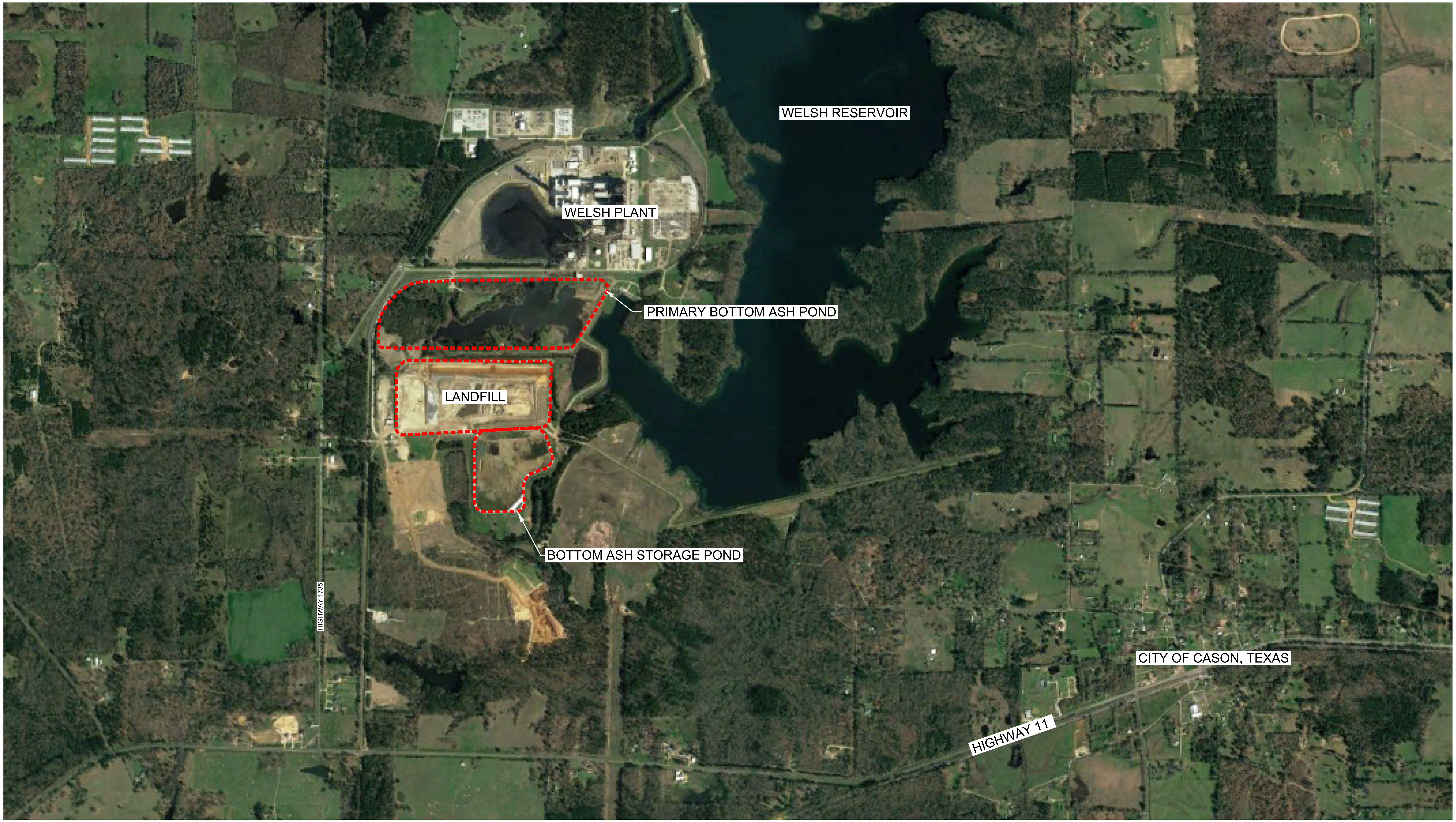
Based upon the information submitted in this demonstration for the PBAP, it has been shown that the Welsh Plant is unable to obtain alternative disposal capacity for the generated CCR and non-CCR wastestreams before April 11, 2021 for the PBAP and qualifies for the site specific alternate time frame 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

Millimeters

Scale For Microfilming

Inches



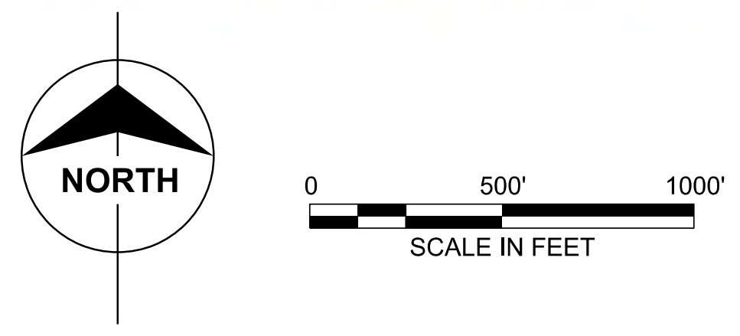


Figure 1

PRELIMINARY - NOT FOR CONSTRUCTION

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

C:\Users\rowens\Desktop\AEP\WELSH\120798SK-C502.dgn

- - - - 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

WELSH POWER PLANT
TITUS COUNTY, TEXAS

CCR UNIT LOCATION MAP

project 120798
contract
drawing SK - C502 — rev. A
sheet of sheets
file 120798SK-C502.DGN

6/29/2020

Legend

⊕ Groundwater Monitoring Well

→ Approximate Groundwater Flow Direction

— Groundwater Elevation Contour

▭ CCR Units

Notes

- Monitoring well coordinates and water level data (collected on February 20-21, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

500 250 0 500
Feet

Groundwater Potentiometric Map
February 2019

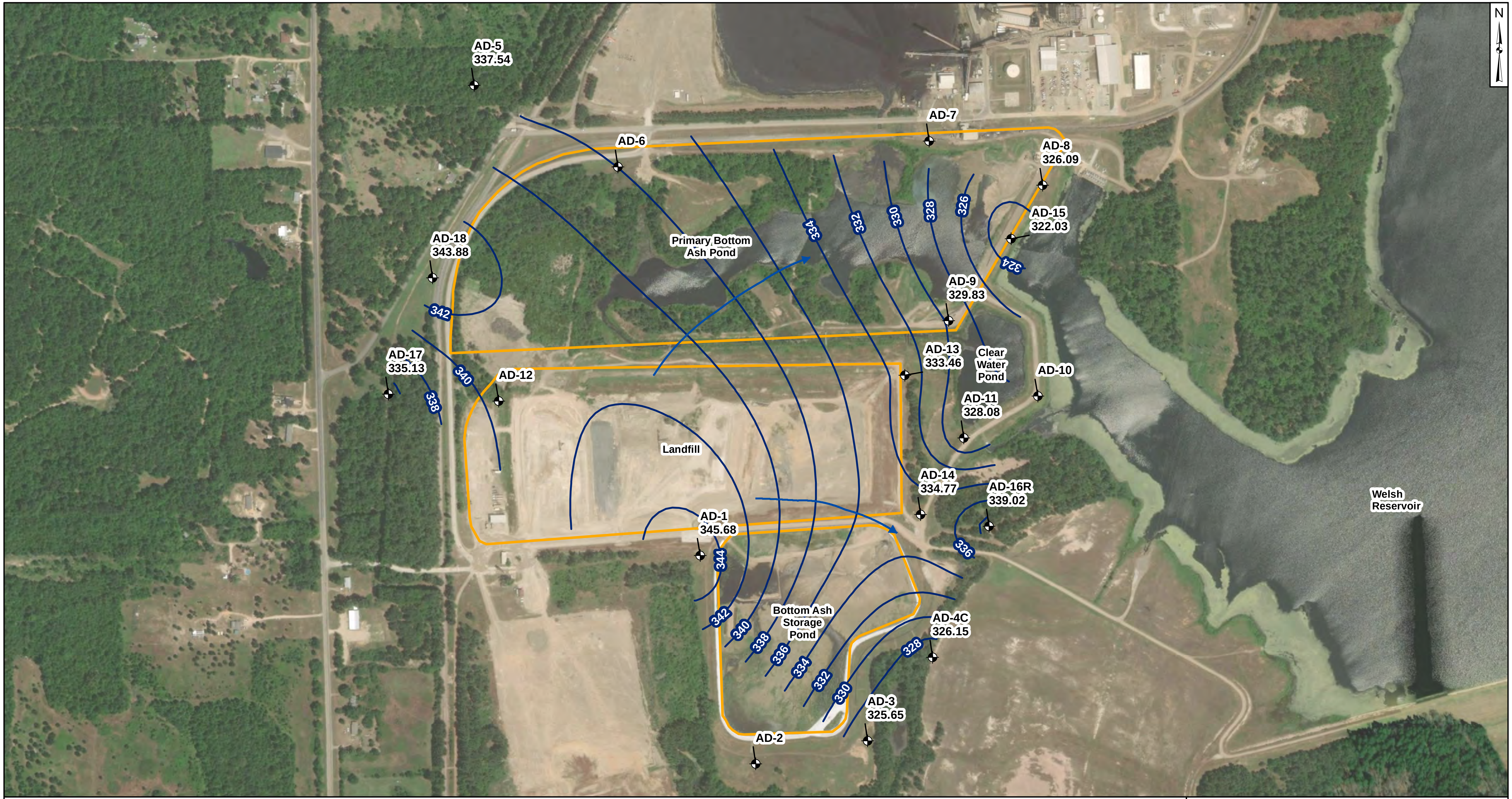
AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Columbus, Ohio | 2020/01/22

Figure
2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2019\AEP-Welsh_GW_2019-20Feb.mxd. ARevezzo. 1/22/2020. CHA8423/14/08.



Legend

- ⊕ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- ▭ CCR Units

Notes

- Monitoring well coordinates and water level data (collected on May 29-30, 2019) provided by AEP.
- AD-10, AD-6, AD-7, AD-2, and AD-12 were not gauged during this event
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

750 375 0 750
Feet

Groundwater Potentiometric Map
May 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Columbus, Ohio 2019/12/12

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2019\AEP-Welsh_GW_2019-05May.mxd. ARevezzo. 12/12/2019. CHA8423/14/08.

Legend
- ⊕ Monitoring Well
- — Groundwater Elevation Contour
- → Groundwater Flow Direction

Notes
- Well coordinates and water level data provided by AEP.

750 375 0 750
Feet

Groundwater Elevation Contour Map
July 2016

AEP Welsh Power Plant
Cason, Texas

Geosyntec consultants

Ann Arbor, Michigan | 2016/11/10

Figure
4

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh_July2016.mxd. CGregory. 11/10/2016. CHA8423/14/08.

Legend

⌖ Monitoring Well

― Groundwater Elevation Contour

➜ Groundwater Flow Direction; 0

Notes

- Well coordinates and water level data provided by AEP and collected on October 19, 2016.

750 375 0 750
Feet

Groundwater Elevation Contour Map
October 2016

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Ann Arbor, Michigan | 2016/12/06

Figure
5

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\Welsh_Oct2016.mxd. MMuenich. 12/6/2016. CHA8423/14/08.

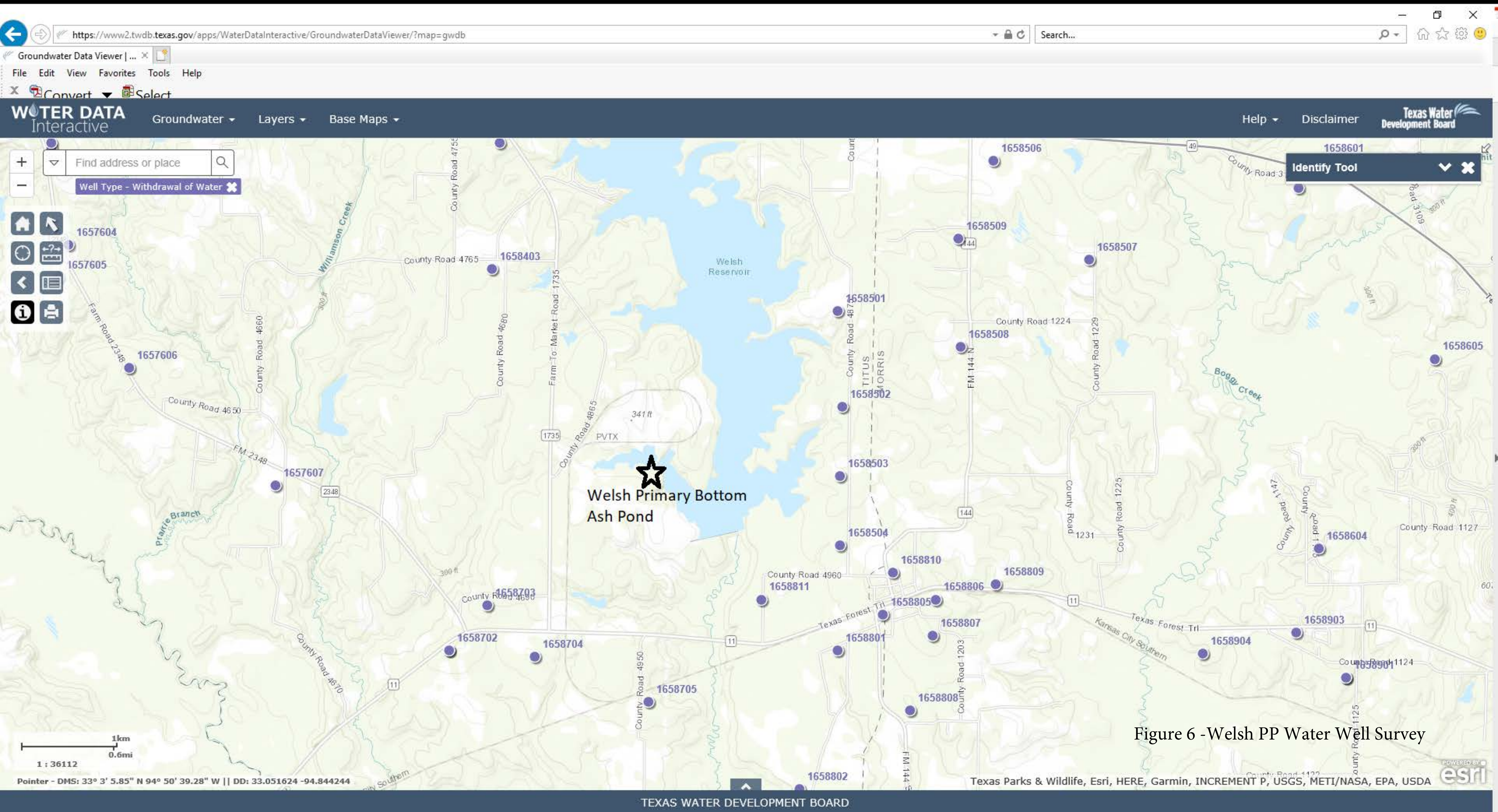
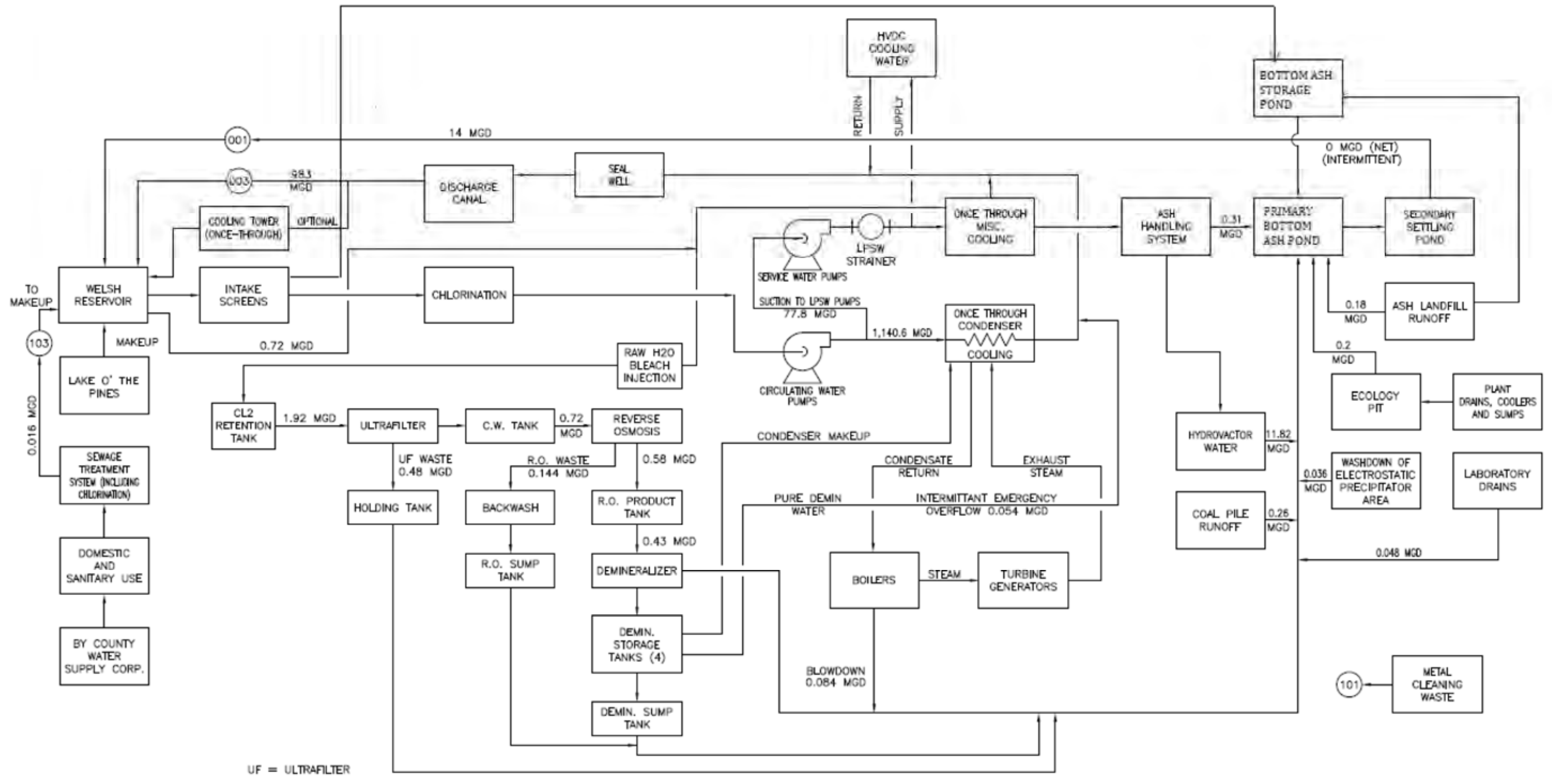


Figure 6 -Welsh PP Water Well Survey

Appendix A

Existing Water Balance



DATE	NO.	DESCRIPTION	APPD.
	11	ISSUED FOR PERMIT RENEWAL PROCESS,	EM BW
		PRELIMINARY - REFERENCE ONLY TDA	

REVISIONS

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SOUTHWESTERN ELECTRIC POWER COMPANY

WELSH PLANT

CASON TEXAS

ENVIRONMENTAL

WATER FLOW DIAGRAM

UNIT: 123
DRAWING NUMBER: WSH7
REV: 11

CIVIL ENGINEERING

SCALE: -
DR: -
CH: -
SUP: -
ENG: -
DATE: SEE REV 0
APPROVED BY

AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

Appendix B
Closure Plan required by 40 CFR §257.102(b)

CLOSURE PLAN

CFR 257.102(b)

Primary Bottom Ash Pond

Welsh Power Plant
Pittsburg, Texas

October 2016
Revised November 2020

Prepared for: Southwest Electric Power Company - Welsh Plant

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS – 20 –011

Closure Plan
CFR 257.102(b)
Welsh Power Plant
Primary Bottom Ash Pond

PREPARED BY Gary F. Zych DATE 11/22/2020
Gary F. Zych, P.E.

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

APPROVED BY Gary F. Zych DATE 11/24/2020
Gary F. Zych, P.E.
Section Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
11/24/2020

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 CFR 257.102(b) for Closure Plans of Existing CCR Surface Impoundments

2.0 DESCRIPTION OF THE CCR UNIT

The AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the Primary Bottom Ash pond and the Bottom Ash Storage pond. This report addresses the closure plan for the Primary Bottom Ash Pond. The Primary Bottom Ash pond CCR unit is located southwest of the Plant and directly west of the Welsh Reservoir.

The Primary Bottom Ash pond is bounded by natural ground surface (topographically higher areas) to the north and west, and embankment dikes to the south and east. The elevation at the top of embankment along the crest area is approximately 340.0 feet above msl.

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 Welsh Power Plant Primary Bottom Ash Pond will be completed by CCR removal.

The closure of the Primary Bottom Ash Pond will include removal of CCR materials within the pond by dredging and/or mechanical means.

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 will include removal of all CCR from the CCR unit. The removal of all CCR unit will be accomplished by dredging and/or mechanical means as decided by the construction contractor with approval by the engineer and AEP. Prior to actual removal, the initial work will include rerouting of non-CCR flows and stormwater runoff that discharge into the pond. The CCR material will be either hauled and placed at the onsite CCR landfill or hauled offsite for beneficial reuse.

A 3rd party QAQC consultant will verify the removal of the CCR material. After verification of CCR removal, 12 inches of bottom soil will be removed as part of the closure of the CCR surface impoundment.

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 soils 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 530,000 cubic yards for the Primary 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.

Table below summarizes the major tasks and durations associated with closing the PBAP.

Initiate PBAP Closure	January 2025
Closure Planning and Engineering	6 months
Environmental and Construction Permits	15 months
Spec, bid, and Award construction contracts	6 months
Commence CCR Closure Phase 1 Construction no later than	February 2027
Dewatering and Wastewater/Stormwater Diversion	3 months
Pond Segregation Berm	2 months
Phase 1 CCR Removal	6 months
Phase 1 Impacted Soil Removal	4 months
Cease Coal Combustion; Start of Phase 2	March 2028
Phase 2 Dewatering	2 months
Phase 2 CCR material removal in remaining PBAP	4 months
Phase 2 Impacted soil removal	3 months
Site Regrading and Restoration	4 months
Complete closure by	October 17, 2028

Appendix C

Groundwater Monitoring and Corrective Action Reports

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
J. Robert Welsh Power Plant

Primary Bottom Ash Pond CCR Management Unit

1187 Country Road 4865
Titus County
Pittsburg, 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), Welsh 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 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Semi-annual groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- SSL for lithium was determined in AD-9 during the 2nd semi-annual 2018 groundwater monitoring event as well as during the 1st and 2nd semi-annual 2019 groundwater monitoring events;
- SSIs were also determined;
- Successful alternate source demonstrations (ASDs) were conducted for the lithium SSLs in AD-9;
- With regard to the SSL determined in AD-9 during the 2nd semi-annual groundwater monitoring event of 2019, either an ASD will be conducted to evaluate if the unit can remain in assessment monitoring or the unit will move to an assessment of corrective measures;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared in accordance with 40 CFR 257.93 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).
- This CCR Unit remains in assessment monitoring throughout 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;

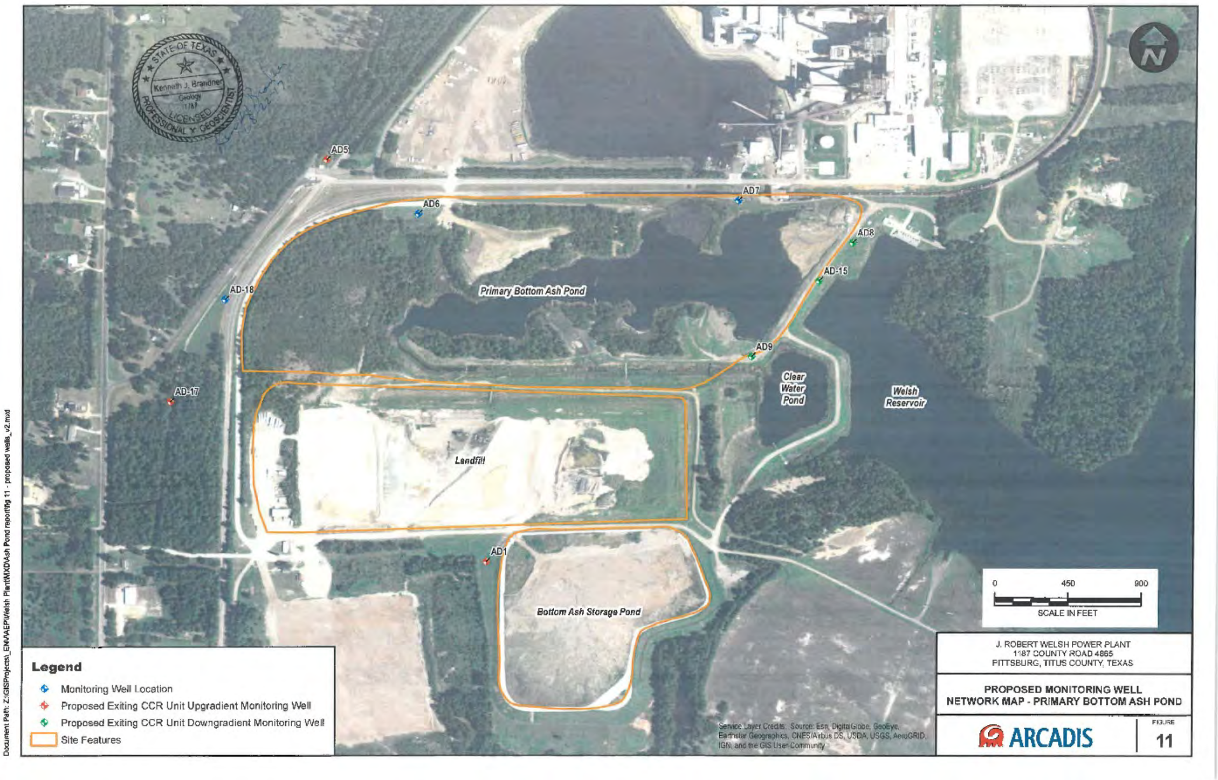
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected 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;
- Statistical reports are located in Appendix II;
- Alternate source demonstrations are located in Appendix III;
- 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 at a statistically significant increase or statistically significant level over background concentrations (Appendix IV);
- Other information required to be included in the annual report such as 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.

Primary Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-1	AD-8
AD-5	AD-9
AD-17	AD-15



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Ash Pond report\fig 11 - proposed wells_v2.mxd

Kenneth J. Brandner
Geology
11101

III. Monitoring Wells Installed or Decommissioned

During 2019, no monitoring wells were installed or decommissioned.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected under 40 CFR 257.90 through 257.98. 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.

The sampling event conducted 5/30/19 satisfies the requirement of 257.95(b).

V. Statistical Evaluations completed in 2018 and 2019

During the 2nd semi-annual 2018 event the following SSIs were determined:

- Boron concentration exceeded the interwell UPL of 0.765 mg/L at AD-8 (1.3 mg/L)
- pH value was below the interwell LPL of 4.84 SU at AD-15 (4.59 SU).

During the 1st semi-annual 2019 event, the following SSIs were determined:

- Boron concentrations exceeded the interwell UPL of 0.775 mg/L at AD-8 (1.27 mg/L and 1.21 mg/L).

During the 2nd semi-annual 2019 event, the following SSIs were determined:

- Boron concentrations exceeded the interwell UPL of 0.700 mg/L at AD-8 (1.21 mg/L).
- pH measurements were recorded below the interwell LPL of 4.8 SU at AD-15 (3.2 SU).

A SSL was determined for lithium in AD-9 during the 2nd semi-annual 2018 event, 1st and 2nd semi-annual 2019 events.

The statistical reports completed in 2019 are found in Appendix II.

VI. Alternate Source Demonstrations completed in 2019

ASDs were successfully conducted for the lithium SSLs which were determined during the 2nd semi-annual 2018 event and the 1st semi-annual 2019 event.

With regard to the lithium SSL in AD-9 determined during the 2nd semi-annual 2019 groundwater monitoring event, either an ASD will be conducted to evaluate if the unit can remain in assessment monitoring or the unit will move to an assessment of corrective measures.

The successful lithium ASDs are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

This unit remained in assessment monitoring throughout 2019.

VIII. Other Information Required

As required by the CCR assessment monitoring rules in 40 CFR 257.95 (b) and (d 1), sampling all CCR wells for the required Appendix III and IV parameters was completed in 2019.

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 will continue;
- Either an ASD will be conducted to evaluate if the unit can remain in assessment monitoring or the unit will move to an assessment of corrective measures.
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for SSIs as well as 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 Well

→ Approximate Groundwater Flow Direction

— Groundwater Elevation Contour

▭ CCR Units

Notes

- Monitoring well coordinates and water level data (collected on February 20-21, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

Groundwater Potentiometric Map
February 2019

AEP Welsh Power Plant
Cason, Texas

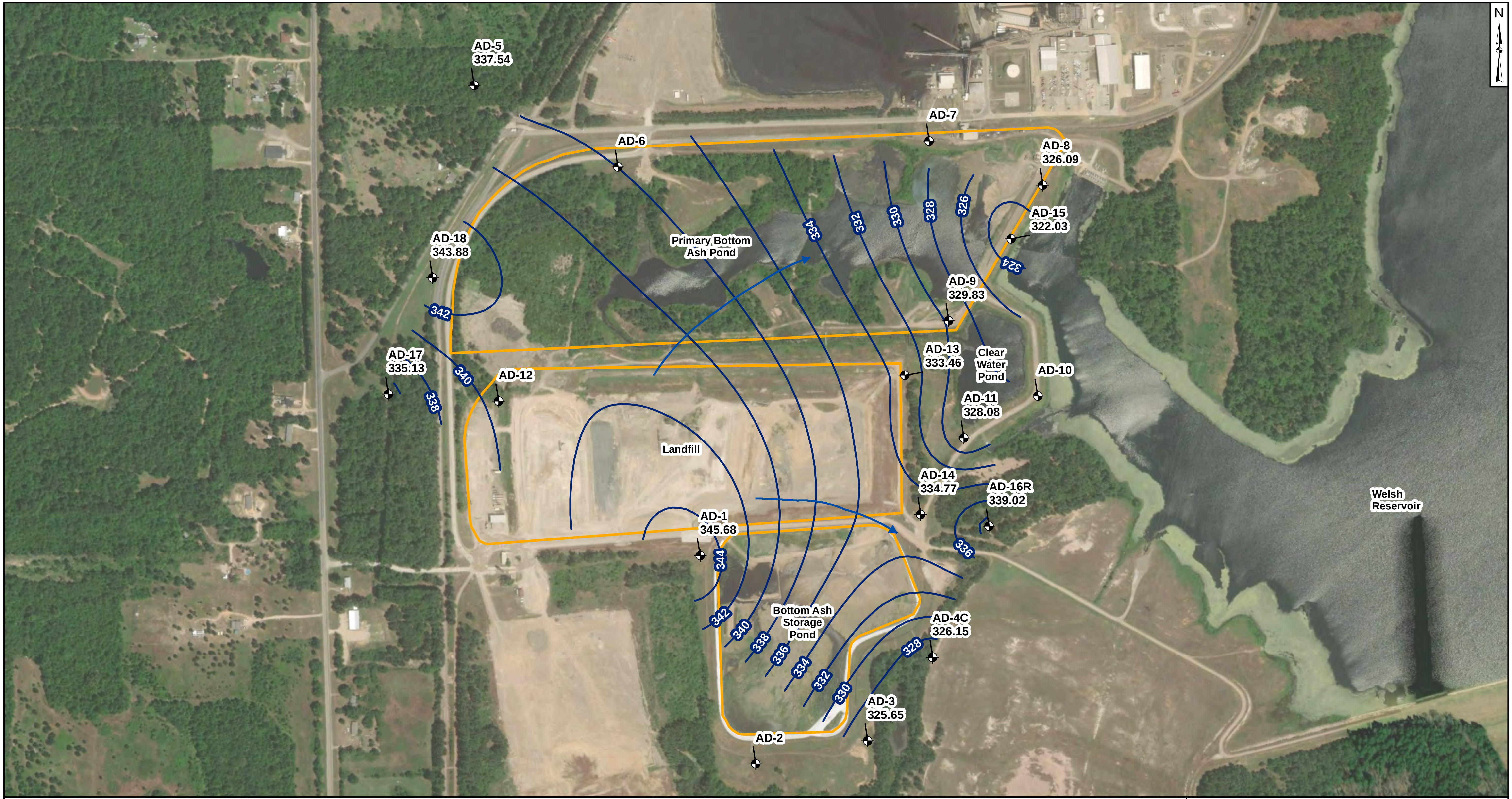
Geosyntec
consultants

Columbus, Ohio

2020/01/22

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2019\AEP-Welsh_GW_2019-20Feb.mxd. ARevezzo. 1/22/2020. CHA8423/14/08.



Legend
- ⊕ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- ☐ CCR Units

Notes
- Monitoring well coordinates and water level data (collected on May 29-30, 2019) provided by AEP.
- AD-10, AD-6, AD-7, AD-2, and AD-12 were not gauged during this event
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

750 375 0 750 Feet

Groundwater Potentiometric Map
May 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Columbus, Ohio
2019/12/12

Figure
2

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Legend

- ⯐ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)
- ▭ CCR Units

Notes

- Monitoring well coordinates and water level data (collected on July 23-24, 2019) provided by AEP.
-AD-12 and AD-6 were not gauged during this event.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- Inferred groundwater contours were ectrapolated from topographic and hydrographic information as well as previous monitoring events.

750 375 0 750
Feet

Groundwater Potentiometric Map
July 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio | 2020/01/22

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Table 1: Residence Time Calculation Summary
Welsh Primary Bottom Ash Pond

			2019-02		**2019-05**		**2019-07**	
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)
Primary Bottom Ash Pond	AD-1 [1]	2.0	2.7	22.4	5.3	11.5	4.1	14.9
	AD-5 [1]	2.0	1.5	40.2	2.4	25.4	2.1	29.2
	AD-8 [2]	2.0	4.1	14.7	4.1	14.8	5.3	11.5
	AD-9 [2]	2.0	4.8	12.8	4.5	13.6	5.1	12.0
	AD-15 [2]	2.0	6.4	9.5	5.5	11.1	7.0	8.7
	AD-17 [1]	2.0	8.9	6.9	4.7	13.0	3.5	17.5

Notes:
[1] - Upgradient Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-1
Welsh - PBAP
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
5/26/2016	Background	0.346	36.5	5	<0.083 U	5.9	252	42
7/29/2016	Background	0.35	39.6	4	<0.083 U	5.3	239	36
9/30/2016	Background	0.332	15	5	<0.083 U	5.4	173	35
10/21/2016	Background	0.398	19.1	4	<0.083 U	5.2	192	42
12/14/2016	Background	0.394	8.74	4	<0.083 U	5.2	200	40
1/20/2017	Background	0.656	129	4	<0.083 U	7.1	538	68
2/24/2017	Background	0.7	147	9	<0.083 U	6.9	612	68
6/8/2017	Background	0.449	15.1	4	<0.083 U	5.1	176	42
10/6/2017	Detection	0.453	14.3	4	<0.083 U	5.3	160	40
5/24/2018	Assessment	0.345	10.2	4	<0.083 U	2.2	150	43
8/14/2018	Assessment	0.443	5.95	5	<0.083 U	5.2	160	44
2/20/2019	Assessment	0.504	142	2.82	0.24	7.3	522	49.2
5/30/2019	Assessment	0.689	138	1.59	0.29	6.7	588	43.3
7/24/2019	Assessment	0.644	62.7	2	0.106 J	6.0	180	58

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-1
Welsh - PBAP
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
5/26/2016	Background	<0.93 U	1.39361 J	191	0.271453 J	0.213294 J	0.240267 J	1.15339 J	1.184	<0.083 U	<0.68 U	0.01	0.033	0.53149 J	1.74922 J	0.959865 J
7/29/2016	Background	<0.93 U	<1.05 U	191	0.315631 J	0.0940357 J	<0.23 U	0.615933 J	0.9952	<0.083 U	<0.68 U	0.019	0.00793 J	<0.29 U	1.81763 J	<0.86 U
9/30/2016	Background	<0.93 U	2.96797 J	141	0.382874 J	<0.07 U	5	0.850408 J	1.38	<0.083 U	3.38434 J	0.014	0.01773 J	<0.29 U	1.02629 J	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	114	0.311247 J	<0.07 U	0.412131 J	0.649606 J	1.141	<0.083 U	<0.68 U	0.008	0.00534 J	1.39872 J	2.03168 J	1.25062 J
12/14/2016	Background	<0.93 U	<1.05 U	72	0.34133 J	<0.07 U	<0.23 U	0.424105 J	0.719	<0.083 U	<0.68 U	0.008	0.01521 J	<0.29 U	1.85825 J	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	410	0.0366913 J	<0.07 U	<0.23 U	0.480125 J	3.009	<0.083 U	<0.68 U	0.000275956 J	<0.005 U	<0.29 U	4.04737 J	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	488	<0.02 U	<0.07 U	<0.23 U	0.765099 J	4.309	<0.083 U	<0.68 U	0.001	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	1.14 J	93.46	0.37 J	<0.07 U	0.66 J	0.77 J	0.676	<0.083 U	<0.68 U	0.00902	0.007 J	<0.29 U	2.1 J	<0.86 U
5/24/2018	Assessment	3.17 J	<1.05 U	79.9	0.39 J	<0.07 U	<0.23 U	0.35 J	1.983	<0.083 U	<0.68 U	0.00814	0.006 J	<0.29 U	1.38 J	<0.86 U
8/14/2018	Assessment	0.03 J	0.21	63	0.482	0.02	- -	- -	1.102	<0.083 U	0.238	0.00708	0.013 J	0.210	1.7	0.03 J
2/20/2019	Assessment	0.16	0.46	457	0.09 J	0.01 J	0.306	0.399	3.159	0.24	0.124	0.00155	<0.005 U	1 J	0.7	<0.1 U
5/30/2019	Assessment	0.16	0.60	512	0.244	0.01 J	0.1 J	0.756	2.717	0.29	0.197	<0.009 U	<0.005 U	2.43	1.4	<0.1 U
7/24/2019	Assessment	0.08 J	0.39	245	0.54	0.02 J	0.1 J	0.789	1.819	0.106 J	0.1 J	0.00557	<0.005 U	2 J	3.4	<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-5
Welsh - PBAP
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
5/31/2016	Background	0.03	36.9	15	0.3469 J	6.4	337	123
7/29/2016	Background	0.04	44.7	16	<0.083 U	5.4	360	163
9/30/2016	Background	0.04	46.3	15	0.2436 J	5.3	416	190
10/21/2016	Background	0.05	50.7	14	<0.083 U	5.9	448	267
12/14/2016	Background	0.05	49.6	13	<0.083 U	6.2	484	233
1/20/2017	Background	0.04	49.8	14	<0.083 U	6.3	438	234
2/24/2017	Background	0.04	33	15	<0.083 U	5.5	286	127
6/8/2017	Background	0.05281	49.7	14	<0.083 U	6.0	300	82
10/6/2017	Detection	0.04322	33.1	16	<0.083 U	5.6	258	82
5/24/2018	Assessment	0.05007	28.1	22	<0.083 U	6.2	242	60
8/15/2018	Assessment	0.05	40.5	19	<0.083 U	6.2	428	240
2/21/2019	Assessment	0.033	33.9	24.7	0.21	5.4	220	46.5
5/30/2019	Assessment	0.03 J	30.0	22.3	0.29	6.3	238	51.3
7/24/2019	Assessment	0.04 J	41.1	18	0.112 J	6.3	354	90

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-5
Welsh - PBAP
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
5/31/2016	Background	<0.93 U	<1.05 U	57	0.149801 J	0.0765156 J	0.555038 J	14	1.634	0.3469 J	<0.68 U	0.135	0.01135 J	<0.29 U	<0.99 U	<0.86 U
7/29/2016	Background	2.05116 J	2.90819 J	93	0.518653 J	0.502155 J	0.411466 J	15	4.75	<0.083 U	<0.68 U	0.191	0.01516 J	<0.29 U	1.08901 J	<0.86 U
9/30/2016	Background	<0.93 U	4.7609 J	87	0.251584 J	<0.07 U	0.90676 J	14	3.33	0.2436 J	<0.68 U	0.186	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	70	0.08781 J	0.107488 J	0.248085 J	9	2.319	<0.083 U	<0.68 U	0.225	<0.005 U	1.36984 J	<0.99 U	<0.86 U
12/14/2016	Background	<0.93 U	1.15381 J	53	0.164529 J	0.203546 J	0.747921 J	13	2.182	<0.083 U	<0.68 U	0.199	0.00802 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	47	0.0574718 J	0.180502 J	<0.23 U	12	1.023	<0.083 U	<0.68 U	0.239	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	42	0.0306858 J	<0.07 U	<0.23 U	13	1.788	<0.083 U	<0.68 U	0.166	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	3.85 J	87.7	0.08 J	0.39 J	0.28 J	11.93	2.32	<0.083 U	<0.68 U	0.124	<0.005 U	<0.29 U	<0.99 U	<0.86 U
5/24/2018	Assessment	<0.93 U	<1.05 U	71.16	<0.02 U	0.23 J	0.8 J	14.24	1.946	<0.083 U	<0.68 U	0.121	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/15/2018	Assessment	0.01 J	1.69	63.7	0.055	0.008 J	0.072	11.4	0.316	<0.083 U	0.079	0.147	<0.005 U	0.13	0.08 J	<0.01 U
2/21/2019	Assessment	0.02 J	1.59	69.4	0.08 J	<0.01 U	0.432	8.58	1.267	0.21	0.147	0.0807	<0.005 U	<0.4 U	0.1 J	<0.1 U
5/30/2019	Assessment	<0.02 U	3.05	60.5	0.08 J	<0.01 U	0.06 J	11.8	1.431	0.29	0.05 J	0.104	0.006 J	<0.4 U	0.05 J	<0.1 U
7/24/2019	Assessment	<0.02 U	2.48	77.4	0.05 J	<0.01 U	0.05 J	8.38	2.533	0.112 J	<0.05 U	0.108	<0.005 U	<0.4 U	0.06 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-8
Welsh - PBAP
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
5/31/2016	Background	1.46	32.6	36	0.6507 J	6.9	524	217
7/29/2016	Background	1.44	25.9	26	0.485 J	5.4	469	202
9/30/2016	Background	1.51	24.3	28	0.4912 J	7.7	432	186
10/21/2016	Background	1.54	25.9	30	0.6234 J	6.1	424	184
12/14/2016	Background	1.53	23.6	27	0.5355 J	5.6	442	168
1/20/2017	Background	1.53	18.7	24	0.5574 J	6.2	352	153
2/24/2017	Background	1.67	19.3	22	<0.083 U	6.8	356	163
6/8/2017	Background	1.39	17.4	22	0.6628 J	5.6	368	151
10/6/2017	Detection	1.49	14.9	20	<0.083 U	6.7	284	128
1/4/2018	Detection	1.47	- -	- -	- -	- -	- -	- -
5/23/2018	Assessment	- -	- -	- -	0.501 J	6.2	- -	- -
8/15/2018	Assessment	- -	- -	- -	- -	6.8	- -	- -
9/17/2018	Assessment	1.3	15	24	- -	- -	288	122
2/5/2019	Assessment	2.55	19.7	22.8	0.72	5.4	- -	153
2/21/2019	Assessment	1.47	17.6	23.2	0.66	6.4	352	163
4/30/2019	Assessment	1.21	- -	- -	- -	6.9	- -	- -
5/29/2019	Assessment	1.07	16.9	19.5	0.89	5.5	324	150
7/23/2019	Assessment	1.21	20.8	15	0.559 J	6.6	392	145

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
Welsh - PBAP
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
5/31/2016	Background	<0.93 U	1.06251 J	34	0.114491 J	<0.07 U	2	7	1.046	0.6507 J	<0.68 U	0.122	0.02103 J	1.01326 J	1.37017 J	1.18455 J
7/29/2016	Background	1.46141 J	<1.05 U	26	0.171642 J	<0.07 U	0.751164 J	9	1.584	0.485 J	<0.68 U	0.098	0.00859 J	1.48301 J	1.96333 J	<0.86 U
9/30/2016	Background	<0.93 U	<1.05 U	23	<0.02 U	<0.07 U	0.51348 J	7	6.3	0.4912 J	<0.68 U	0.111	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	24	0.028758 J	<0.07 U	0.617826 J	7	0.3449	0.6234 J	<0.68 U	0.135	<0.005 U	0.838863 J	<0.99 U	1.64377 J
12/14/2016	Background	<0.93 U	<1.05 U	21	<0.02 U	<0.07 U	<0.23 U	7	1.083	0.5355 J	<0.68 U	0.11	0.01007 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	20	<0.02 U	<0.07 U	<0.23 U	6	0.823	0.5574 J	<0.68 U	0.094	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	19	<0.02 U	<0.07 U	<0.23 U	6	0.536	<0.083 U	<0.68 U	0.092	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	<1.05 U	19.08	<0.02 U	<0.07 U	<0.23 U	3.86 J	1.0735	0.6628 J	<0.68 U	0.09491	0.008 J	<0.29 U	<0.99 U	<0.86 U
5/23/2018	Assessment	3.19 J	<1.05 U	22.12	<0.02 U	<0.07 U	<0.23 U	3.19 J	0.3366	0.501 J	<0.68 U	0.0956	<0.005 U	<0.29 U	1.75 J	<0.86 U
8/15/2018	Assessment	0.01 J	0.31	21.2	0.008 J	0.02 J	0.05	5.36	3.44	- -	0.039	0.0555	0.007	0.16	0.07 J	0.129
2/21/2019	Assessment	<0.02 U	0.57	28.1	0.03 J	0.03 J	0.456	2.88	0.417	0.66	0.223	0.0911	<0.005 U	<0.4 U	0.1 J	<0.1 U
5/29/2019	Assessment	<0.02 U	0.37	30.3	<0.02 U	0.02 J	0.1 J	6.03	0.911	0.89	0.07 J	0.067	<0.005 U	<0.4 U	0.06 J	0.1 J
7/23/2019	Assessment	<0.02 U	0.41	31.0	<0.02 U	0.02 J	0.09 J	7.07	0.72	0.559 J	0.08 J	0.0641	<0.005 U	<0.4 U	0.08 J	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-9
Welsh - PBAP
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
5/31/2016	Background	0.120	229	88	0.4191 J	6.3	2541	1352
7/29/2016	Background	0.105	255	98	0.4339 J	5.0	2564	1464
9/30/2016	Background	0.115	220	86	0.304 J	4.7	2448	1301
10/21/2016	Background	0.109	228	76	0.6227 J	5.2	2494	1350
12/14/2016	Background	0.108	250	92	<0.083 U	5.7	2667	1639
1/20/2017	Background	0.312	91.1	54	<0.083 U	5.4	1360	884
2/24/2017	Background	0.1	258	86	<0.083 U	5.8	2662	1774
6/8/2017	Background	0.146	191	19	<0.083 U	4.6	308	105
10/6/2017	Detection	0.129	9.64	20	<0.083 U	5.8	248	86
5/23/2018	Assessment	- -	- -	- -	<0.083 U	5.3	- -	- -
8/15/2018	Assessment	- -	- -	- -	- -	5.0	- -	- -
9/17/2018	Assessment	0.198	230	103	- -	- -	2694	1910
2/5/2019	Assessment	0.096	133	27.9	0.16	4.2	- -	181
2/21/2019	Assessment	1.39	211	89	0.19	5.0	2240	1350
4/30/2019	Assessment	0.07	- -	- -	- -	4.5	- -	- -
5/29/2019	Assessment	0.06 J	10.1	44.0	0.16	3.6	1758	503
7/23/2019	Assessment	0.081	222	77	0.5736 J	6.3	2460	1701

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-9
Welsh - PBAP
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
5/31/2016	Background	<0.93 U	<1.05 U	51	0.999439 J	1	<0.23 U	27	2.945	0.4191 J	<0.68 U	1.32	0.0194 J	<0.29 U	1.04175 J	<0.86 U
7/29/2016	Background	<0.93 U	<1.05 U	31	0.726564 J	2	0.262163 J	22	1.447	0.4339 J	<0.68 U	1.38	0.045	<0.29 U	8.00	<0.86 U
9/30/2016	Background	<0.93 U	<1.05 U	33	0.582852 J	0.187457 J	<0.23 U	12	3.199	0.304 J	<0.68 U	1.17	0.00739 J	<0.29 U	3.52832 J	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	26	0.478576 J	0.965032 J	<0.23 U	16	1.311	0.6227 J	<0.68 U	1.44	<0.005 U	<0.29 U	3.09028 J	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	27	0.481339 J	2	<0.23 U	24	3	<0.083 U	<0.68 U	1.33	0.02123 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	98	2	0.693618 J	<0.23 U	42	2.349	<0.083 U	<0.68 U	0.634	0.00717 J	<0.29 U	<0.99 U	1.7755 J
2/24/2017	Background	<0.93 U	<1.05 U	22	0.301057 J	0.680144 J	<0.23 U	24	2.32	<0.083 U	<0.68 U	1.41	<0.005 U	<0.29 U	1.06022 J	1.45295 J
6/8/2017	Background	<0.93 U	<1.05 U	42.27	0.77 J	2.22	<0.23 U	24.16	1.586	<0.083 U	<0.68 U	1	0.006 J	<0.29 U	<0.99 U	<0.86 U
5/23/2018	Assessment	<0.93 U	<1.05 U	30.45	0.32 J	2.88	<0.23 U	26.7	2.556	<0.083 U	<0.68 U	1.2	<0.005 U	<0.29 U	<0.99 U	8.46
8/15/2018	Assessment	<10 U	1.68	24.2	0.268	0.06	0.42	11.1	1.864	- -	0.262	0.851	0.013	0.11	0.3	0.062
2/21/2019	Assessment	<0.02 U	1.18	52.4	0.474	0.09	0.313	14.8	2.51	0.19	0.08 J	1.12	0.01 J	<0.4 U	0.3	0.1 J
5/29/2019	Assessment	<0.02 U	0.20	49.7	0.941	0.21	0.346	15.9	1.360	0.16	0.07 J	0.225	<0.005 U	<0.4 U	0.2	0.2 J
7/23/2019	Assessment	<0.02 U	1.39	32.1	0.361	0.06	0.2 J	12.7	1.689	0.5736 J	0.2 J	1.11	<0.005 U	<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-15
Welsh - PBAP
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
5/31/2016	Background	0.329	5.09	30	<0.083 U	5.6	188	24
7/29/2016	Background	0.407	3.83	34	<0.083 U	4.8	196	28
9/30/2016	Background	0.360	13.7	28	0.2621 J	4.6	367	23
10/21/2016	Background	0.152	4.57	26	<0.083 U	4.4	152	17
12/14/2016	Background	0.334	3.6	26	<0.083 U	4.7	204	19
1/20/2017	Background	0.413	3.35	32	<0.083 U	5.8	176	25
2/24/2017	Background	0.1	4.21	20	<0.083 U	4.6	88	8
6/8/2017	Background	0.321	3.57	27	<0.083 U	4.8	184	19
10/6/2017	Detection	0.395	3.08	30	<0.083 U	5.9	200	21
5/23/2018	Assessment	- -	- -	- -	<0.083 U	4.8	- -	- -
8/15/2018	Assessment	- -	- -	- -	- -	4.6	- -	- -
9/17/2018	Assessment	0.341	3.04	37	- -	- -	174	24
2/5/2019	Assessment	0.03 J	2.18	20.6	0.06	3.9	- -	0.2 J
2/21/2019	Assessment	0.169	2.67	28.2	0.09	5.0	150	10.6
5/29/2019	Assessment	<0.02 U	2.97	21.4	0.06 J	4.9	34	2.1
7/23/2019	Assessment	0.306	3.45	28	0.086 J	3.2	214	18

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-15
Welsh - PBAP
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
5/31/2016	Background	<0.93 U	12	215	0.959793 J	0.351465 J	17	11	2.284	<0.083 U	7	0.017	0.054	1.77432 J	3.46337 J	<0.86 U
7/29/2016	Background	<0.93 U	6	124	0.362598 J	0.111427 J	4	6	1.322	<0.083 U	<0.68 U	0.021	0.01646 J	0.586779 J	1.19442 J	<0.86 U
9/30/2016	Background	<0.93 U	131	1930	15	7.00	280	134	9.92	0.2621 J	161	0.149	0.707	3.60313 J	14.0	<0.86 U
10/21/2016	Background	<0.93 U	23	415	2	0.575938 J	54	19	3.567	<0.083 U	22	0.036	0.1	1.54555 J	1.17613 J	1.55993 J
12/14/2016	Background	<0.93 U	6	184	0.695316 J	0.246456 J	15	10	3.36	<0.083 U	3.96087 J	0.013	0.026	0.463544 J	1.32943 J	<0.86 U
1/20/2017	Background	<0.93 U	6	153	0.449612 J	<0.07 U	9	7	2.386	<0.083 U	2.87518 J	0.008	0.01932 J	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	20	353	2	0.319406 J	49	20	2.261	<0.083 U	19	0.025	0.058	1.42695 J	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	8.54	166	0.61 J	0.48 J	12.35	8.44	2.491	<0.083 U	2.98 J	0.0108	0.022 J	<0.29 U	2.71 J	<0.86 U
5/23/2018	Assessment	<0.93 U	2.56 J	102	0.03 J	0.1 J	2.63	4.74 J	1.46	<0.083 U	<0.68 U	0.00562	<0.005 U	<0.29 U	1.54 J	1.37 J
8/15/2018	Assessment	0.03 J	3.26	85.2	0.116	0.01 J	0.481	3.71	1.076	- -	0.438	0.00338	- -	0.05 J	0.9	0.09
2/21/2019	Assessment	<0.02 U	2.21	76.6	0.208	0.01 J	0.225	2.90	0.841	0.090	0.104	0.00294	<0.005 U	<0.4 U	0.4	<0.1 U
5/29/2019	Assessment	0.05 J	2.95	203	1.50	0.08	9.31	5.49	3.55	0.06 J	9.85	0.01 J	0.081	<0.4 U	5.1	0.1 J
7/23/2019	Assessment	0.03 J	2.10	113	0.573	0.04 J	2.26	5.41	2.245	0.086 J	2.87	0.00414	0.025	<0.4 U	1.6	<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
Welsh - PBAP
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
5/26/2016	Background	0.121	200	43	0.4023 J	7.2	1810	1166
7/29/2016	Background	0.119	195	32	0.4135 J	5.7	1576	1005
9/30/2016	Background	0.111	191	36	0.3055 J	6.2	1663	1055
10/21/2016	Background	0.124	194	32	0.583 J	6.1	1612	1163
12/14/2016	Background	0.135	196	31	0.5399 J	6.0	1560	1096
1/20/2017	Background	0.101	196	33	<0.083 U	5.9	1686	1445
2/24/2017	Background	0.135	189	30	<0.083 U	5.7	1628	1055
6/8/2017	Background	0.121	188	30	<0.083 U	5.8	1578	1105
10/6/2017	Detection	0.183	183	31	<0.083 U	5.9	1548	1090
5/24/2018	Assessment	0.239	193	39	<0.083 U	6.3	1836	1067
8/15/2018	Assessment	0.118	187	40	<0.083 U	5.6	1748	1168
2/21/2019	Assessment	0.151	207	43.2	0.18	6.9	1722	1060
5/30/2019	Assessment	0.158	202	41.7	<0.04 U	6.1	1546	1120
7/24/2019	Assessment	0.113	216	37	0.085 J	6.0	1864	1127

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
Welsh - PBAP
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
5/26/2016	Background	<0.93 U	1.37501 J	21	0.173275 J	2	1	63	1.525	0.4023 J	<0.68 U	0.37	0.032	<0.29 U	<0.99 U	<0.86 U
7/29/2016	Background	1.13716 J	<1.05 U	20	0.307264 J	4	1	68	2.78	0.4135 J	<0.68 U	0.374	0.02133 J	1.04115 J	4.56733 J	<0.86 U
9/30/2016	Background	<0.93 U	<1.05 U	31	0.175474 J	0.848199 J	3	58	2.358	0.3055 J	<0.68 U	0.354	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	34	0.200656 J	2	4	65	2.224	0.583 J	<0.68 U	0.394	<0.005 U	0.322249 J	3.34422 J	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	17	0.0498325 J	3	0.816224 J	68	2.384	0.5399 J	<0.68 U	0.323	0.01485 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	14	0.0319852 J	3	68	68	2.436	<0.083 U	<0.68 U	0.341	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	20	0.0665729 J	2	1	73	2.288	<0.083 U	<0.68 U	0.331	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	<1.05 U	10.3	<0.02 U	6.06	<0.23 U	74.8	1.598	<0.083 U	<0.68 U	0.329	0.013 J	<0.29 U	<0.99 U	<0.86 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
PRIMARY BOTTOM ASH POND
J. Robert Welsh Plant
Pittsburg, Texas

Submitted to

AMERICAN ELECTRIC POWER

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January 8, 2019

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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
PBAP	Primary Bottom Ash Pond
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 Primary Bottom Ash Pond (PBAP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas.

Based on detection monitoring conducted in 2017 and 2018, a statistically significant increase (SSI) over background was concluded for boron at the PBAP. An alternate source was not identified at the time, so two assessment monitoring events were conducted at the PBAP in 2018, in accordance with 40 CFR 257.95.

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 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 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

PRIMARY BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) and 257.95(d)(1). Samples collected from background wells for the May and August 2018 sampling events were analyzed for both Appendix III and Appendix IV parameters, whereas samples collected from downgradient wells were analyzed for Appendix IV parameters only. Lead and molybdenum values for the August 2018 event are not reported as they were not detected in any wells during the first event. Additional samples were collected from downgradient wells for Appendix III parameters in September 2018. A summary of data collected during assessment monitoring 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.9.5 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 PBAP 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(b) and 257.95(d)(1) were screened for potential outliers. Outliers for the Appendix III parameters identified from the background and detection monitoring events conducted through January 2018 were summarized in a previous report (Geosyntec, 2018). The reported chromium value of 0.068 milligrams per liter (mg/L) for the January 20, 2017 sampling event at background well AD-17 was removed as an outlier. No other 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 regional screening level (RSL) 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. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for barium, beryllium, and combined radium. Non-parametric tolerance limits were calculated for arsenic, chromium, cobalt, lithium, mercury, molybdenum and selenium due to apparent non-normal distributions; for antimony, fluoride, lead, and thallium due to a high non-detect frequency; and for cadmium 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 SSL was identified at the Welsh PBAP:

- The LCL for lithium exceeded the GWPS of 0.390 mg/L at AD-9 (0.935 mg/L).

As a result, the Welsh PBAP 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.

2.3 Conclusions

Three assessment monitoring events were conducted in 2018 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 2018 data. GWPSs were 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 for lithium was identified.

Based on this evaluation, the Welsh PBAP 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 – Welsh Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Primary Bottom Ash Pond, J Robert Welsh Plant, Pittsburg, Texas. January 15, 2018.

TABLES

Table 1 – Groundwater Data Summary
Welsh – Primary Bottom Ash Pond

Parameter	Unit	AD-1		AD-5		AD-8			AD-9			AD-15			AD-17	
		5/24/2018	8/14/2018	5/24/2018	8/15/2018	5/23/2018	8/15/2018	9/17/2018	5/23/2018	8/15/2018	9/17/2018	5/23/2018	8/15/2018	9/17/2018	5/24/2018	8/15/2018
Antimony	mg/L	0.00317 J	0.0000300 J	0.005 U	0.0000100 J	0.00319 J	0.0000100 J	-	0.005 U	0.00005 U	-	0.005 U	0.0000300 J	-	0.005 U	0.0000200 J
Arsenic	mg/L	0.005 U	0.000210	0.005 U	0.00169	0.005 U	0.000310	-	0.005 U	0.00168	-	0.00256 J	0.00326	-	0.005 U	0.00183
Barium	mg/L	0.0799	0.0630	0.0712	0.0637	0.0221	0.0212	-	0.0305	0.0242	-	0.102	0.0852	-	0.00965	0.0128
Beryllium	mg/L	0.000390 J	0.000482	0.001 U	0.0000550	0.001 U	0.00000800 J	-	0.000320 J	0.000268	-	0.0000300 J	0.000116	-	0.001 U	0.0000690
Boron	mg/L	0.345	0.443	0.0501	0.0500	-	-	1.30	-	-	0.198	-	-	0.341	0.239	0.118
Cadmium	mg/L	0.001 U	0.0000200	0.000230 J	0.00000800 J	0.001 U	0.0000200 J	-	0.00288	0.0000600	-	0.000100 J	0.0000100 J	-	0.00646	0.000250
Calcium	mg/L	10.2	5.95	28.1	40.5	-	-	15.0	-	-	230	-	-	3.04	193	187
Chloride	mg/L	4.00	5.00	22.0	19.0	-	-	24.0	-	-	103	-	-	37.0	39.0	40.0
Chromium	mg/L	0.001 U	0.000160	0.000800 J	0.0000720	0.001 U	0.0000500	-	0.001 U	0.000420	-	0.00263	0.000481	-	0.001 U	0.000604
Cobalt	mg/L	0.000350 J	0.000797	0.0142	0.0114	0.00319 J	0.00536	-	0.0267	0.0111	-	0.00474 J	0.00371	-	0.0717	0.0435
Combined Radium	pCi/L	1.98	1.10	1.95	0.316	0.337	3.44	-	2.56	1.86	-	1.46	1.08	-	1.94	2.35
Fluoride	mg/L	1 U	1 U	1 U	1 U	0.501 J	0.615	-	1 U	1 U	-	1 U	1 U	-	1 U	1 U
Lead	mg/L	0.005 U	NR	0.005 U	NR	0.005 U	NR	-	0.005 U	NR	-	0.005 U	NR	-	0.005 U	NR
Lithium	mg/L	0.00814	0.00708	0.121	0.147	0.0956	0.0555	-	1.20	0.851	-	0.00562	0.00338	-	0.308	0.243
Mercury	mg/L	0.00000600 J	0.0000130 J	0.000025 U	0.000025 U	0.000025 U	0.00000700 J	-	0.000025 U	0.000013 J	-	0.000025 U	0.000008 J	-	0.000025 U	0.0000110 J
Molybdenum	mg/L	0.005 U	NR	0.005 U	NR	0.005 U	NR	-	0.005 U	NR	-	0.005 U	NR	-	0.005 U	NR
Selenium	mg/L	0.00138 J	0.00170	0.005 U	0.0000800 J	0.00175 J	0.0000700 J	-	0.005 U	0.000300	-	0.00154 J	0.000900	-	0.005 U	0.000300
Total Dissolved Solids	mg/L	150	160	242	428	-	-	288	-	-	2690	-	-	174	1840	1750
Sulfate	mg/L	43.0	44.0	60.0	240	-	-	122	-	-	1910	-	-	24.0	1070	1170
Thallium	mg/L	0.002 U	0.0000300 J	0.002 U	0.00005 U	0.002 U	0.000129	-	0.00846	0.0000620	-	0.00137 J	0.0000900	-	0.002 U	0.0000740
pH	SU	5.19	5.18	6.22	6.23	6.20	6.77	-	5.30	4.96	-	4.76	4.59	-	6.28	5.60

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
NR: Values are not reported as this parameter was not detected during the May 2018 event at any wells
The fluoride and pH values collected on 8/15/2018 were also used in Appendix III analyses.

Table 2: Groundwater Protection Standards
Welsh Plant - Primary Bottom Ash Pond

Constituent Name	MCL	Rule Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.36
Beryllium, Total (mg/L)	0.004		0.00077
Cadmium, Total (mg/L)	0.005		0.0065
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.075
Combined Radium, Total (pCi/L)	5		4.21
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.39
Mercury, Total (mg/L)	0.002		0.000033
Molybdenum, Total (mg/L)	n/a	0.1	0.005
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.0013

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/RSL is used as the GWPS.

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 Welsh Primary 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
112498

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

01.08.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 16, 2018

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Welsh PBAP
Assessment Monitoring Event – September 2018

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of September 2018 groundwater data for American Electric Power Inc.'s Welsh PBAP. 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-1, AD-5, and AD-17; and
- **Downgradient wells:** AD-8, AD-9, and AD-15.

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. Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs.

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron and pH; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, chloride, fluoride, sulfate and TDS. The statistical method selected for each parameter was determined based on the results of the screening analysis performed in December 2017.

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 SSIs were noted for any of the Appendix III parameters in downgradient wells except for boron in well AD-8 and pH (lower limit) in well AD-15. Chloride in upgradient well AD-5 exceeded its intrawell prediction limit which may be an indication that groundwater is changing naturally upgradient of the facility. Concentrations will continue to be monitored over the next sampling events. 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 patters 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. A Trend Test summary table follows this letter.

Evaluation of Appendix IV Parameters

Parametric tolerance limits were used to calculate background limits from pooled upgradient well data for Appendix IV parameters with a target of 95% confidence and 95% coverage to determine the Alternate Contaminant Level (ACL). 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 Regional Screening Levels (RSLs) 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.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, RSL, or ACL as discussed above. Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence intervals exceedances were found except for lithium in well AD-9. 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 Welsh PBAP. If you have any questions or comments, please feel free to contact me.

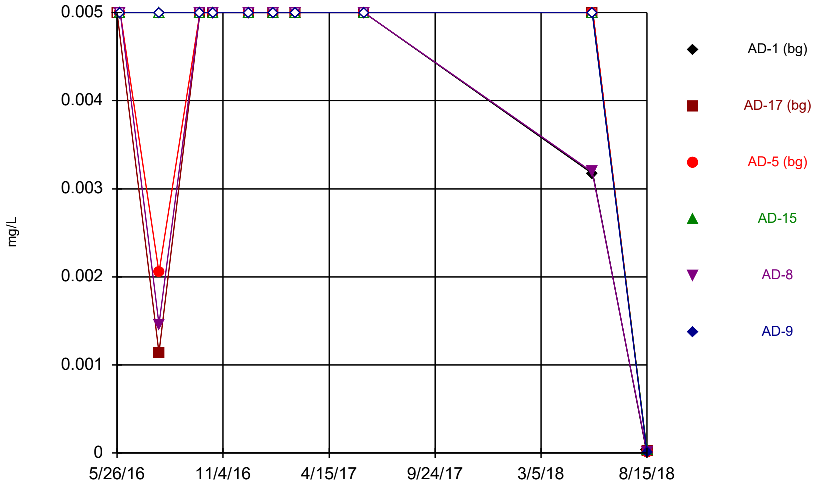
For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

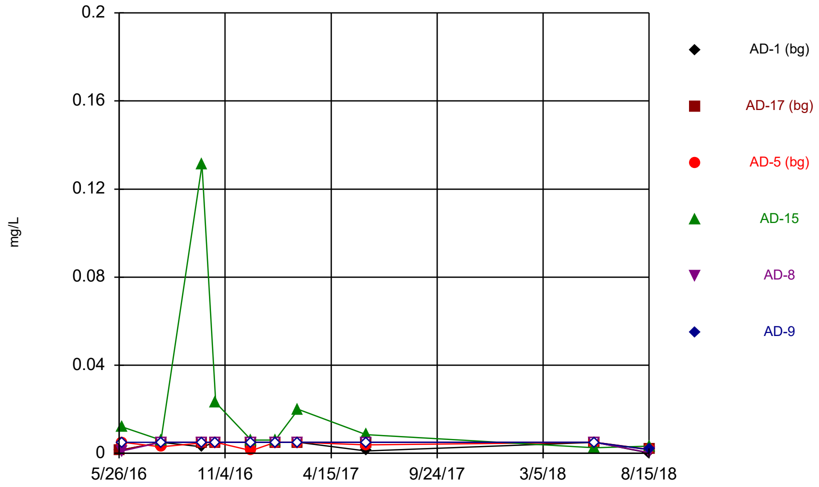
Time Series



Constituent: Antimony, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

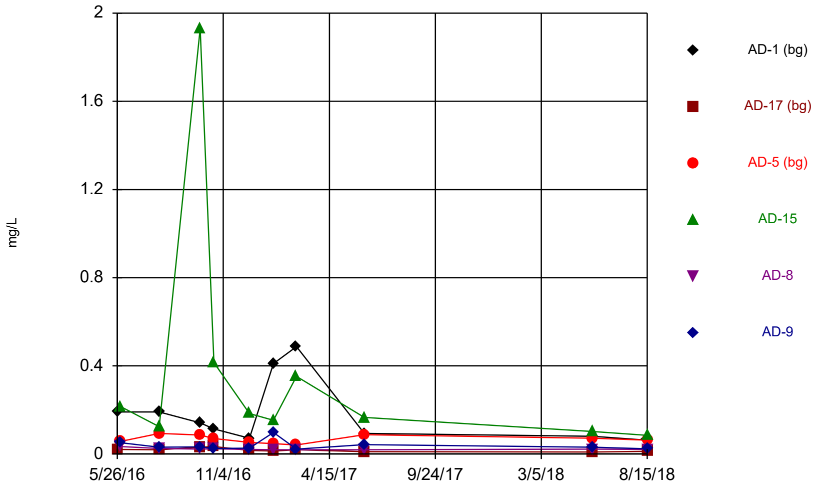
Time Series



Constituent: Arsenic, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

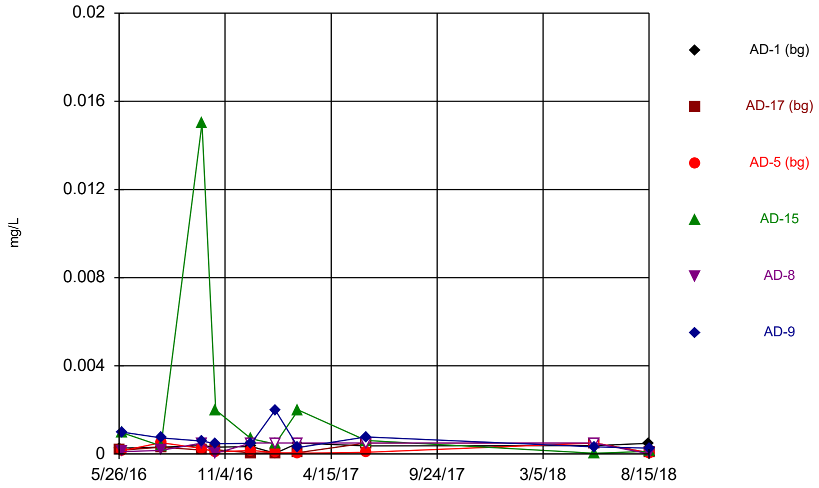
Time Series



Constituent: Barium, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

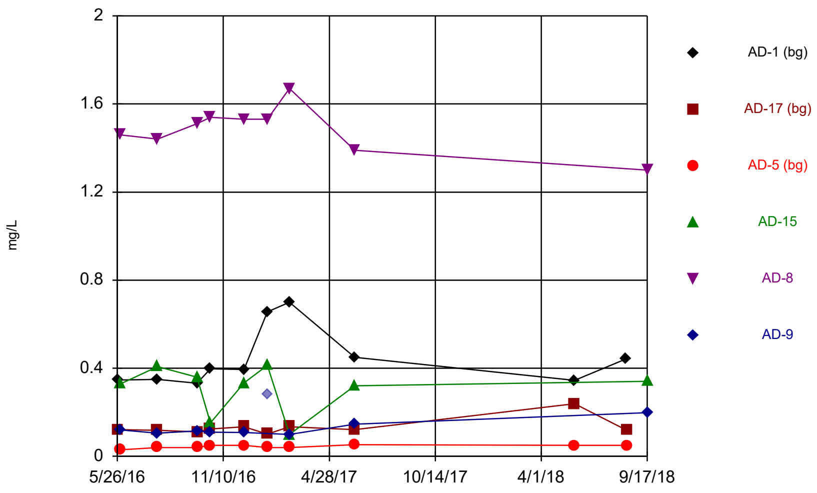
Time Series



Constituent: Beryllium, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

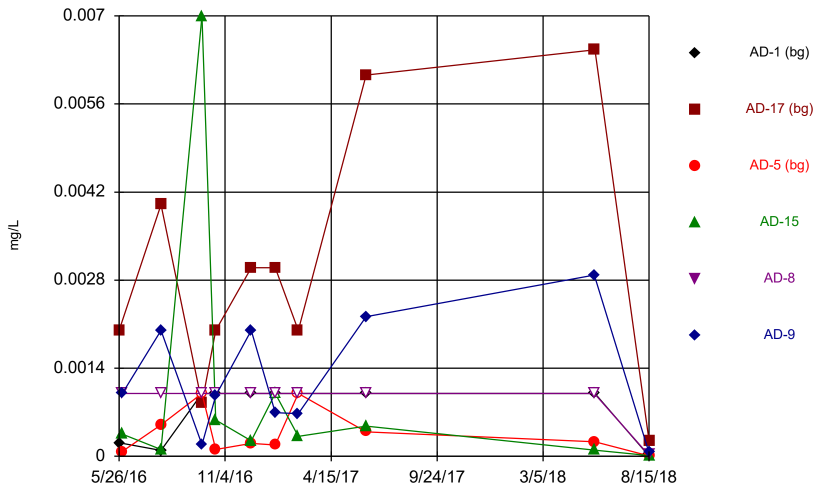
Time Series



Constituent: Boron, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

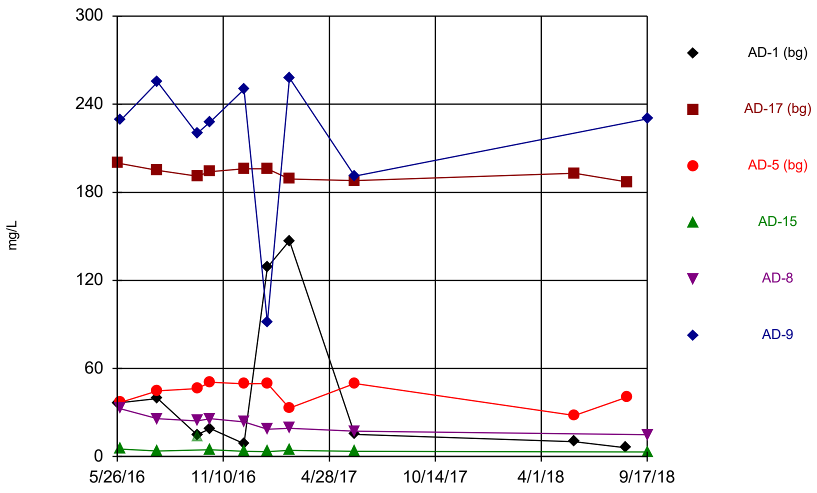
Time Series



Constituent: Cadmium, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

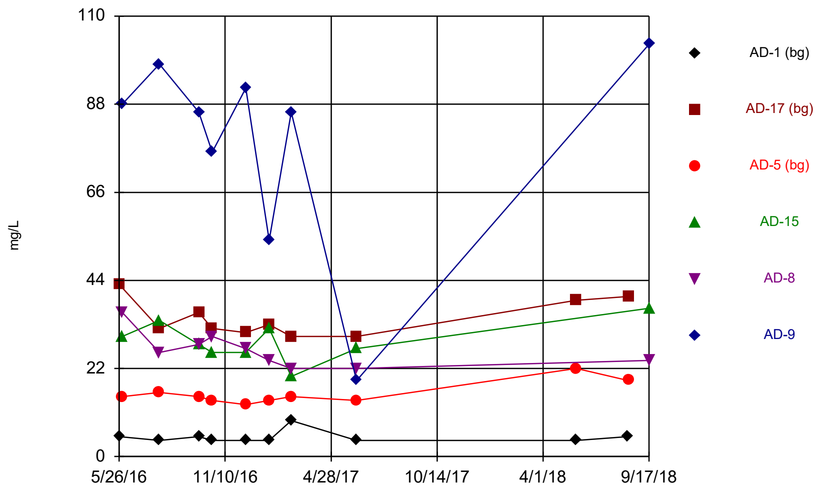
Time Series



Constituent: Calcium, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

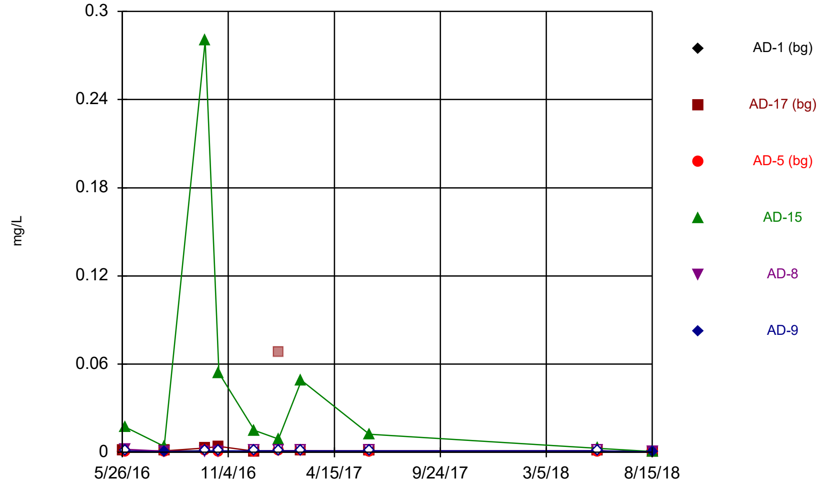
Time Series



Constituent: Chloride, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

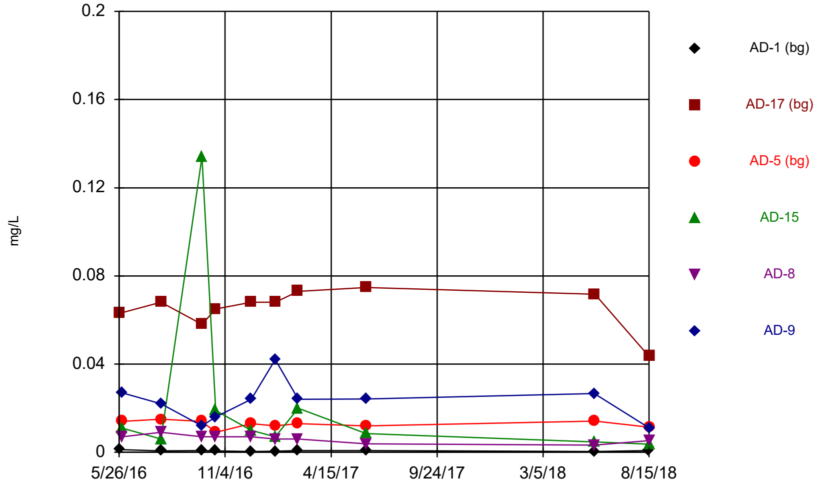
Time Series



Constituent: Chromium, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

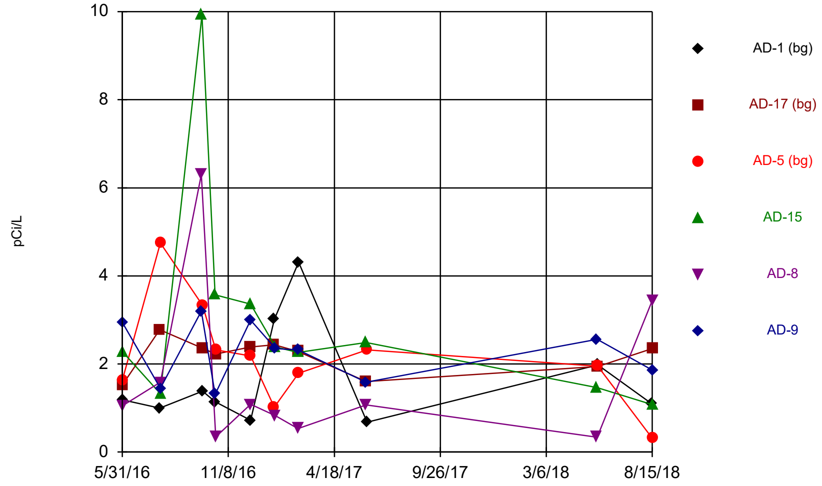
Time Series



Constituent: Cobalt, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

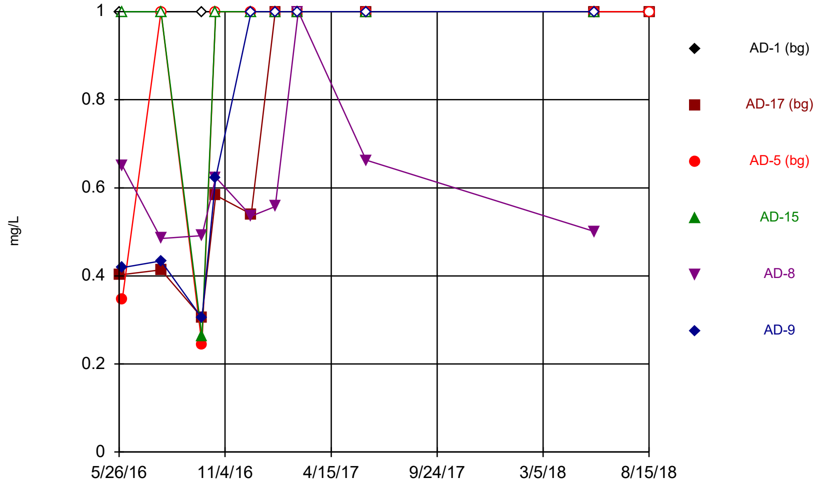
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

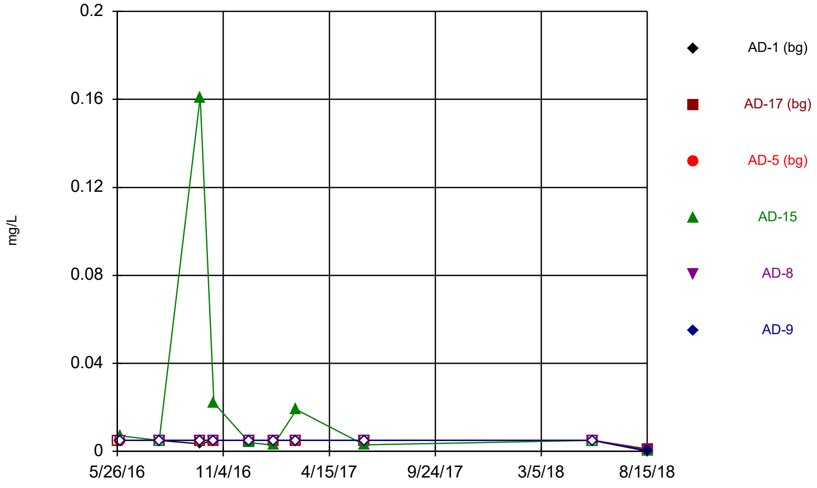
Time Series



Constituent: Fluoride, total Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

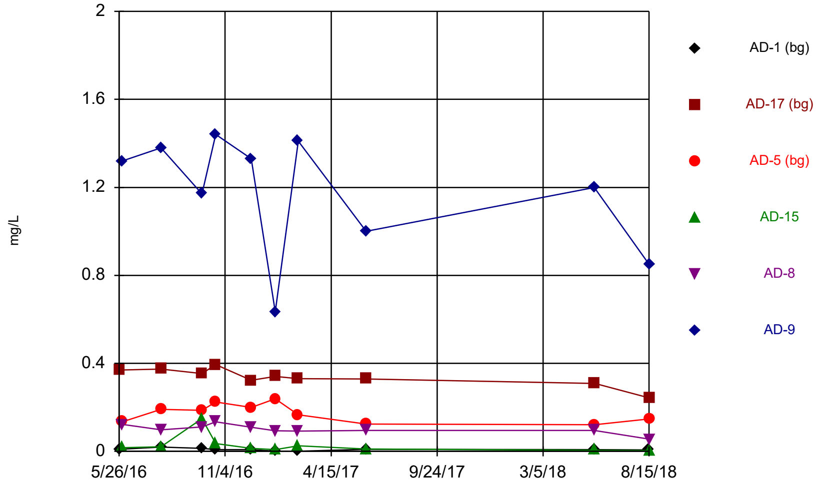
Time Series



Constituent: Lead, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

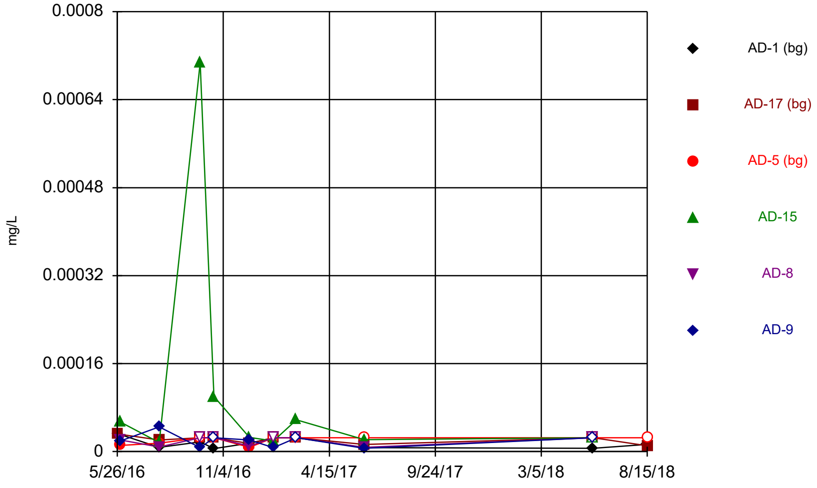
Time Series



Constituent: Lithium, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

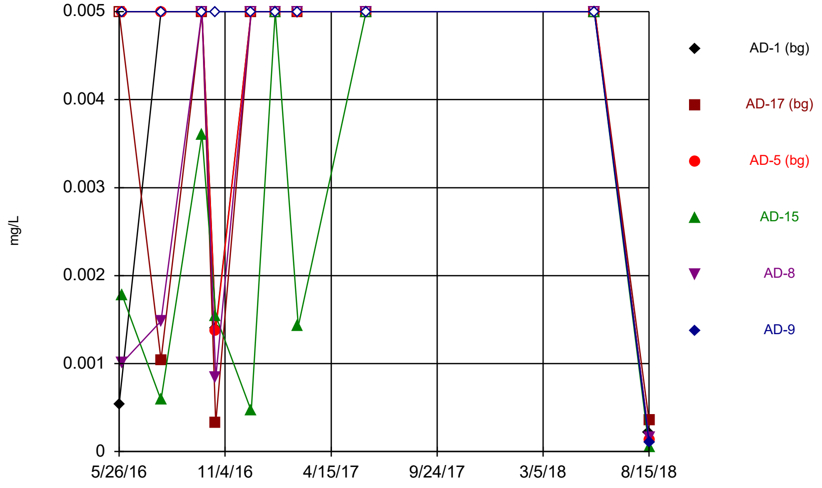
Time Series



Constituent: Mercury, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

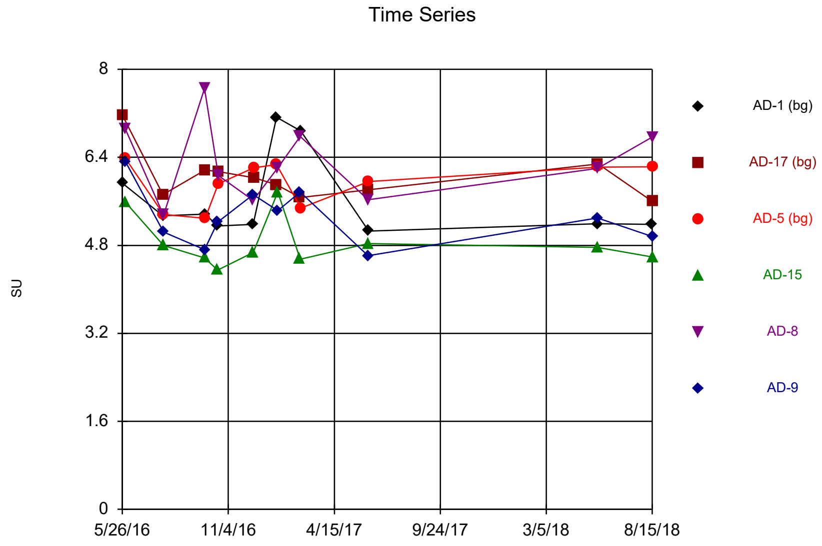
Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



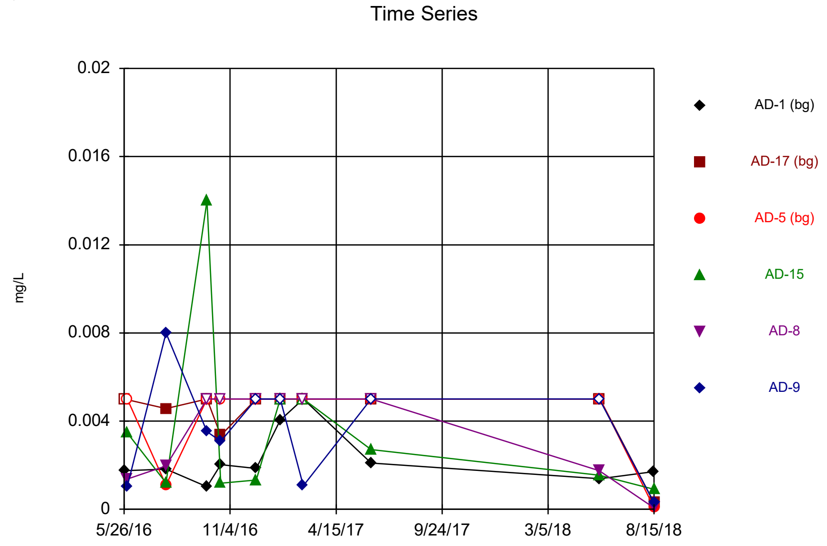
Constituent: Molybdenum, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



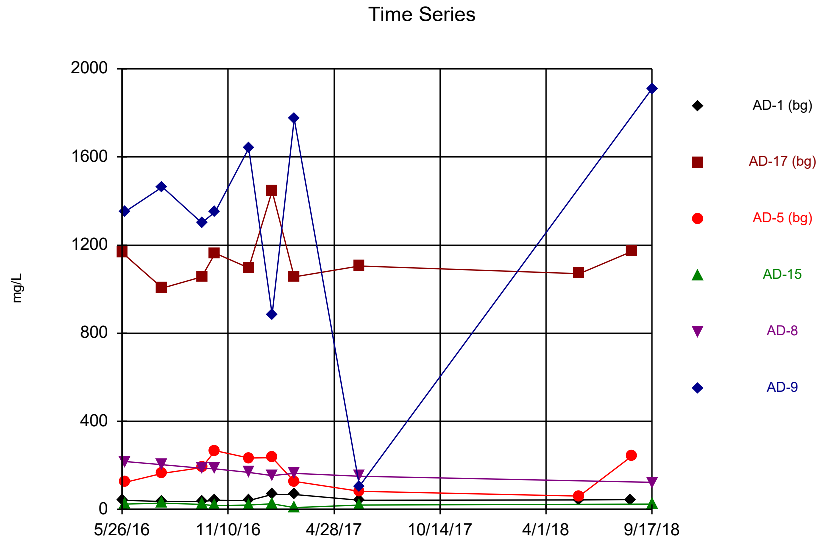
Constituent: pH, field   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



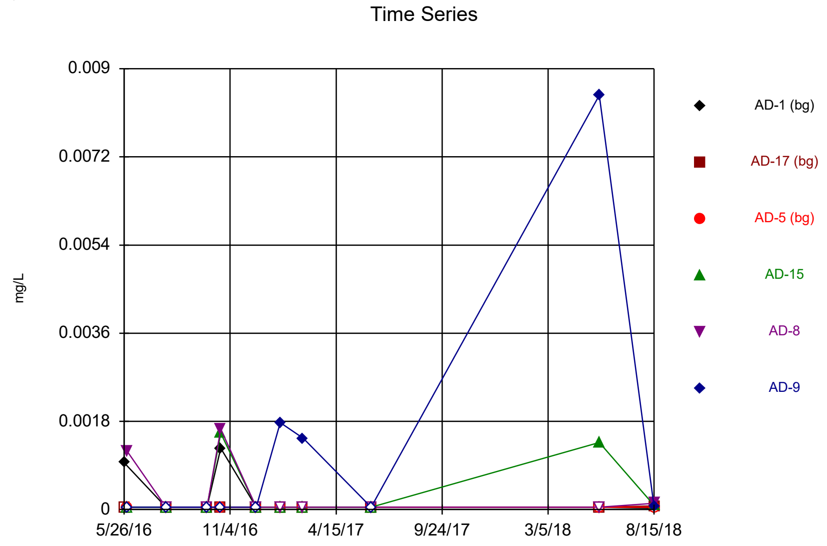
Constituent: Selenium, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

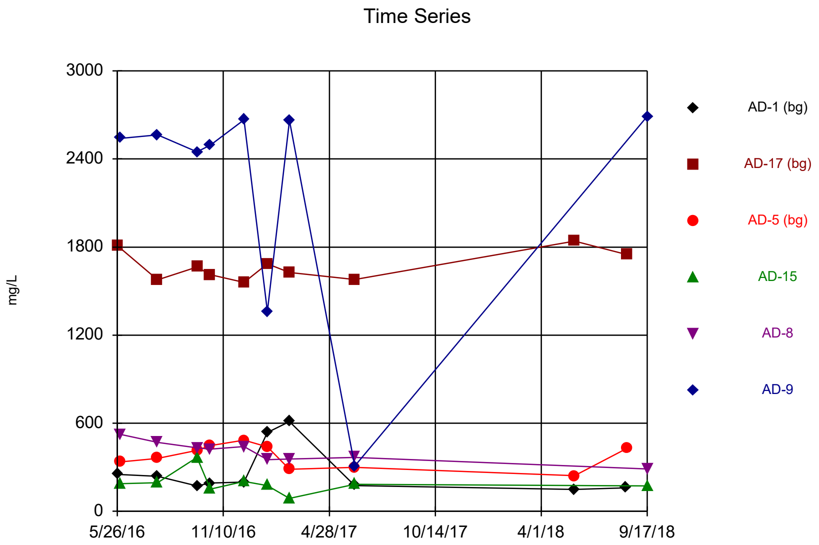


Constituent: Sulfate, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Thallium, total   Analysis Run 12/16/2018 8:11 AM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP



Constituent: Total Dissolved Solids Analysis Run 12/16/2018 8:11 AM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Interwell Prediction Limit Summary Table - Significant Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/16/2018, 8:10 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-8**	**0.765**	**n/a**	**9/17/2018**	**1.3**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
pH, field (SU)	**AD-15**	**6.899**	**4.849**	**8/15/2018**	**4.59**	**Yes**	**30**	**5.874**	**0.5713**	**0**	**None**	**No**	**0.001253**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary Table - All Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/16/2018, 8:10 AM

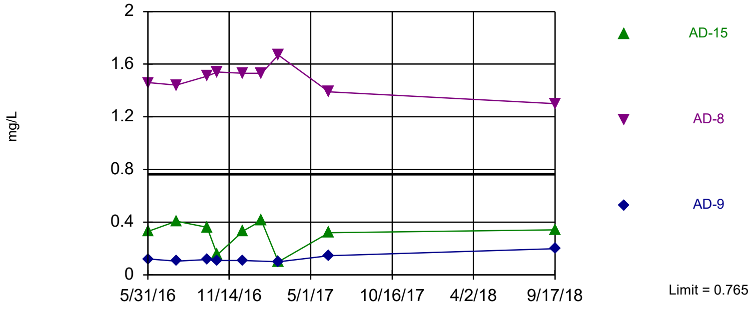
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-15	0.765	n/a	9/17/2018	0.341	No	30	-2.011	0.9717	0	None	ln(x)	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-8**	**0.765**	**n/a**	**9/17/2018**	**1.3**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	AD-9	0.765	n/a	9/17/2018	0.198	No	30	-2.011	0.9717	0	None	ln(x)	0.002505	Param Inter 1 of 2
pH, field (SU)	**AD-15**	**6.899**	**4.849**	**8/15/2018**	**4.59**	**Yes**	**30**	**5.874**	**0.5713**	**0**	**None**	**No**	**0.001253**	**Param Inter 1 of 2**
pH, field (SU)	AD-8	6.899	4.849	8/15/2018	6.77	No	30	5.874	0.5713	0	None	No	0.001253	Param Inter 1 of 2
pH, field (SU)	AD-9	6.899	4.849	8/15/2018	4.96	No	30	5.874	0.5713	0	None	No	0.001253	Param Inter 1 of 2

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-8

Prediction Limit

Interwell Parametric



Background Data Summary (based on natural log transformation): Mean=-2.011, Std. Dev.=0.9717, n=30. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9108, critical = 0.9. Kappa = 1.794 (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 12/16/2018 8:00 AM View: PL's - Interwell

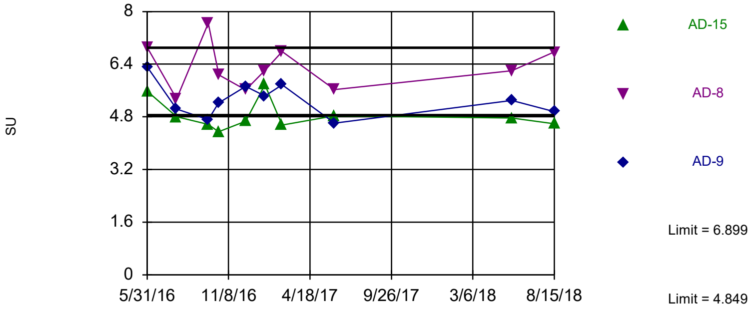
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits: AD-15

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=5.874, Std. Dev.=0.5713, n=30. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9326, critical = 0.9. Kappa = 1.794 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 3 points to limit.

Constituent: pH, field Analysis Run 12/16/2018 8:00 AM View: PL's - Interwell

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Intrawell Prediction Limit Summary Table - Significant Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/9/2018, 2:22 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-5**	**16.78**	**n/a**	**8/15/2018**	**19**	**Yes**	**8**	**14.5**	**0.9258**	**0**	**None**	**No**	**0.002505**	Param 1 of 2

Intrawell Prediction Limit Summary Table - All Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/9/2018, 2:22 PM

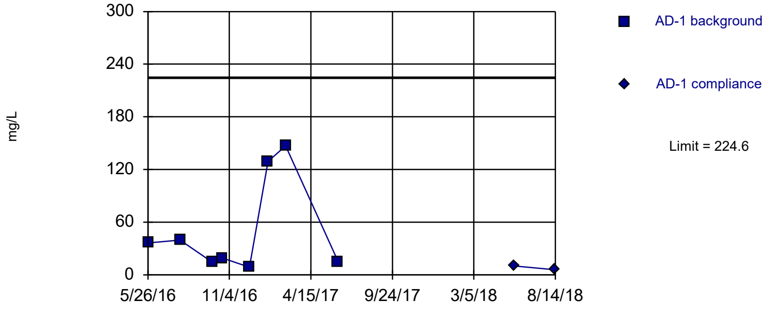
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-1	224.6	n/a	8/14/2018	5.95	No	8	6.363	3.508	0	None	sqrt(x)	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-15	5.711	n/a	9/17/2018	3.04	No	7	4.031	0.6254	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-17	203.5	n/a	8/15/2018	187	No	8	193.6	4.033	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-5	61.45	n/a	8/15/2018	40.5	No	8	45.09	6.656	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-8	35.68	n/a	9/17/2018	15	No	8	23.46	4.969	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-9	349.9	n/a	9/17/2018	230	No	8	215.3	54.76	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-1	9	n/a	8/14/2018	5	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Chloride, total (mg/L)	AD-15	38.42	n/a	9/17/2018	37	No	8	27.88	4.291	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-17	44.04	n/a	8/15/2018	40	No	8	33.38	4.34	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	**AD-5**	**16.78**	**n/a**	**8/15/2018**	**19**	**Yes**	**8**	**14.5**	**0.9258**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Chloride, total (mg/L)	AD-8	38.29	n/a	9/17/2018	24	No	8	26.88	4.643	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-9	139.3	n/a	9/17/2018	103	No	8	74.88	26.2	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-1	1	n/a	8/14/2018	1ND	No	8	n/a	n/a	100	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-15	1	n/a	5/23/2018	1ND	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-17	0.6953	n/a	8/15/2018	1ND	No	8	0.4488	0.1003	37.5	Kapla…	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-5	1	n/a	8/15/2018	1ND	No	8	n/a	n/a	75	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	1.034	n/a	5/23/2018	0.501	No	8	0.6258	0.166	12.5	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-9	0.7259	n/a	5/23/2018	1ND	No	8	0.4449	0.1143	50	Kapla…	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-1	82.3	n/a	8/14/2018	44	No	8	6.772	0.9358	0	None	sqrt(x)	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-15	35.58	n/a	9/17/2018	24	No	8	20.38	6.186	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-17	1471	n/a	8/15/2018	1170	No	8	1136	136.3	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-5	336.4	n/a	8/15/2018	240	No	8	177.4	64.69	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-8	235.8	n/a	9/17/2018	122	No	8	178	23.53	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-9	2527	n/a	9/17/2018	1910	No	8	1234	526.1	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-1	784.8	n/a	8/14/2018	160	No	8	16.71	4.598	0	None	sqrt(x)	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-15	388.1	n/a	9/17/2018	174	No	8	194.4	78.82	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1840	n/a	8/15/2018	1750	No	8	1639	81.77	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-5	563.5	n/a	8/15/2018	428	No	8	383.6	73.17	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-8	568.6	n/a	9/17/2018	288	No	8	420.9	60.09	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-9	3147	n/a	9/17/2018	2690	No	8	1.3e10	7.4e9	0	None	x^3	0.002505	Param 1 of 2

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=6.363, Std. Dev.=3.508, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8248, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

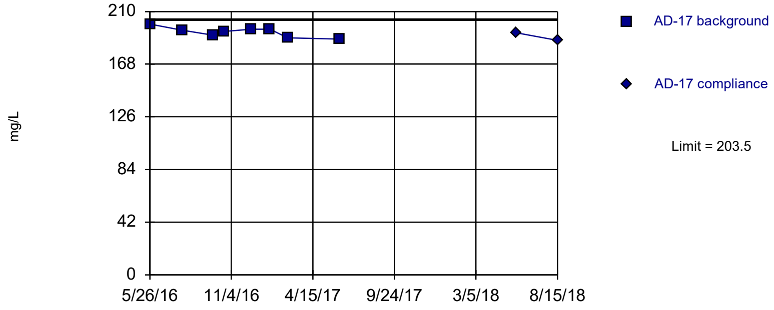
Constituent: Calcium, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=193.6, Std. Dev.=4.033, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9507, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

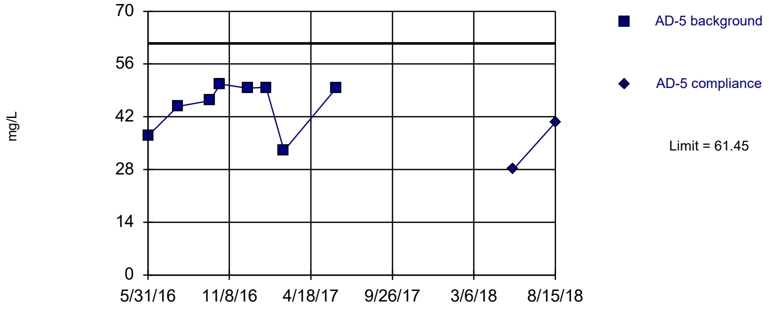
Constituent: Calcium, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=45.09, Std. Dev.=6.656, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8101, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

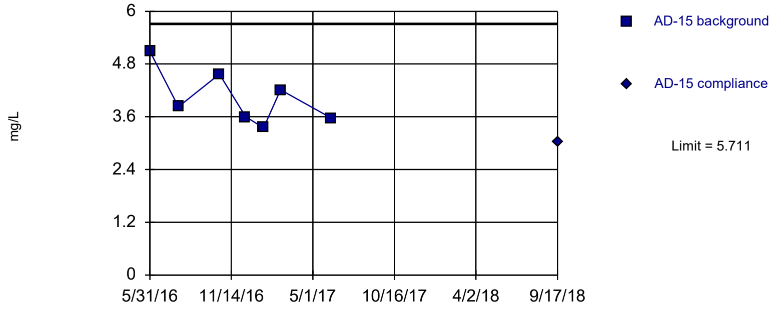
Constituent: Calcium, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.031, Std. Dev.=0.6254, n=7. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9248, critical = 0.73. Kappa = 2.685 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

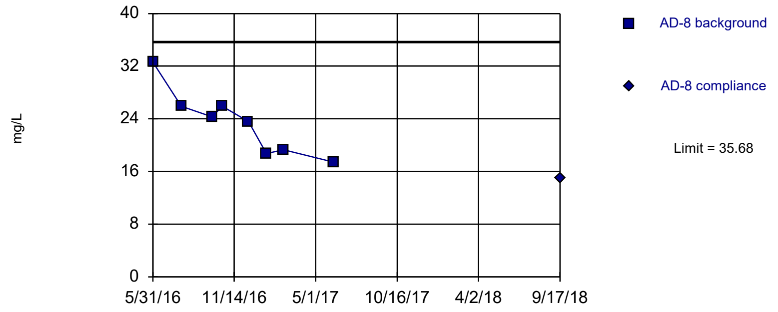
Constituent: Calcium, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=23.46, Std. Dev.=4.969, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9282, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

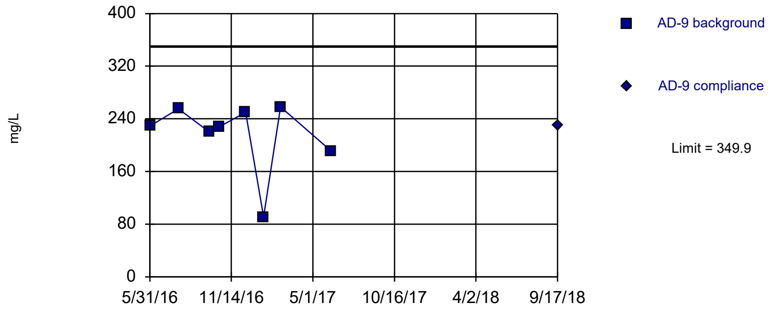
Constituent: Calcium, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=215.3, Std. Dev.=54.76, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7629, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

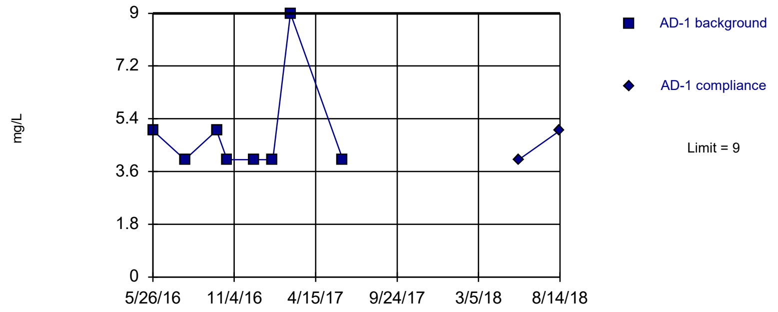
Constituent: Calcium, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 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).

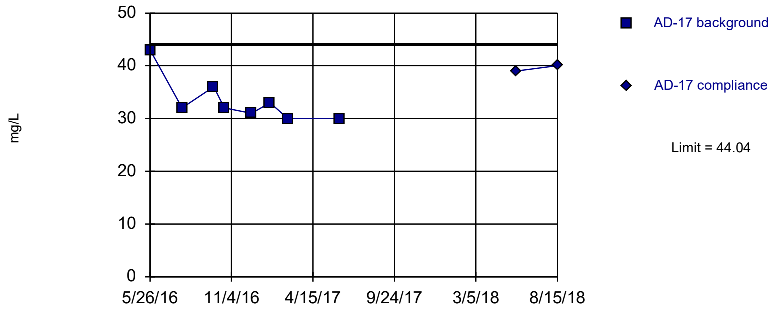
Constituent: Chloride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=33.38, Std. Dev.=4.34, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

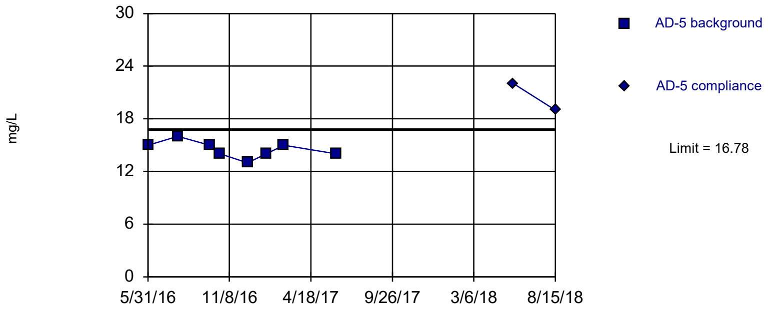
Constituent: Chloride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=14.5, Std. Dev.=0.9258, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9302, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

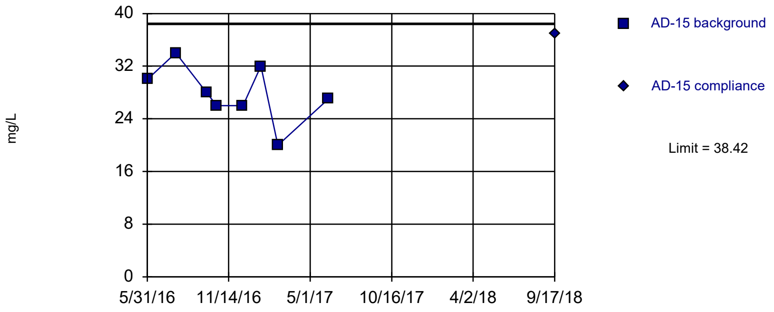
Constituent: Chloride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=27.88, Std. Dev.=4.291, 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.

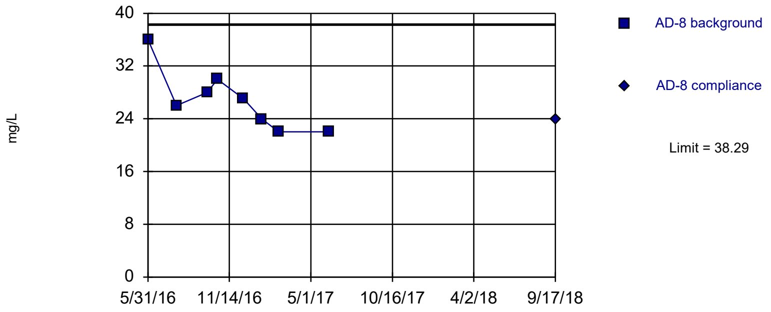
Constituent: Chloride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=26.88, Std. Dev.=4.643, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9162, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

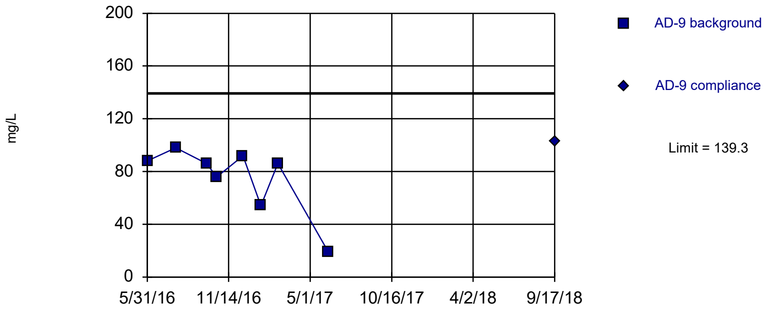
Constituent: Chloride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=74.88, Std. Dev.=26.2, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7978, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

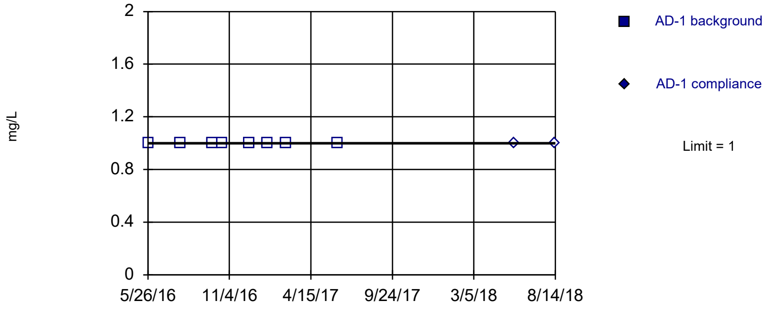
Constituent: Chloride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 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).

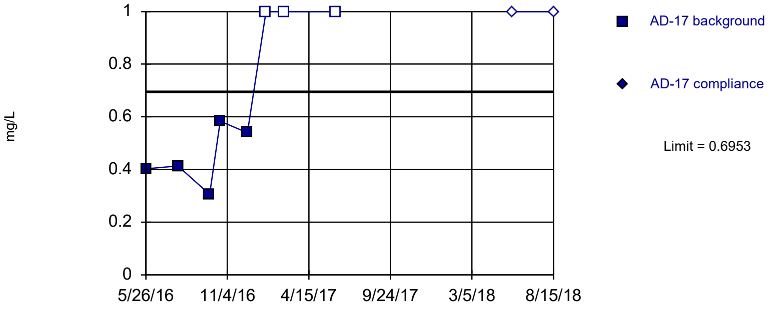
Constituent: Fluoride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.4488, Std. Dev.=0.1003, n=8, 37.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8226, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

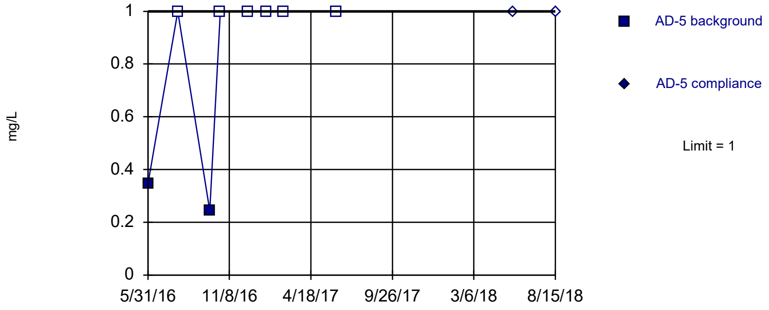
Constituent: Fluoride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 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. 75% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

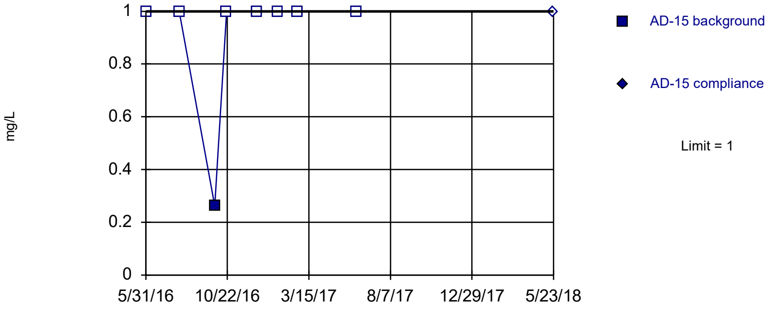
Constituent: Fluoride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 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).

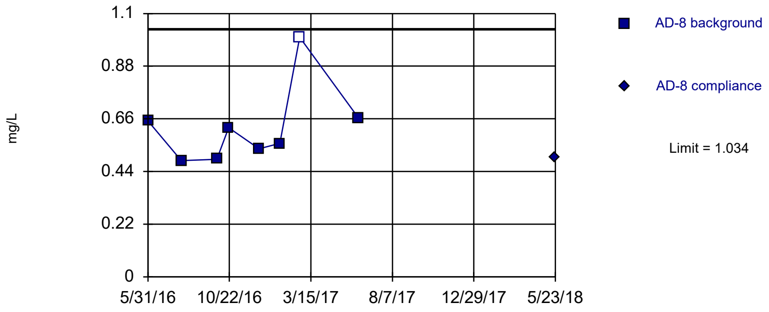
Constituent: Fluoride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.6258, Std. Dev.=0.166, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7879, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

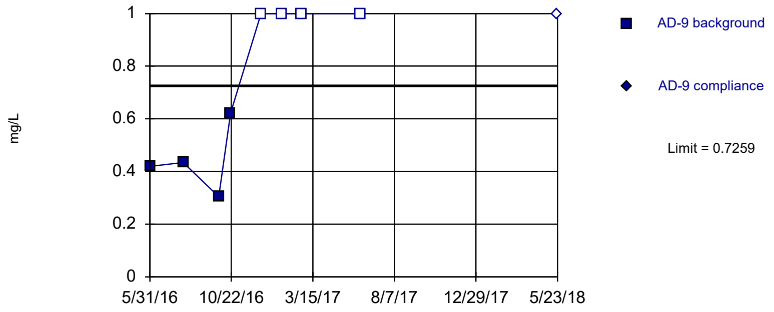
Constituent: Fluoride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.4449, Std. Dev.=0.1143, n=8, 50% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.786, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

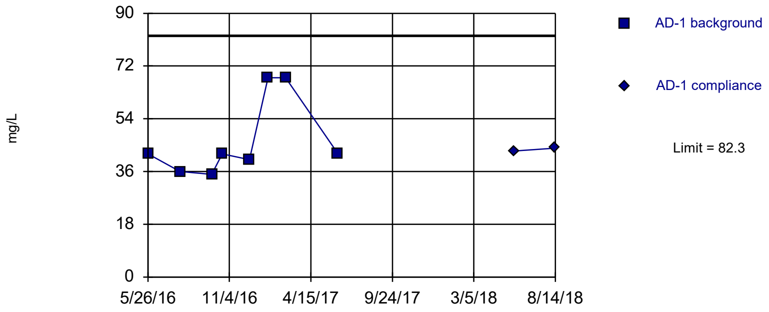
Constituent: Fluoride, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=6.772, Std. Dev.=0.9358, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7528, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

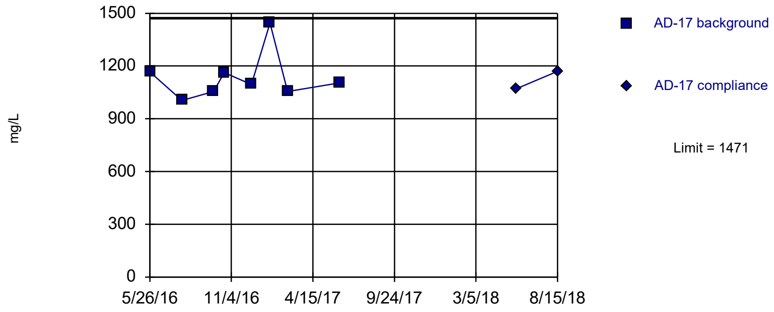
Constituent: Sulfate, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1136, Std. Dev.=136.3, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7916, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

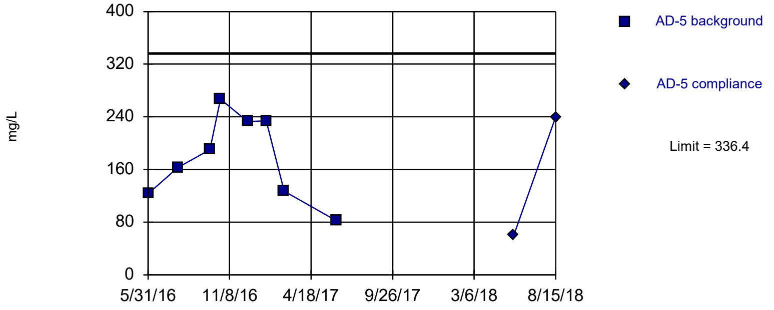
Constituent: Sulfate, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=177.4, Std. Dev.=64.69, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.953, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

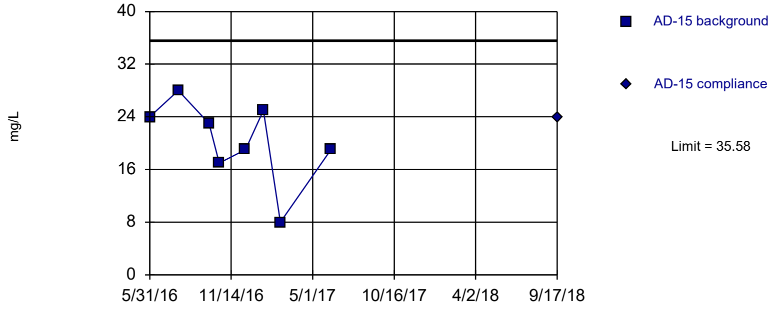
Constituent: Sulfate, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=20.38, Std. Dev.=6.186, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9238, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

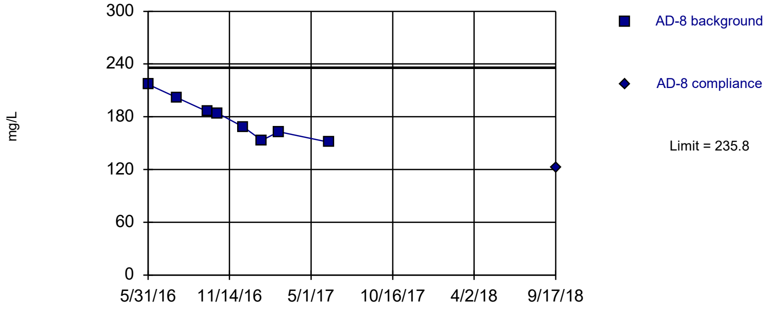
Constituent: Sulfate, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=178, Std. Dev.=23.53, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9398, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

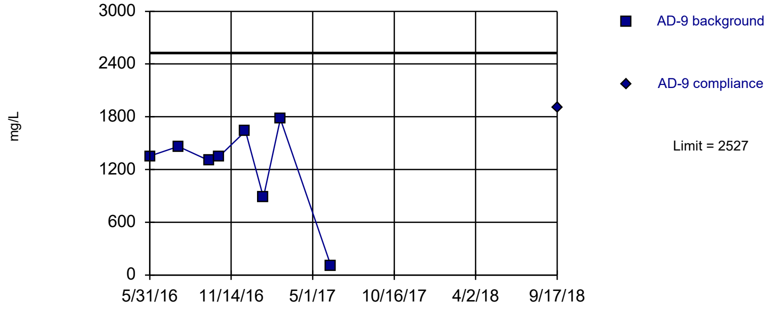
Constituent: Sulfate, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1234, Std. Dev.=526.1, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8423, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

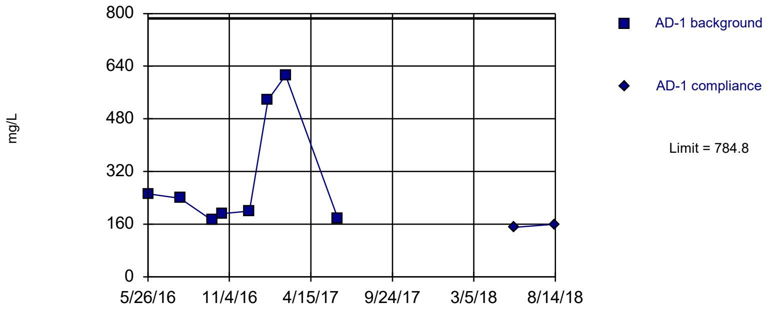
Constituent: Sulfate, total Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=16.71, Std. Dev.=4.598, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.756, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

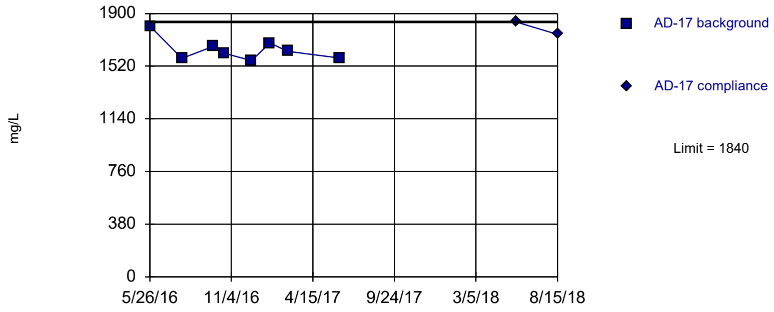
Constituent: Total Dissolved Solids Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1639, Std. Dev.=81.77, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8702, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

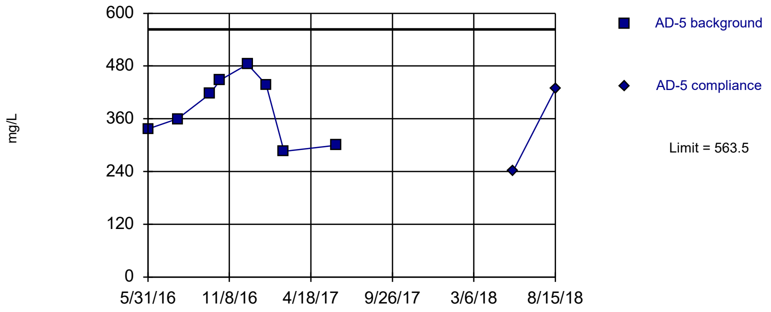
Constituent: Total Dissolved Solids Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=383.6, Std. Dev.=73.17, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.937, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

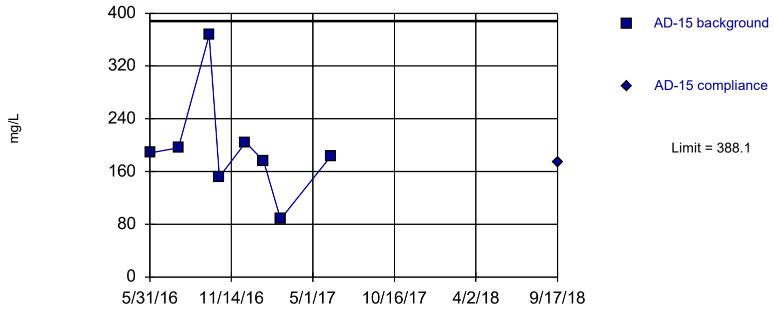
Constituent: Total Dissolved Solids Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=194.4, Std. Dev.=78.82, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8214, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

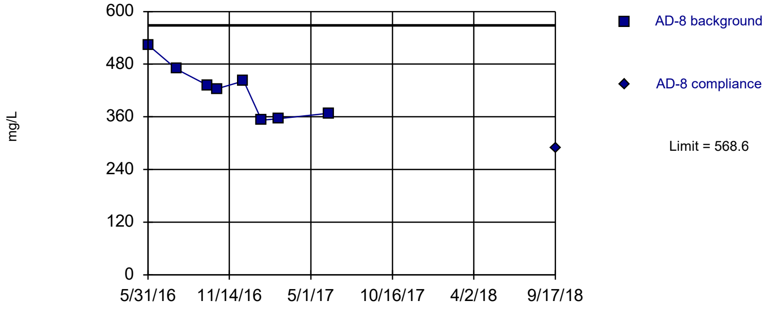
Constituent: Total Dissolved Solids Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=420.9, Std. Dev.=60.09, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9284, 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 Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell

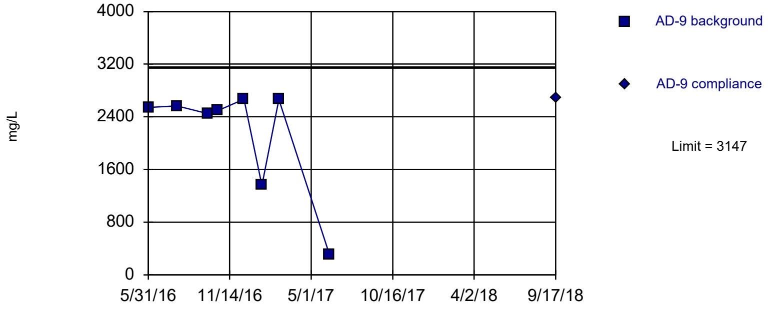
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on cube transformation): Mean=1.3e10, Std. Dev.=7.4e9, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.759, 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 Analysis Run 12/9/2018 2:17 PM View: PL's - Intrawell

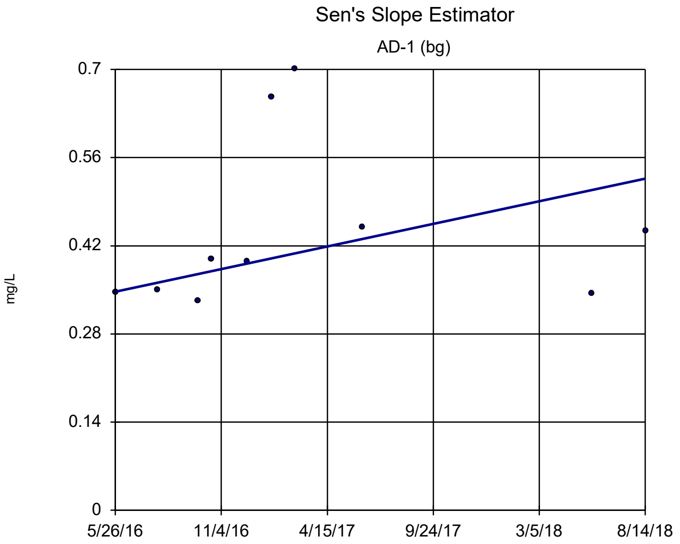
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Trend Test Summary Table - All Results (No Significant Results)

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/16/2018, 8:17 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-1 (bg)	0.08093	15	30	No	10	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-17 (bg)	0.007399	7	30	No	10	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-5 (bg)	0.005828	22	30	No	10	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8	-0.02005	-1	-25	No	9	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-1 (bg)	-0.1093	-10	-30	No	10	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-17 (bg)	-0.4462	-19	-30	No	10	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-15	-0.05	-5	-30	No	10	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 10

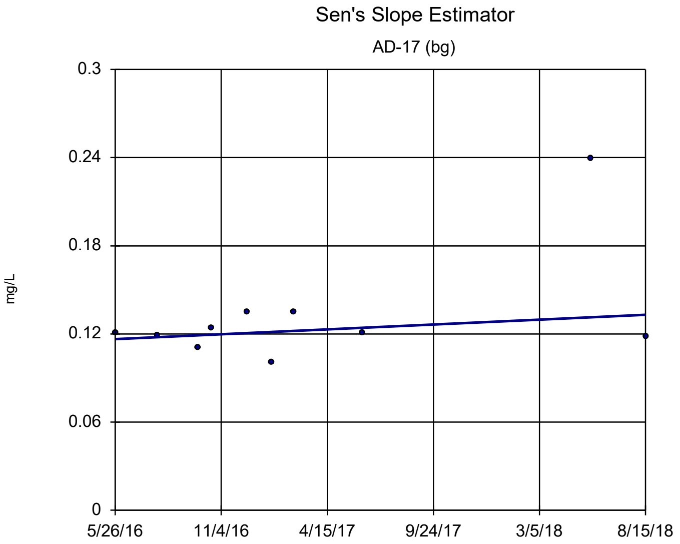
Slope = 0.08093 units per year.

Mann-Kendall statistic = 15 critical = 30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 10

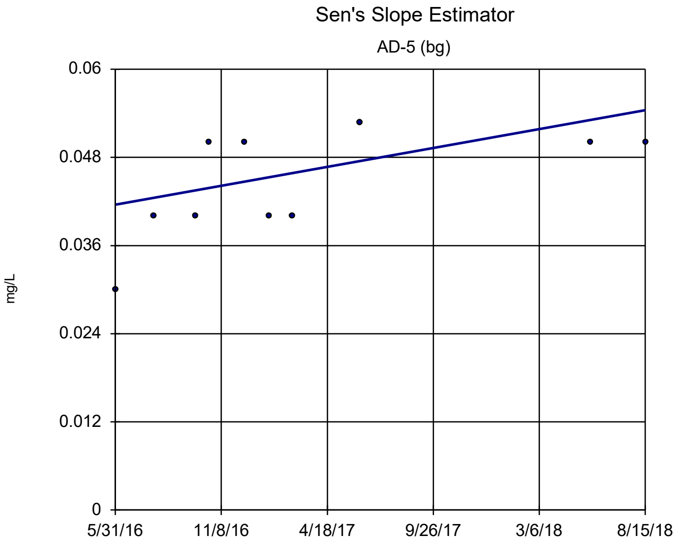
Slope = 0.007399 units per year.

Mann-Kendall statistic = 7 critical = 30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 10

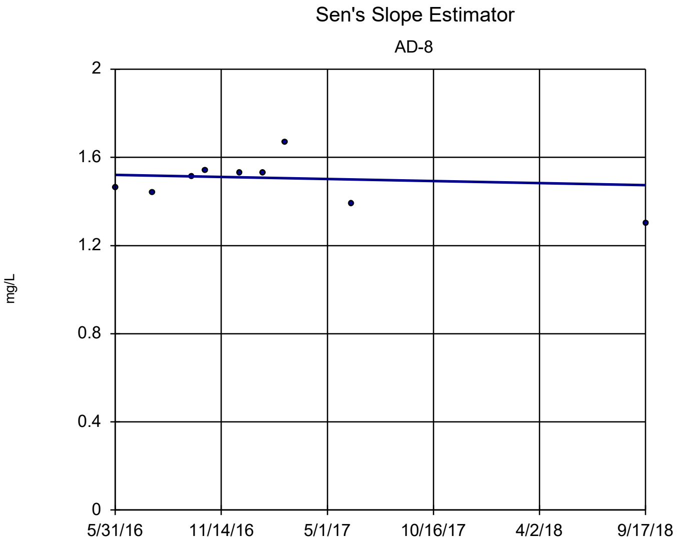
Slope = 0.005828 units per year.

Mann-Kendall statistic = 22 critical = 30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 9

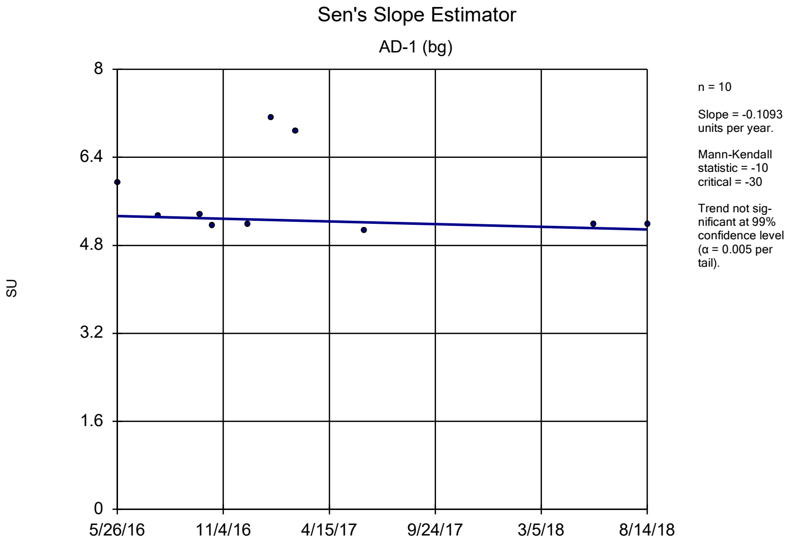
Slope = -0.02005 units per year.

Mann-Kendall statistic = -1 critical = -25

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 10

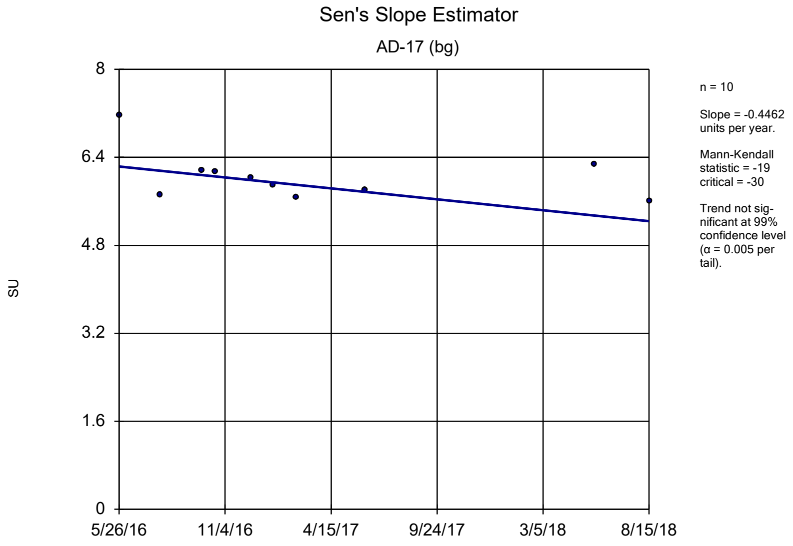
Slope = -0.1093 units per year.

Mann-Kendall statistic = -10 critical = -30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 10

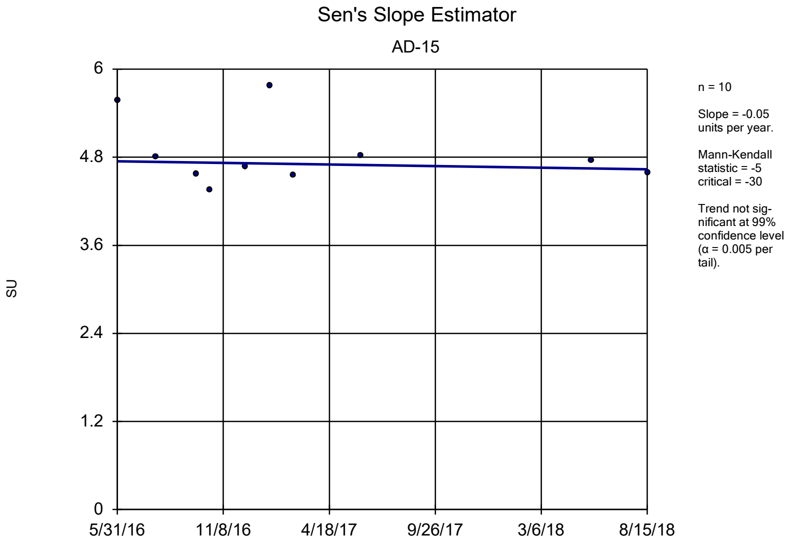
Slope = -0.4462 units per year.

Mann-Kendall statistic = -19 critical = -30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 10

Slope = -0.05 units per year.

Mann-Kendall statistic = -5 critical = -30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/16/2018 8:16 AM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Upper Tolerance Limits - Appendix IV

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/9/2018, 2:38 PM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	30	n/a	n/a	80	n/a	n/a	0.2146	NP Inter(NDs)
Arsenic, total (mg/L)	0.005	30	n/a	n/a	63.33	n/a	n/a	0.2146	NP Inter(normality)
Barium, total (mg/L)	0.362	30	0.4014	0.1402	0	None	x^(1/3)	0.05	Inter
Beryllium, total (mg/L)	0.0007706	30	0.01454	0.005955	13.33	None	sqrt(x)	0.05	Inter
Cadmium, total (mg/L)	0.00646	30	n/a	n/a	30	n/a	n/a	0.2146	NP Inter(Cohens/xform)
Chromium, total (mg/L)	0.004	29	n/a	n/a	31.03	n/a	n/a	0.2259	NP Inter(normality)
Cobalt, total (mg/L)	0.0748	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	4.205	30	2	0.9933	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	30	n/a	n/a	76.67	n/a	n/a	0.2146	NP Inter(NDs)
Lead, total (mg/L)	0.005	30	n/a	n/a	86.67	n/a	n/a	0.2146	NP Inter(NDs)
Lithium, total (mg/L)	0.394	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Mercury, total (mg/L)	0.000033	30	n/a	n/a	46.67	n/a	n/a	0.2146	NP Inter(normality)
Molybdenum, total (mg/L)	0.005	30	n/a	n/a	73.33	n/a	n/a	0.2146	NP Inter(normality)
Selenium, total (mg/L)	0.005	30	n/a	n/a	53.33	n/a	n/a	0.2146	NP Inter(normality)
Thallium, total (mg/L)	0.001251	30	n/a	n/a	86.67	n/a	n/a	0.2146	NP Inter(NDs)

Confidence Intervals - Significant Results

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 12/9/2018, 2:44 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Lithium, total (mg/L)	**AD-9**	**1.412**	**0.9353**	**0.39**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**

Confidence Intervals - All Results

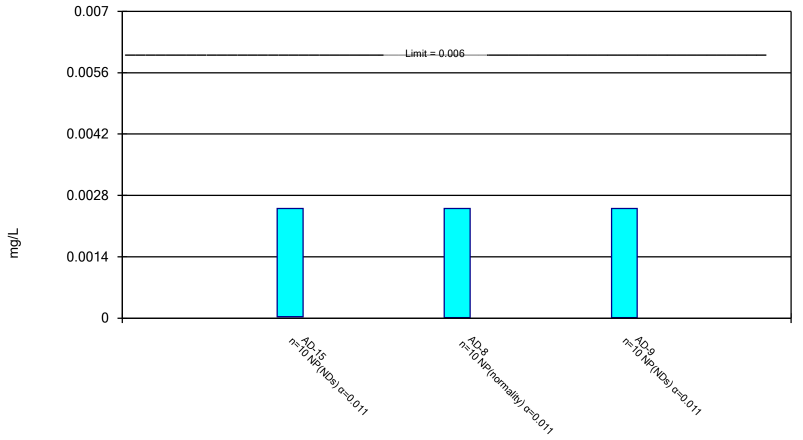
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/9/2018, 2:44 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-15	0.0025	0.00003	0.006	No	10	90	No	0.011	NP (NDs)
Antimony, total (mg/L)	AD-8	0.0025	0.00001	0.006	No	10	70	No	0.011	NP (normality)
Antimony, total (mg/L)	AD-9	0.0025	0.00001	0.006	No	10	90	No	0.011	NP (NDs)
Arsenic, total (mg/L)	AD-15	0.02801	0.003648	0.01	No	10	0	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-8	0.0025	0.00031	0.01	No	10	80	No	0.011	NP (NDs)
Arsenic, total (mg/L)	AD-9	0.0025	0.00168	0.01	No	10	90	No	0.011	NP (NDs)
Barium, total (mg/L)	AD-15	0.5012	0.09935	2	No	10	0	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-8	0.02657	0.01924	2	No	10	0	x^(1/3)	0.01	Param.
Barium, total (mg/L)	AD-9	0.05147	0.02327	2	No	10	0	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-15	0.002922	0.0001454	0.004	No	10	0	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-8	0.0005	0.000008	0.004	No	10	60	No	0.011	NP (normality)
Beryllium, total (mg/L)	AD-9	0.001065	0.000306	0.004	No	10	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-15	0.001225	0.00006409	0.0065	No	10	10	ln(x)	0.01	Param.
Cadmium, total (mg/L)	AD-8	0.0005	0.00002	0.0065	No	10	90	No	0.011	NP (NDs)
Cadmium, total (mg/L)	AD-9	0.002112	0.0004252	0.0065	No	10	0	No	0.01	Param.
Chromium, total (mg/L)	AD-15	0.07284	0.001981	0.1	No	10	0	x^(1/3)	0.01	Param.
Chromium, total (mg/L)	AD-8	0.0007512	0.00005	0.1	No	10	50	No	0.011	NP (normality)
Chromium, total (mg/L)	AD-9	0.0005	0.0002622	0.1	No	10	80	No	0.011	NP (NDs)
Cobalt, total (mg/L)	AD-15	0.02826	0.004545	0.075	No	10	0	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-8	0.007648	0.004634	0.075	No	10	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-9	0.0308	0.01499	0.075	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-15	4.273	1.398	5	No	10	0	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-8	2.718	0.4242	5	No	10	0	x^(1/3)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-9	2.865	1.65	5	No	10	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-15	0.5	0.2621	4	No	9	88.89	No	0.002	NP (NDs)
Fluoride, total (mg/L)	AD-8	0.6628	0.485	4	No	9	11.11	No	0.002	NP (normality)
Fluoride, total (mg/L)	AD-9	0.5584	0.3926	4	No	9	55.56	No	0.01	Param.
Lead, total (mg/L)	AD-15	0.022	0.000438	0.015	No	10	20	No	0.011	NP (Cohens/xfrm)
Lead, total (mg/L)	AD-8	0.0025	0.000039	0.015	No	10	90	No	0.011	NP (NDs)
Lead, total (mg/L)	AD-9	0.0025	0.000262	0.015	No	10	90	No	0.011	NP (NDs)
Lithium, total (mg/L)	AD-15	0.04766	0.005034	0.39	No	10	0	x^(1/3)	0.01	Param.
Lithium, total (mg/L)	AD-8	0.1197	0.08187	0.39	No	10	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-9**	**1.412**	**0.9353**	**0.39**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-15	0.000707	0.0000125	0.002	No	9	11.11	No	0.002	NP (normality)
Mercury, total (mg/L)	AD-8	0.00002103	0.000008	0.002	No	9	55.56	No	0.002	NP (normality)
Mercury, total (mg/L)	AD-9	0.000045	0.000006	0.002	No	9	33.33	No	0.002	NP (Cohens/xfrm)
Molybdenum, total (mg/L)	AD-15	0.005266	0.0005303	0.1	No	10	30	No	0.01	Param.
Molybdenum, total (mg/L)	AD-8	0.0025	0.00016	0.1	No	10	60	No	0.011	NP (normality)
Molybdenum, total (mg/L)	AD-9	0.0025	0.00011	0.1	No	10	90	No	0.011	NP (NDs)
Selenium, total (mg/L)	AD-15	0.003463	0.0009	0.05	No	10	20	No	0.011	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-8	0.0025	0.00007	0.05	No	10	60	No	0.011	NP (normality)
Selenium, total (mg/L)	AD-9	0.003528	0.0003	0.05	No	10	40	No	0.011	NP (Cohens/xfrm)
Thallium, total (mg/L)	AD-15	0.00137	0.00009	0.002	No	10	70	No	0.011	NP (normality)
Thallium, total (mg/L)	AD-8	0.001185	0.000129	0.002	No	10	70	No	0.011	NP (normality)
Thallium, total (mg/L)	AD-9	0.001776	0.000062	0.002	No	10	60	No	0.011	NP (normality)

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

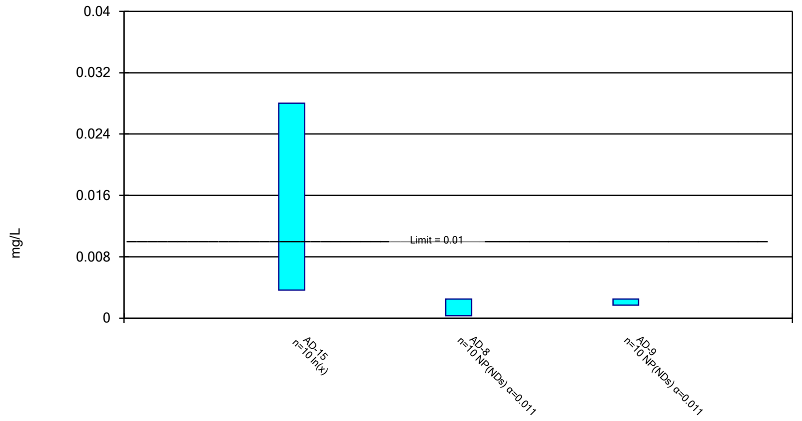


Constituent: Antimony, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

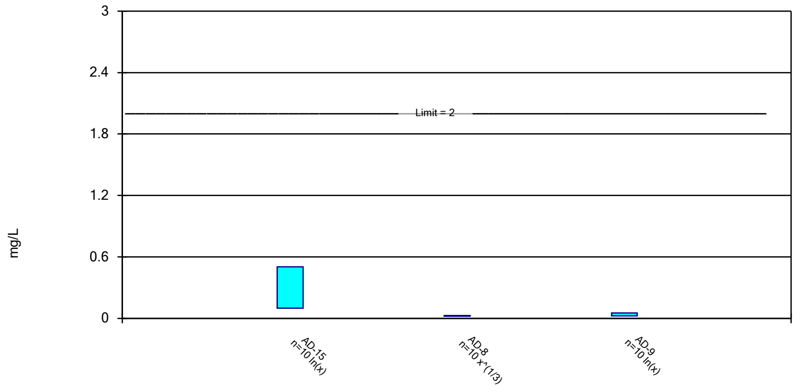


Constituent: Arsenic, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

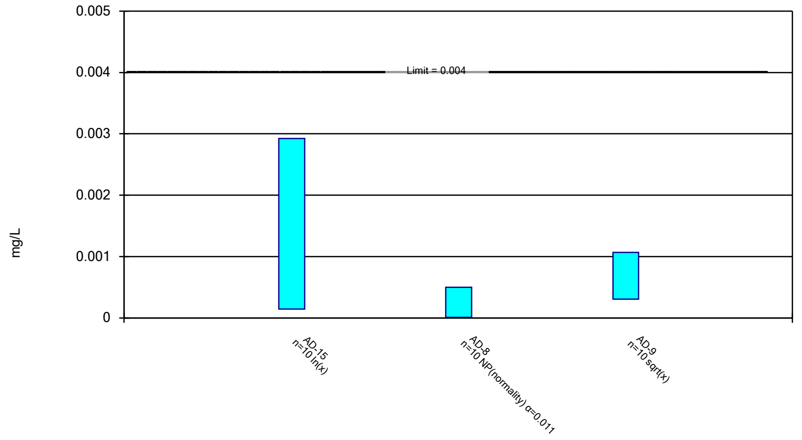


Constituent: Barium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

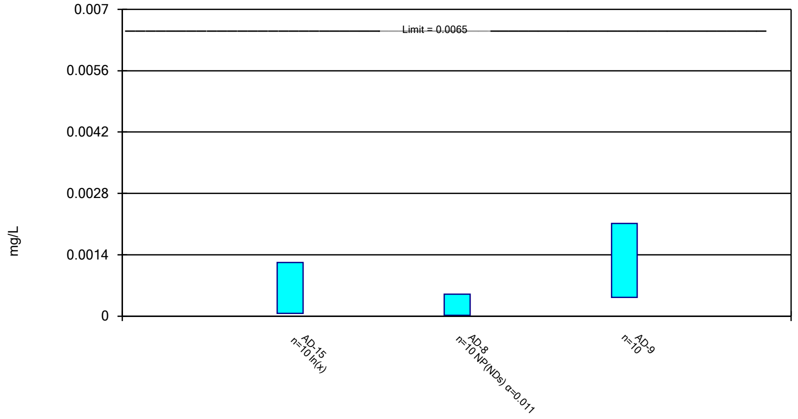


Constituent: Beryllium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

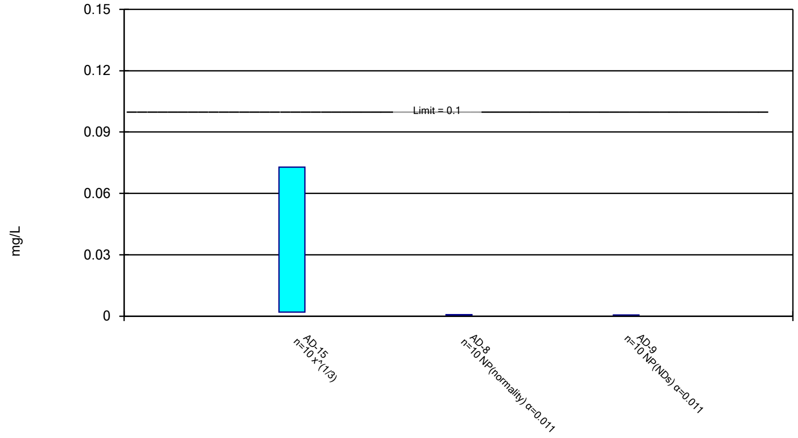


Constituent: Cadmium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

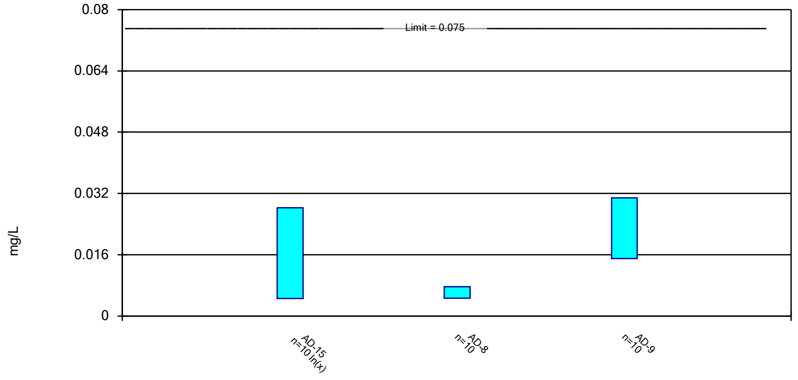


Constituent: Chromium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

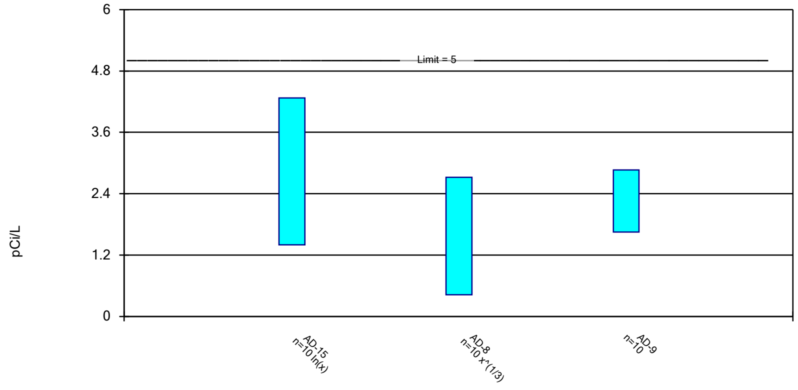


Constituent: Cobalt, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

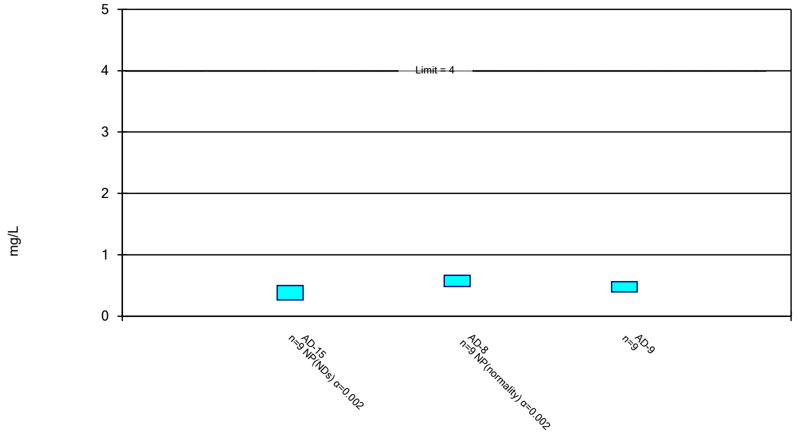


Constituent: Combined Radium 226 + 228   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals -
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

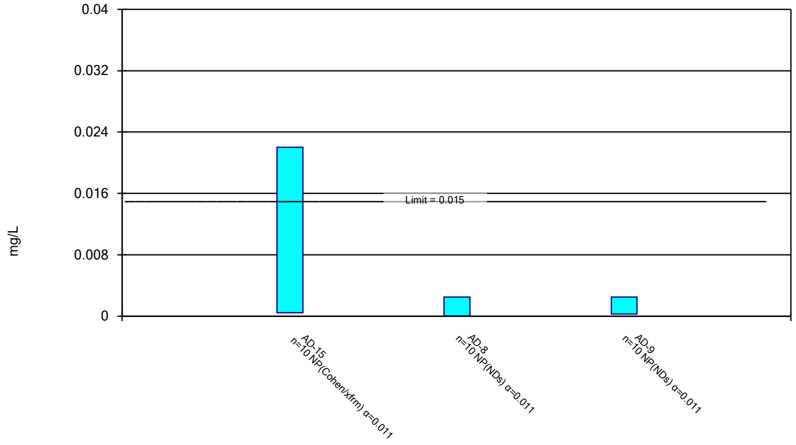


Constituent: Fluoride, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

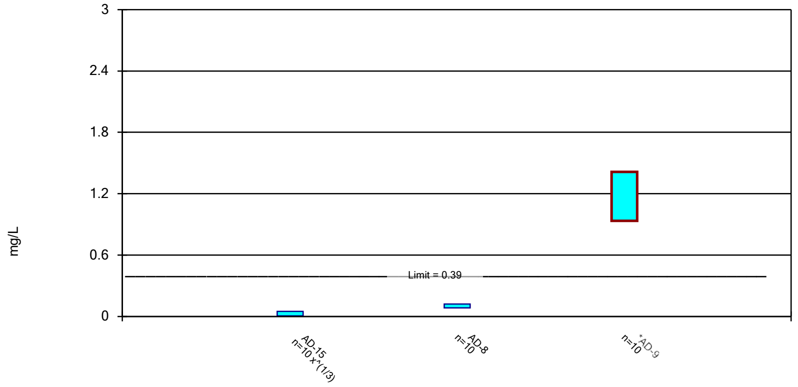


Constituent: Lead, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

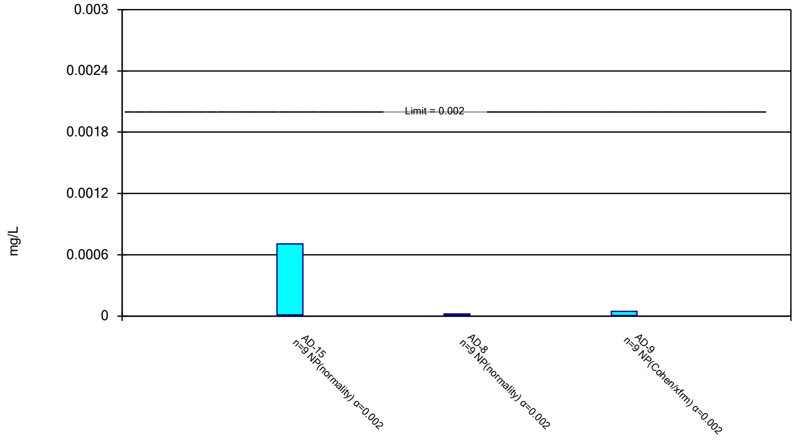


Constituent: Lithium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

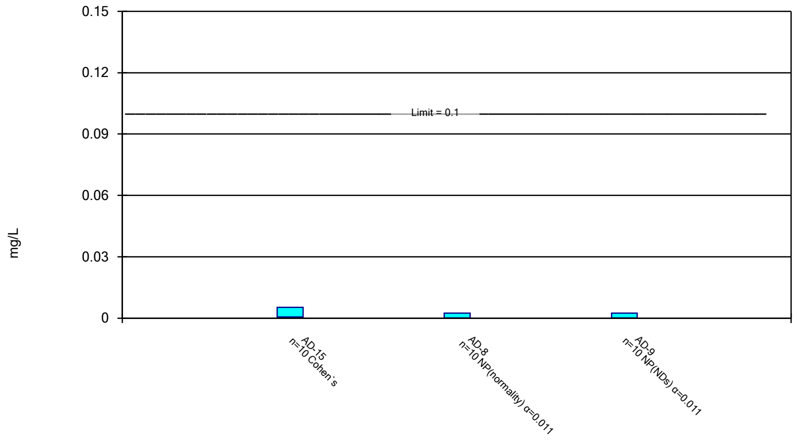


Constituent: Mercury, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 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.

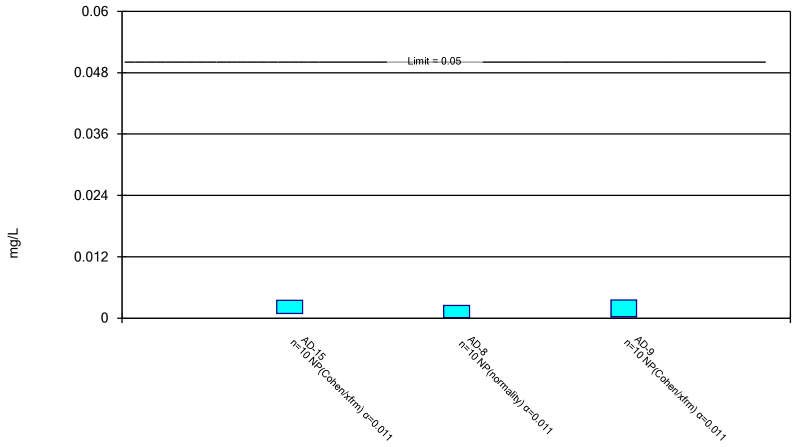


Constituent: Molybdenum, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

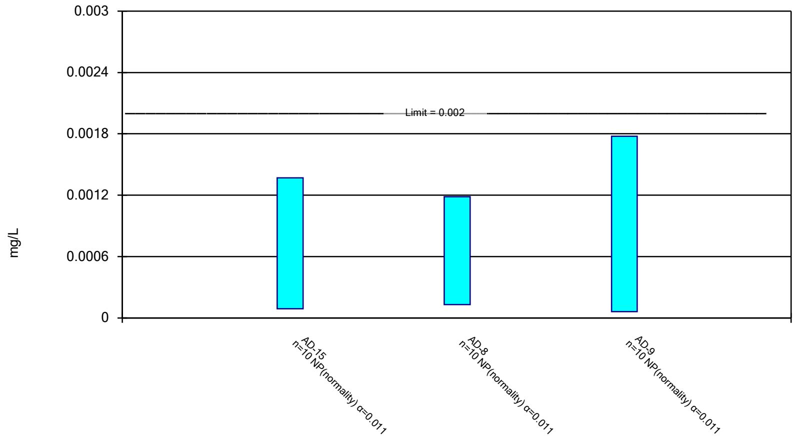


Constituent: Selenium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total   Analysis Run 12/9/2018 2:41 PM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

STATISTICAL ANALYSIS SUMMARY
PRIMARY BOTTOM ASH POND
J. Robert Welsh Plant
Pittsburg, 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

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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
PBAP	Primary Bottom Ash Pond
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 Primary Bottom Ash Pond (PBAP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas.

Based on detection monitoring conducted in 2017 and 2018, a statistically significant increase (SSIs) over background was concluded for boron at the PBAP. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the PBAP in 2018, in accordance with 40 CFR 257.95. An SSL was identified for lithium at well AD-9. An alternative source demonstration (ASD) was successfully completed and the unit remained in assessment monitoring (Arcadis, 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.

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 lithium. Appendix III concentrations for boron and pH remained above background. Thus, either the unit will remain in assessment monitoring or an ASD will be conducted to evaluate if the unit can return to detection monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

PRIMARY 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). Samples from the February 2019 semi-annual sampling event were analyzed for the 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 PBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017). 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 antimony, arsenic, cobalt, fluoride, lithium, mercury, molybdenum, and selenium due to apparent non-normal distributions and for lead 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 identified at the Welsh PBAP:

- The LCL for lithium exceeded the GWPS of 0.39 mg/L at AD-9 (0.957 mg/L).

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, chloride, fluoride, sulfate, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron and pH.

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 during the February 2019 event. 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 and pH.

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, chloride, fluoride, sulfate, and TDS.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate if results were above background values. Verification sampling was completed in April 2019. 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 0.775 mg/L at AD-8 (1.27 mg/L and 1.21 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Welsh PBAP 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 for lithium was identified. Appendix III parameters were also evaluated, with an exceedance of boron identified.

Based on this evaluation, the Welsh PBAP 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 – Welsh Plant. January 2017.

Arcadis. 2019. Alternative Source Demonstration – Lithium. Primary Bottom Ash Pond, J. Robert. Welsh Plant. February 7, 2019.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Primary Bottom Ash Pond, J Robert Welsh Plant, Pittsburg, Texas. January 15, 2018.

TABLES

Table 1 - Groundwater Data Summary
Welsh - Primary Bottom Ash Pond

Parameter	Unit	AD-1	AD-5	AD-8	AD-9	AD-15	AD-17
		2/20/2019	2/21/2019	2/21/2019	2/21/2019	2/21/2019	2/21/2019
Antimony	µg/L	0.160	0.0200 J	0.100 U	0.100 U	0.100 U	0.0800 J
Arsenic	µg/L	0.460	1.59	0.570	1.18	2.21	2.51
Barium	µg/L	457	69.4	28.1	52.4	76.6	120
Beryllium	µg/L	0.0900 J	0.0800 J	0.0300 J	0.474	0.208	0.240
Boron	mg/L	0.504	0.0330	1.47	1.39	0.169	0.151
Cadmium	µg/L	0.0100 J	0.0500 U	0.0300 J	0.0900	0.0100 J	0.270
Calcium	mg/L	142	33.9	17.6	211	2.67	207
Chloride	mg/L	2.82	24.7	23.2	89.0	28.2	43.2
Chromium	µg/L	0.306	0.432	0.456	0.313	0.225	3.34
Cobalt	µg/L	0.399	8.58	2.88	14.8	2.90	64.5
Combined Radium	pCi/L	3.16	1.27	0.417	2.51	0.841	2.66
Fluoride	mg/L	0.240	0.210	0.660	0.190	0.0900	0.180
Lead	µg/L	0.124	0.147	0.223	0.0800 J	0.104	2.49
Lithium	mg/L	0.00155	0.0807	0.0911	1.12	0.00294	0.268
Mercury	mg/L	0.0000250 U	0.0000250 U	0.0000250 U	0.0000100 J	0.0000250 U	0.00000700 J
Molybdenum	µg/L	1.00 J	2.00 U	2.00 U	2.00 U	2.00 U	0.700 J
Selenium	µg/L	0.700	0.100 J	0.100 J	0.300	0.400	0.800
Total Dissolved Solids	mg/L	522	220	352	2240	150	1720
Sulfate	mg/L	49.2	46.5	163	1350	10.6	1060
Thallium	µg/L	0.500 U	0.500 U	0.500 U	0.100 J	0.500 U	0.500 U
pH	SU	7.31	5.38	6.40	4.98	4.98	6.93

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
Welsh Plant - Primary Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.58
Beryllium, Total (mg/L)	0.004		0.00073
Cadmium, Total (mg/L)	0.005		0.01
Chromium, Total (mg/L)	0.1		0.0036
Cobalt, Total (mg/L)	n/a	0.006	0.075
Combined Radium, Total (pCi/L)	5		4.18
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.39
Mercury, Total (mg/L)	0.002		0.000033
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.0013

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
Welsh Plant - Primary Bottom Ash Pond

Parameter	Units	Description	AD-15	AD-8		AD-9	
			2/21/2019	2/21/2019	4/30/2019	2/21/2019	4/30/2019
Boron	mg/L	Interwell Background Value (UPL)	0.775				
		Detection Monitoring Result	0.169	**1.47**	**1.21**	**1.39**	0.07
Calcium	mg/L	Intrawell Background Value (UPL)	5.71	35.7		350	
		Detection Monitoring Result	2.67	17.6	--	211	--
Chloride	mg/L	Intrawell Background Value (UPL)	38.4	38.3		139	
		Detection Monitoring Result	28.2	23.2	--	89	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00	1.03		0.73	
		Detection Monitoring Result	0.09	0.66	--	0.19	--
pH	SU	Interwell Background Value (UPL)	7.1				
		Interwell Background Value (LPL)	4.8				
		Detection Monitoring Result	5.0	6.4	6.9	5.0	**4.5**
Sulfate	mg/L	Intrawell Background Value (UPL)	35.6	236		2527	
		Detection Monitoring Result	10.6	163	--	1350	--
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	388	569		3147	
		Detection Monitoring Result	150	352	--	2240	--

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

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 calculated background value.

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 Welsh Primary Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

112498

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498

License Number

TEXAS

Licensing State

07.11.19

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: Welsh PBAP
Assessment Monitoring Event – April 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of April 2019 groundwater data for American Electric Power Inc.'s Welsh PBAP. 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-1, AD-5, and AD-17; and
- **Downgradient wells:** AD-8, AD-9, and AD-15.

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 the Outlier Summary following this letter (Figure B), and are plotted in a lighter font and disconnected symbol on the time series graphs. Note that the measured concentrations of most metals for September 30, 2016 at well AD-15 are very high compared to the rest of the observations, which suggests a possible laboratory problem. These values are not currently flagged in the database pending verification.

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron and pH; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, chloride, fluoride, sulfate and TDS (Figure 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.

No prediction limit exceedances were noted for any of the Appendix III parameters in downgradient wells except for boron in wells AD-8 and AD-9. Calcium in upgradient well AD-17 and chloride in upgradient well AD-5 exceeded their intrawell prediction limits which is typically an indication that groundwater is changing naturally upgradient of the facility. The results of the prediction limit analyses 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 D). Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site. Such patterns would be an indication of natural variability in groundwater quality unrelated to practices at the site. No statistically significant increasing or decreasing trends were found for any of the well/parameter pairs. A Trend Test summary table follows this letter.

Evaluation of Appendix IV Parameters

Upper 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 tolerance 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 and compared to 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. No confidence intervals exceedances were found except for lithium in well AD-9. 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 Welsh PBAP. If you have any questions or comments, please feel free to contact me.

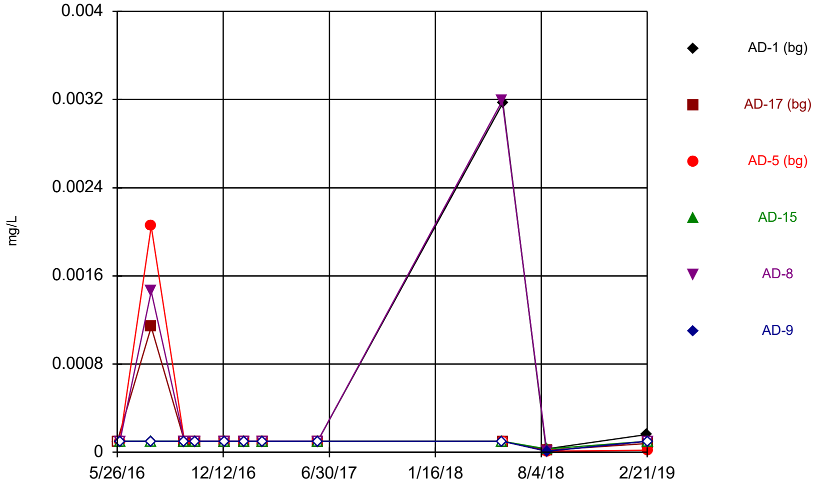
For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

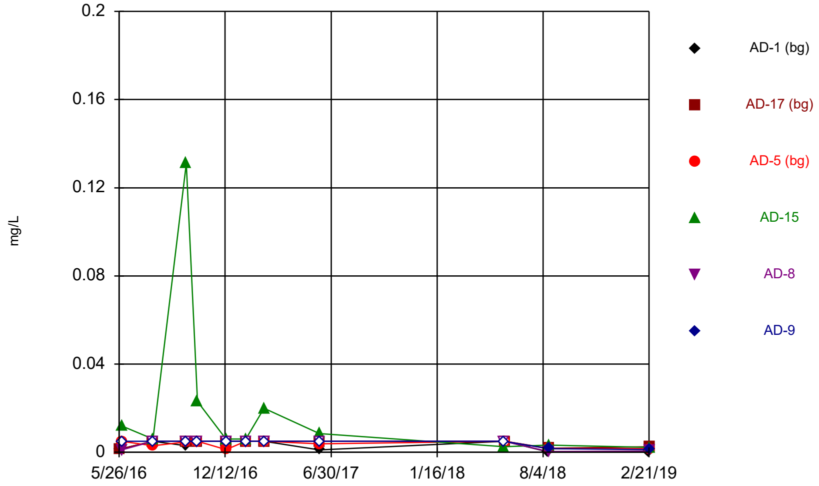
Time Series



Constituent: Antimony, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

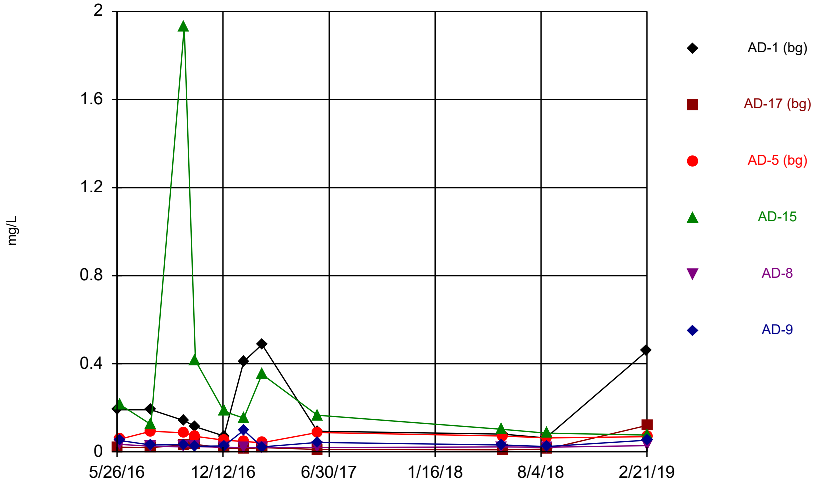
Time Series



Constituent: Arsenic, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

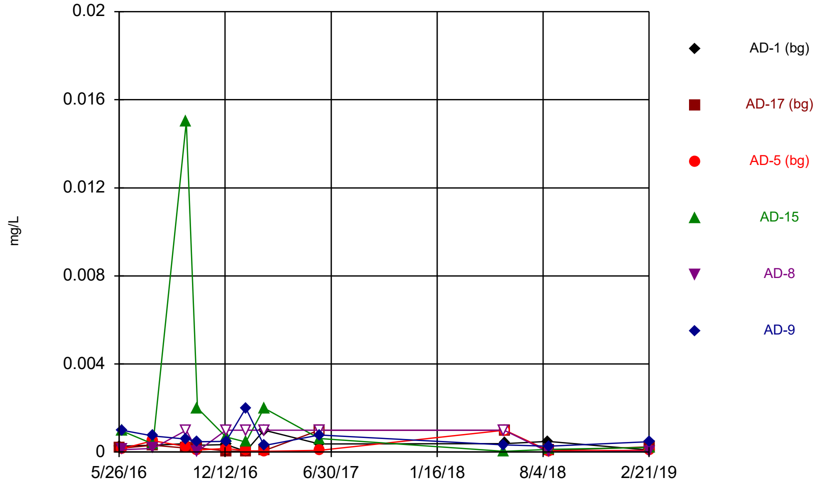
Time Series



Constituent: Barium, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

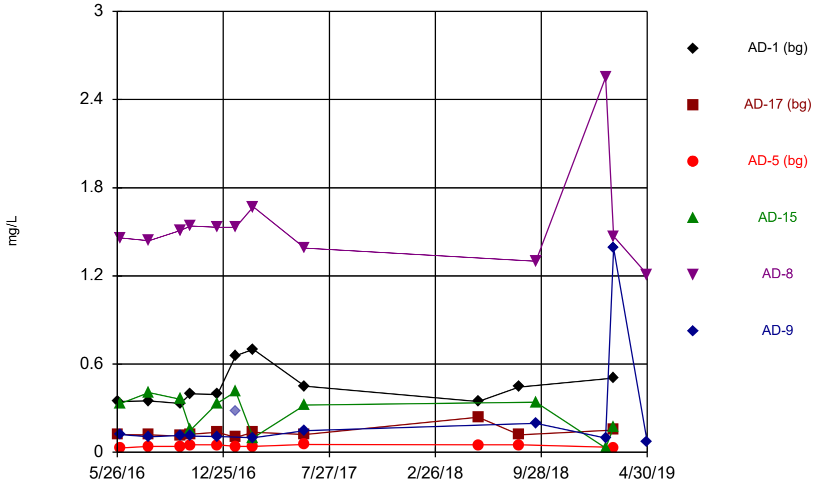
Time Series



Constituent: Beryllium, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



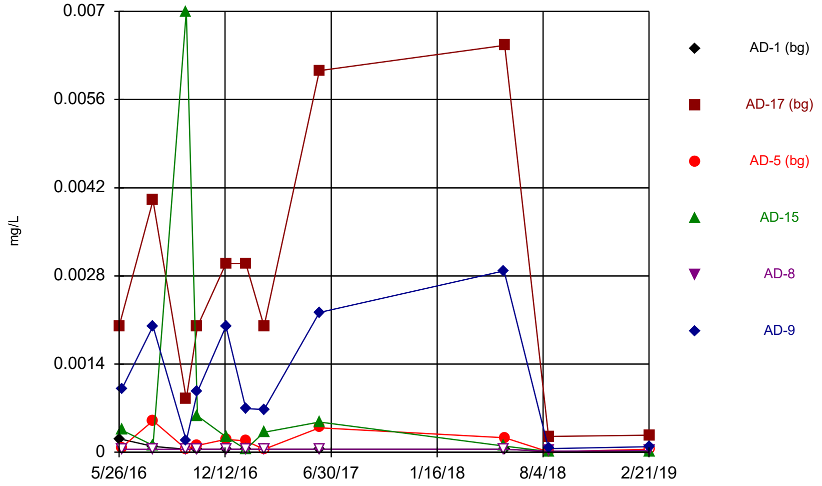
Constituent: Boron, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Time Series

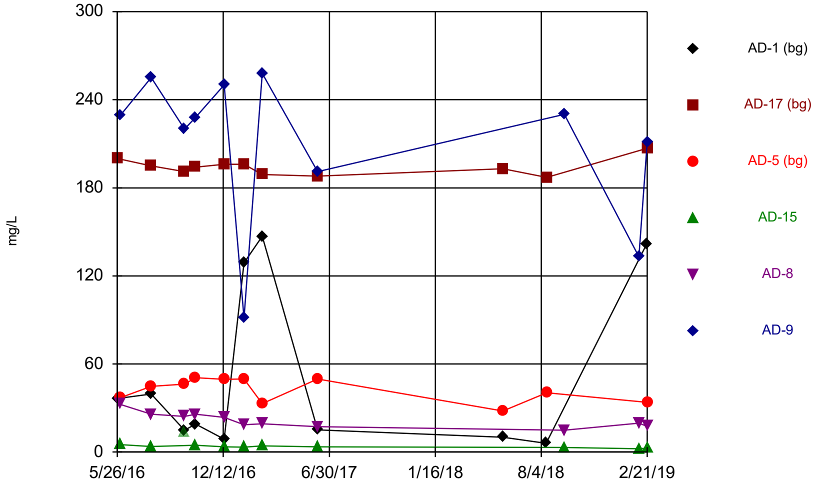


Constituent: Cadmium, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series

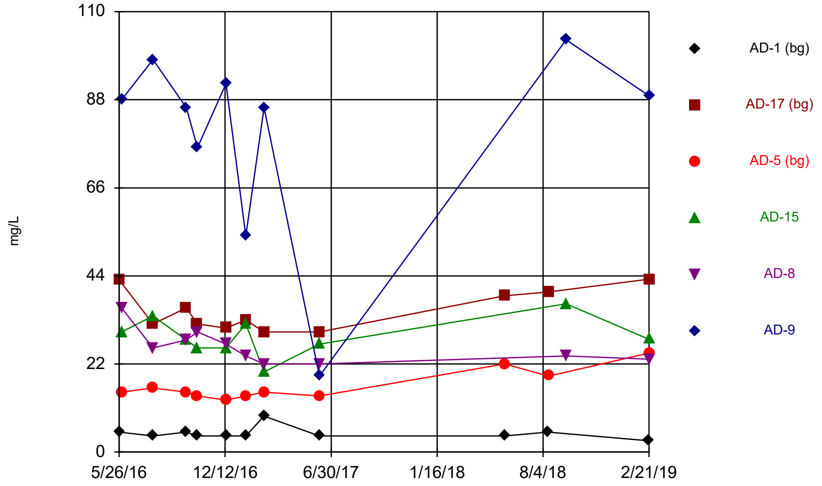


Constituent: Calcium, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series

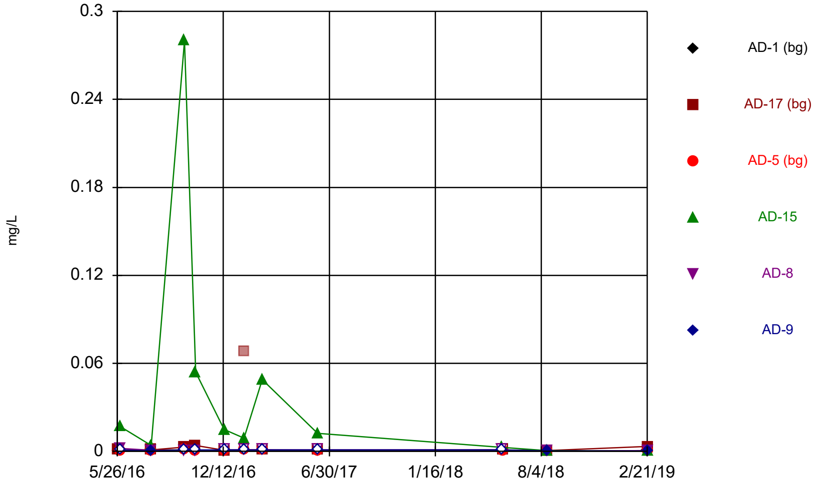


Constituent: Chloride, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

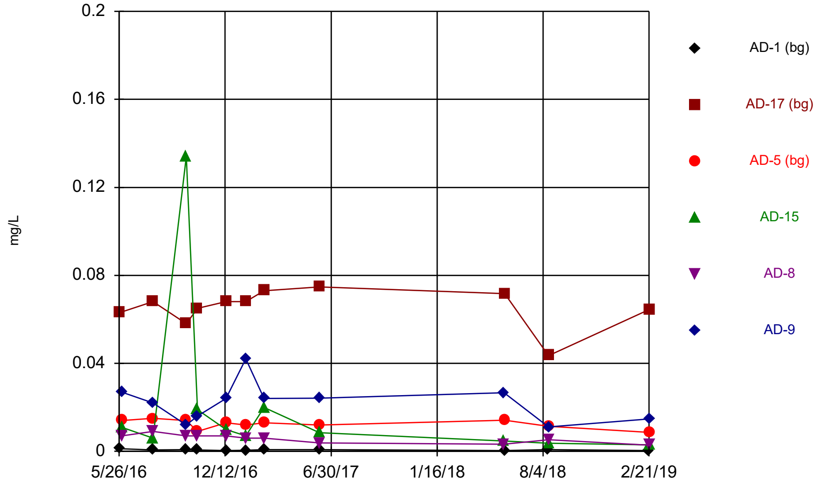
Time Series



Constituent: Chromium, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

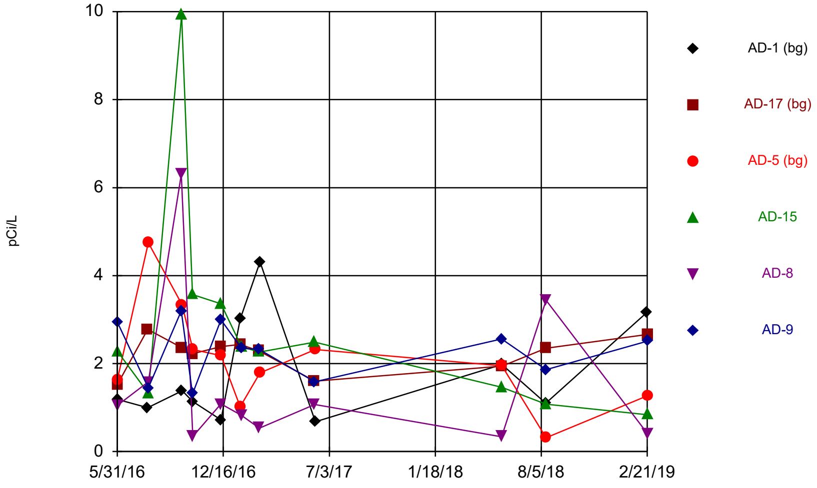
Time Series



Constituent: Cobalt, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

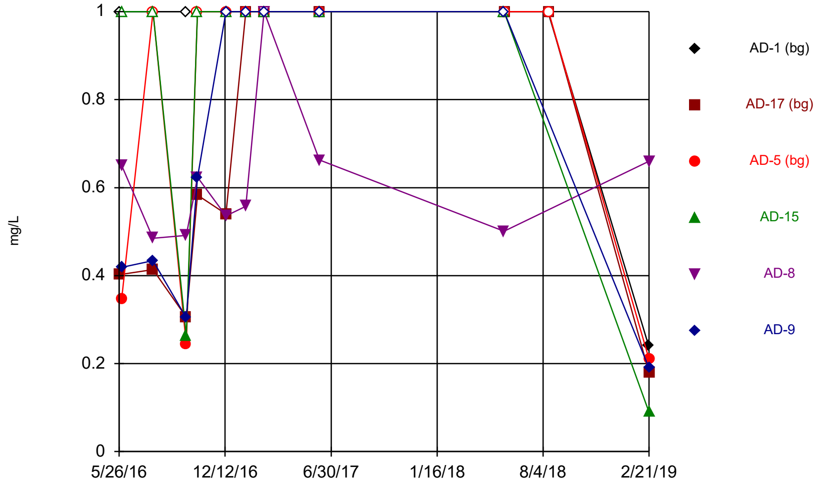
Time Series



Constituent: Combined Radium 226 + 228   Analysis Run 6/30/2019 6:49 PM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

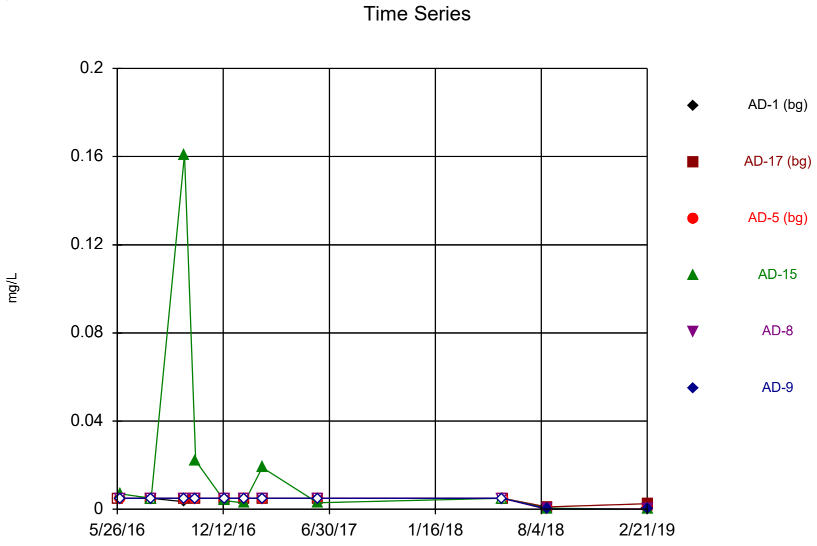
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



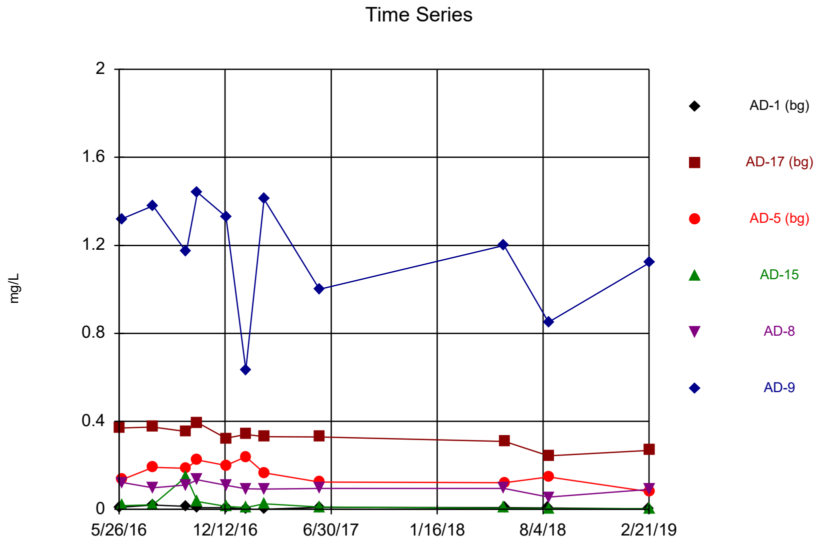
Constituent: Fluoride, total   Analysis Run 6/30/2019 6:49 PM   View: Descriptive
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



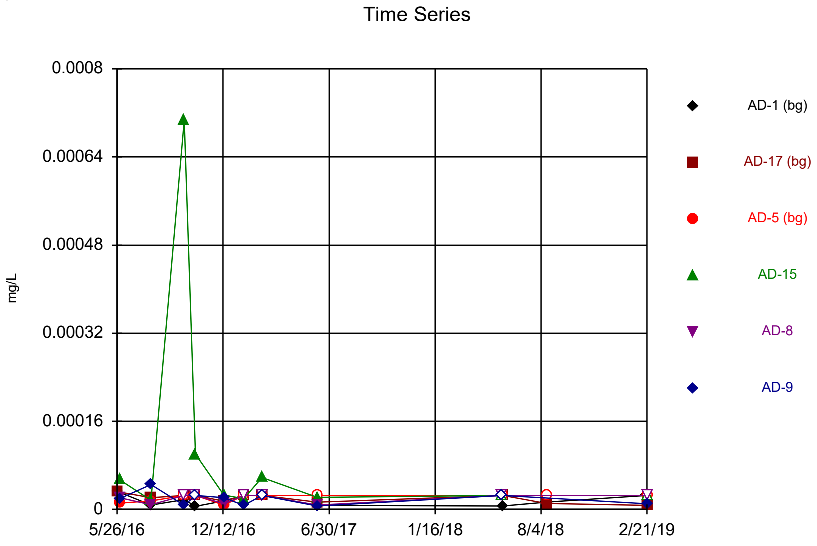
Constituent: Lead, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



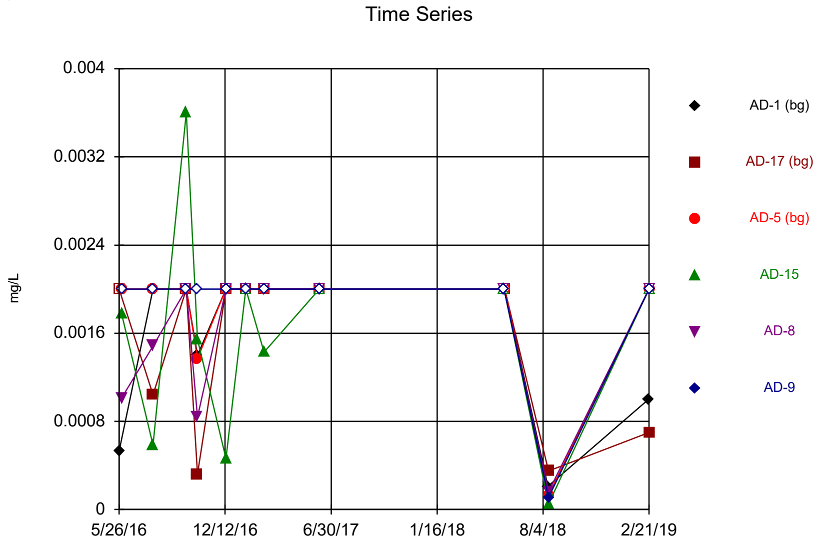
Constituent: Lithium, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



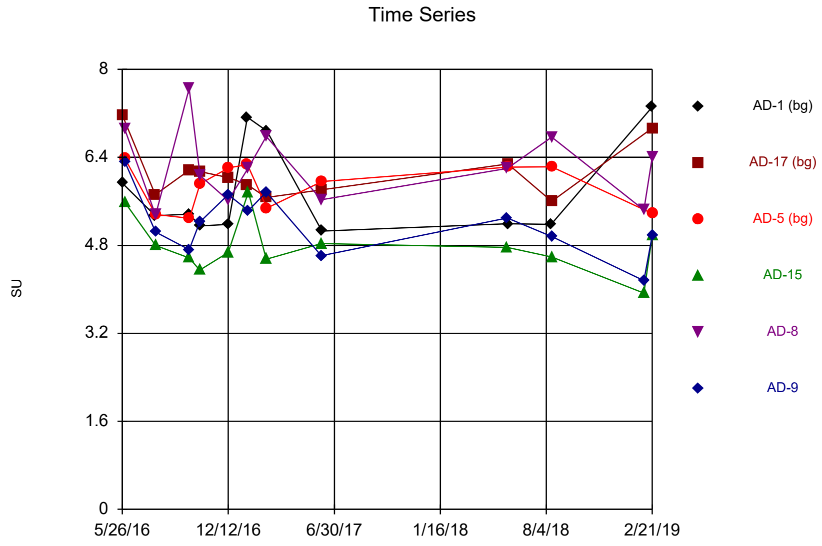
Constituent: Mercury, total Analysis Run 6/30/2019 6:49 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



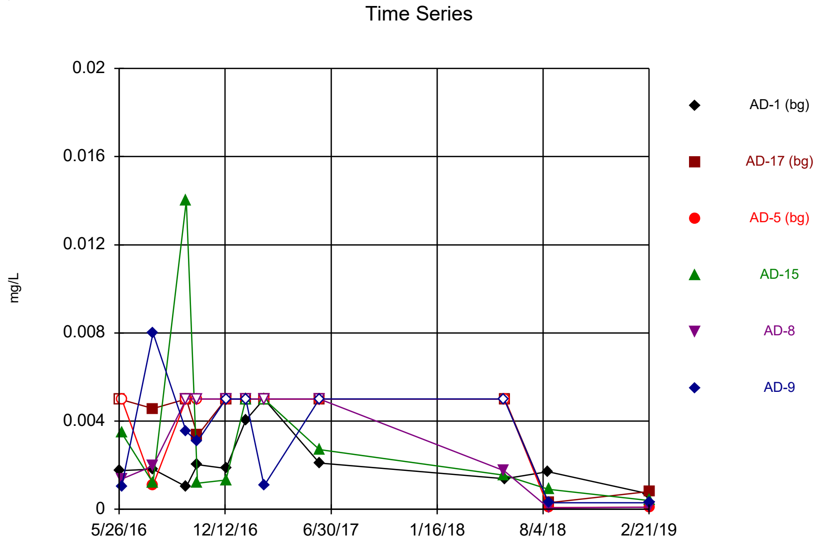
Constituent: Molybdenum, total Analysis Run 6/30/2019 6:50 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



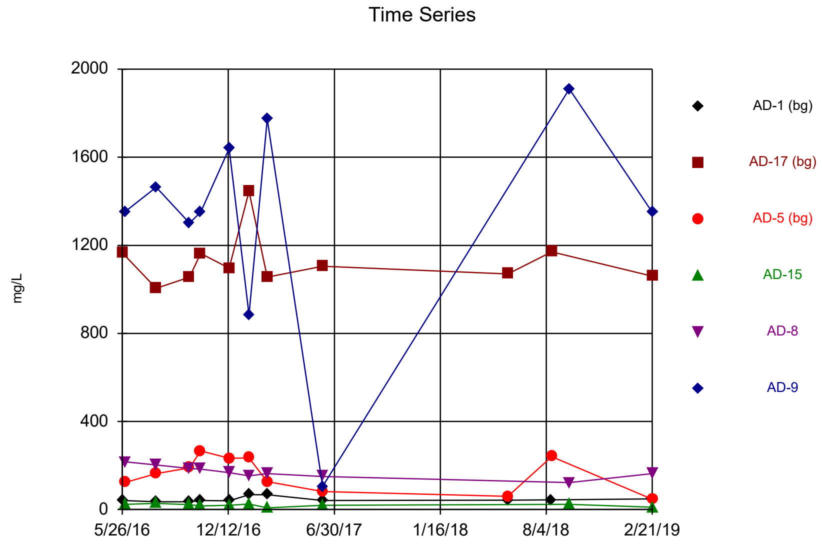
Constituent: pH, field Analysis Run 6/30/2019 6:50 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



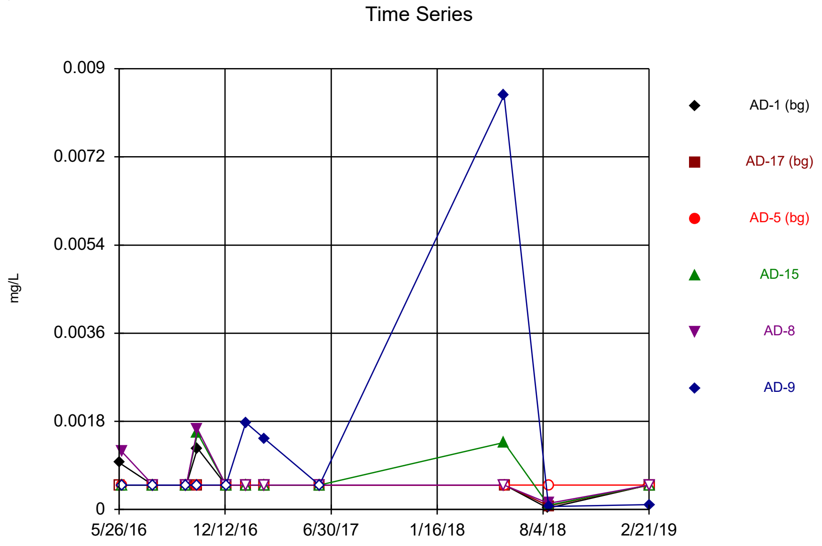
Constituent: Selenium, total Analysis Run 6/30/2019 6:50 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

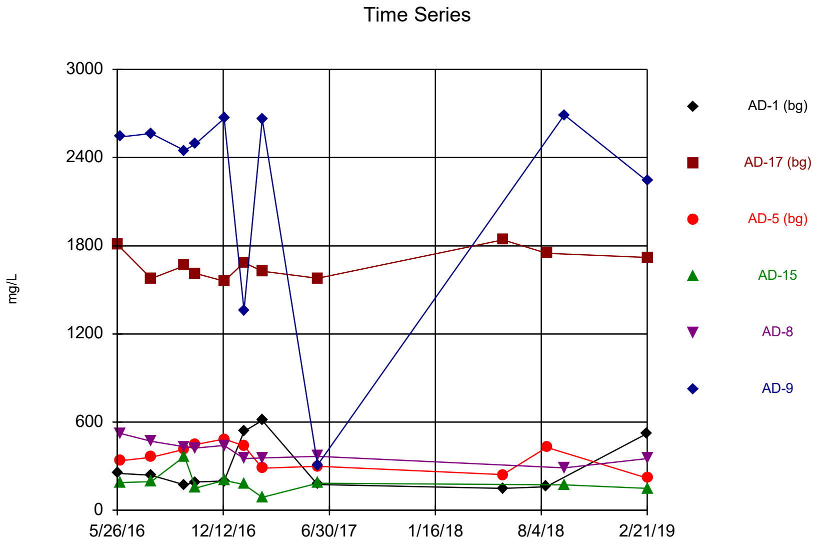


Constituent: Sulfate, total Analysis Run 6/30/2019 6:50 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Thallium, total Analysis Run 6/30/2019 6:50 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP



Constituent: Total Dissolved Solids Analysis Run 6/30/2019 6:50 PM View: Descriptive
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Outlier Summary Table

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 07/05/2019, 1:19 PM

	AD-9 Boron, total (mg/L)	AD-15 Calcium, total (mg/L)	AD-17 Chromium, total (mg/L)
9/30/2016		13.7 (o)	
1/20/2017	0.283 (o)		0.068 (o)

Interwell Prediction Limit Summary - Significant Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 6/30/2019, 7:00 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-8**	**0.775**	**n/a**	**2/21/2019**	**1.47**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-9**	**0.775**	**n/a**	**2/21/2019**	**1.39**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary - All Results

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 6/30/2019, 7:00 PM

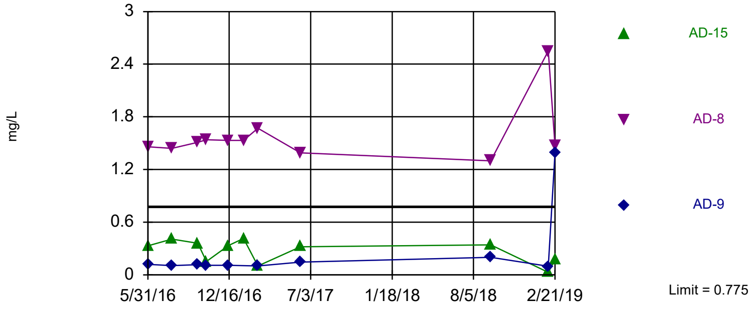
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-15	0.775	n/a	2/21/2019	0.169	No	33	-2.01	0.986	0	None	ln(x)	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-8**	**0.775**	**n/a**	**2/21/2019**	**1.47**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-9**	**0.775**	**n/a**	**2/21/2019**	**1.39**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
pH, field (SU)	AD-15	7.059	4.811	2/21/2019	4.98	No	33	5.935	0.6316	0	None	No	0.001253	Param Inter 1 of 2
pH, field (SU)	AD-8	7.059	4.811	2/21/2019	6.4	No	33	5.935	0.6316	0	None	No	0.001253	Param Inter 1 of 2
pH, field (SU)	AD-9	7.059	4.811	2/21/2019	4.98	No	33	5.935	0.6316	0	None	No	0.001253	Param Inter 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-8, AD-9

Prediction Limit

Interwell Parametric



Background Data Summary (based on natural log transformation): Mean=-2.01, Std. Dev.=0.986, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9116, 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.

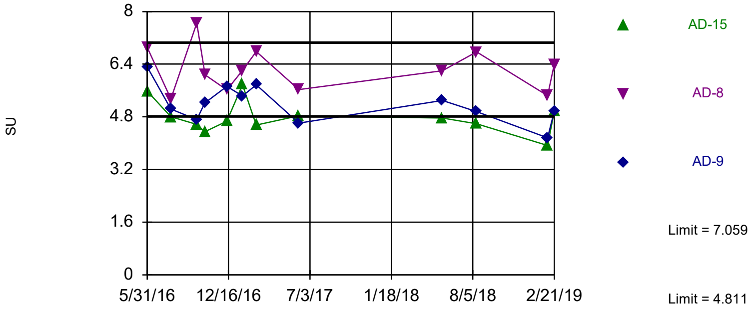
Constituent: Boron, total Analysis Run 6/30/2019 6:58 PM View: PL's - Interwell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=5.935, Std. Dev.=0.6316, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9252, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 3 points to limit.

Constituent: pH, field Analysis Run 6/30/2019 6:58 PM View: PL's - Interwell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Intrawell Prediction Limit Summary - Significant Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 6/30/2019, 7:06 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-17**	**203.5**	**n/a**	**2/21/2019**	**207**	**Yes**	**8**	**193.6**	**4.033**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Chloride, total (mg/L)	**AD-5**	**16.78**	**n/a**	**2/21/2019**	**24.7**	**Yes**	**8**	**14.5**	**0.9258**	**0**	**None**	**No**	**0.002505**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 6/30/2019, 7:06 PM

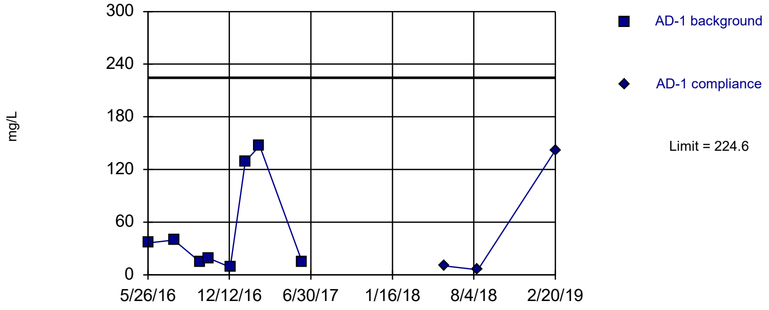
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-1	224.6	n/a	2/20/2019	142	No	8	6.363	3.508	0	None	sqrt(x)	0.002505	Param 1 of 2
Calcium, total (mg/L)	**AD-17**	**203.5**	**n/a**	**2/21/2019**	**207**	**Yes**	**8**	**193.6**	**4.033**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Calcium, total (mg/L)	AD-5	61.45	n/a	2/21/2019	33.9	No	8	45.09	6.656	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-15	5.711	n/a	2/21/2019	2.67	No	7	4.031	0.6254	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-8	35.68	n/a	2/21/2019	17.6	No	8	23.46	4.969	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-9	349.9	n/a	2/21/2019	211	No	8	215.3	54.76	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-1	9	n/a	2/20/2019	2.82	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Chloride, total (mg/L)	AD-17	44.04	n/a	2/21/2019	43.2	No	8	33.38	4.34	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	**AD-5**	**16.78**	**n/a**	**2/21/2019**	**24.7**	**Yes**	**8**	**14.5**	**0.9258**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Chloride, total (mg/L)	AD-15	38.42	n/a	2/21/2019	28.2	No	8	27.88	4.291	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-8	38.29	n/a	2/21/2019	23.2	No	8	26.88	4.643	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-9	139.3	n/a	2/21/2019	89	No	8	74.88	26.2	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-1	1	n/a	2/20/2019	0.24	No	8	n/a	n/a	100	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-17	0.6953	n/a	2/21/2019	0.18	No	8	0.4488	0.1003	37.5	Kaplan-Meier	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-5	1	n/a	2/21/2019	0.21	No	8	n/a	n/a	75	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-15	1	n/a	2/21/2019	0.09	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	1.034	n/a	2/21/2019	0.66	No	8	0.6258	0.166	12.5	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-9	0.7259	n/a	2/21/2019	0.19	No	8	0.4449	0.1143	50	Kaplan-Meier	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-1	82.3	n/a	2/20/2019	49.2	No	8	6.772	0.9358	0	None	sqrt(x)	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-17	1471	n/a	2/21/2019	1060	No	8	1136	136.3	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-5	336.4	n/a	2/21/2019	46.5	No	8	177.4	64.69	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-15	35.58	n/a	2/21/2019	10.6	No	8	20.38	6.186	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-8	235.8	n/a	2/21/2019	163	No	8	178	23.53	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-9	2527	n/a	2/21/2019	1350	No	8	1234	526.1	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-1	784.8	n/a	2/20/2019	522	No	8	16.71	4.598	0	None	sqrt(x)	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1840	n/a	2/21/2019	1720	No	8	1639	81.77	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-5	563.5	n/a	2/21/2019	220	No	8	383.6	73.17	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-15	388.1	n/a	2/21/2019	150	No	8	194.4	78.82	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-8	568.6	n/a	2/21/2019	352	No	8	420.9	60.09	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids (mg/L)	AD-9	3147	n/a	2/21/2019	2240	No	8	1.3e10	7.4e9	0	None	x^3	0.002505	Param 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=6.363, Std. Dev.=3.508, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8248, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

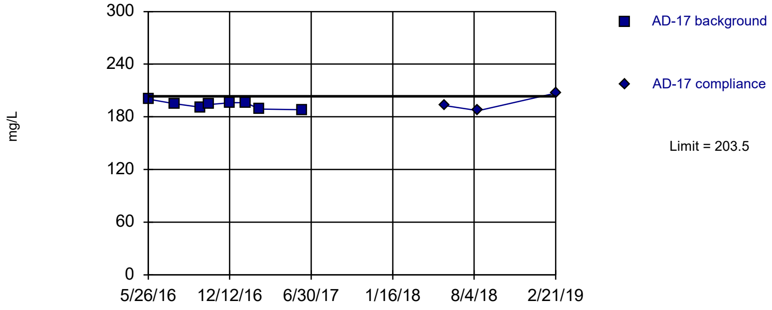
Constituent: Calcium, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=193.6, Std. Dev.=4.033, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9507, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

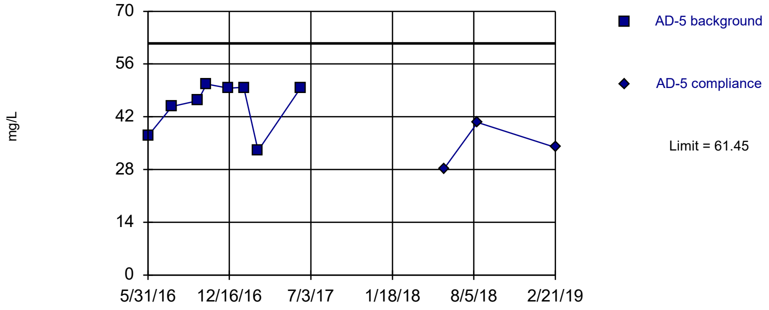
Constituent: Calcium, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=45.09, Std. Dev.=6.656, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8101, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

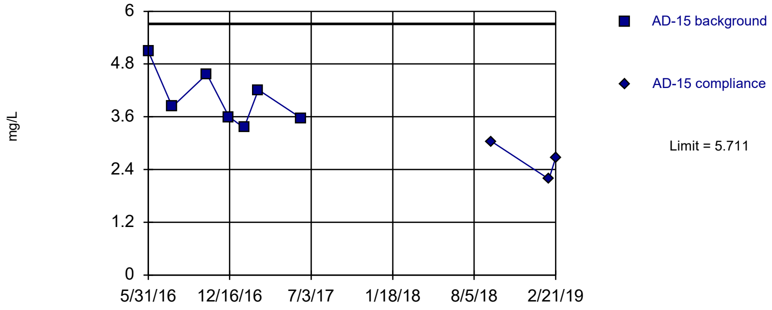
Constituent: Calcium, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.031, Std. Dev.=0.6254, n=7. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9248, critical = 0.73. Kappa = 2.685 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

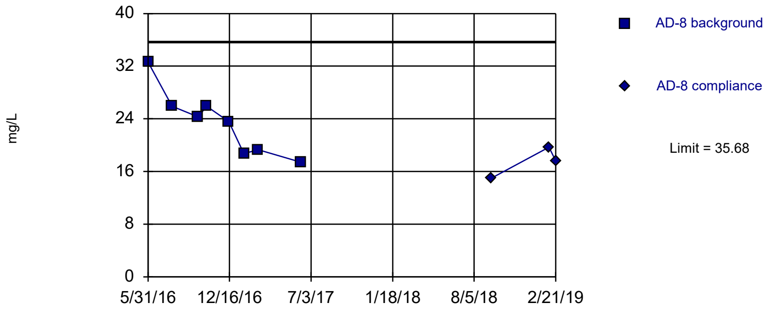
Constituent: Calcium, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=23.46, Std. Dev.=4.969, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9282, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

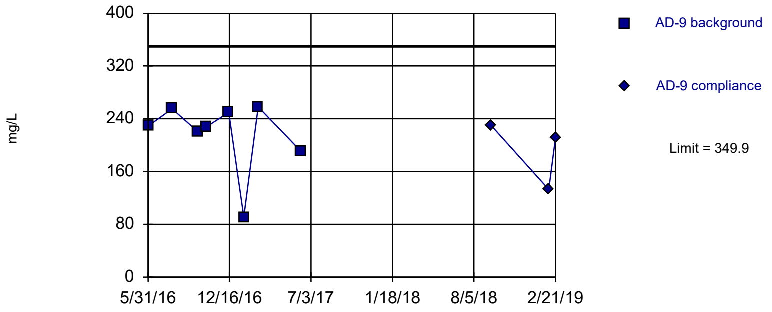
Constituent: Calcium, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=215.3, Std. Dev.=54.76, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7629, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

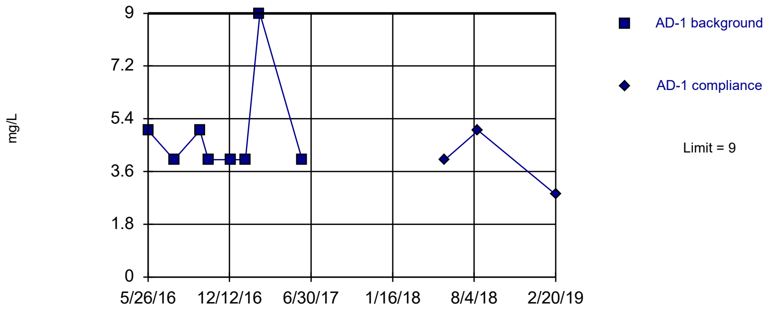
Constituent: Calcium, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 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).

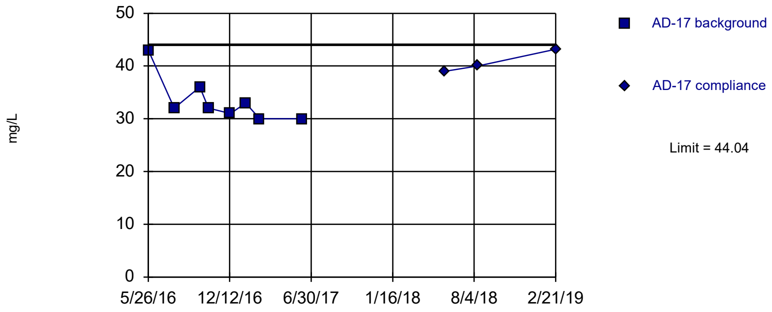
Constituent: Chloride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=33.38, Std. Dev.=4.34, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

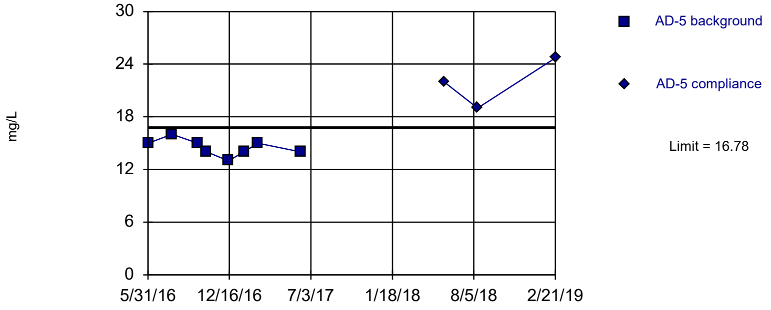
Constituent: Chloride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=14.5, Std. Dev.=0.9258, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9302, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

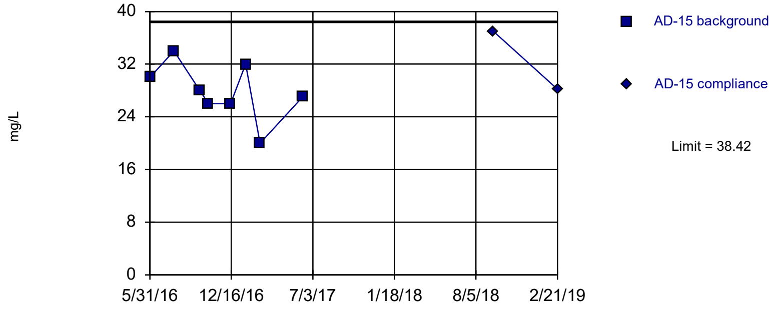
Constituent: Chloride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=27.88, Std. Dev.=4.291, 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.

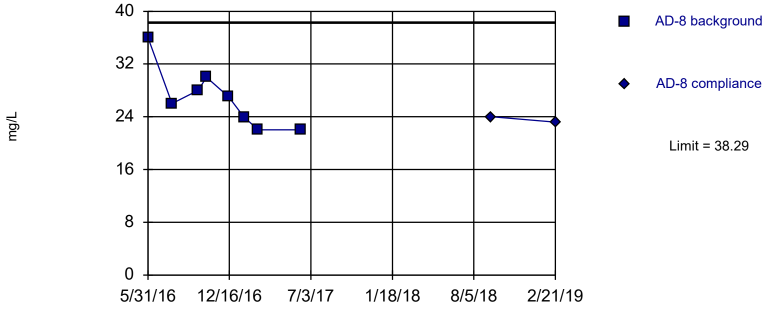
Constituent: Chloride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=26.88, Std. Dev.=4.643, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9162, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

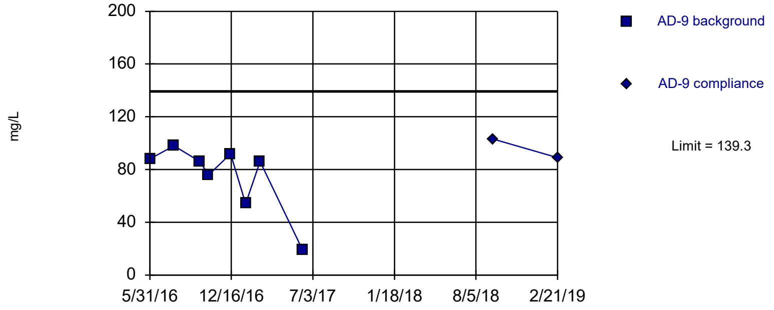
Constituent: Chloride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=74.88, Std. Dev.=26.2, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7978, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

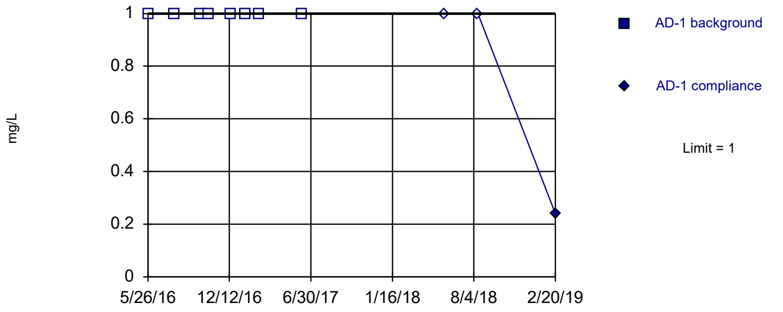
Constituent: Chloride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 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).

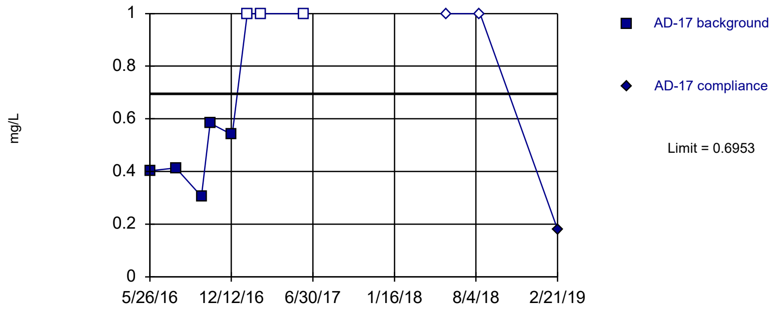
Constituent: Fluoride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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 (after Kaplan-Meier Adjustment): Mean=0.4488, Std. Dev.=0.1003, n=8, 37.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8226, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

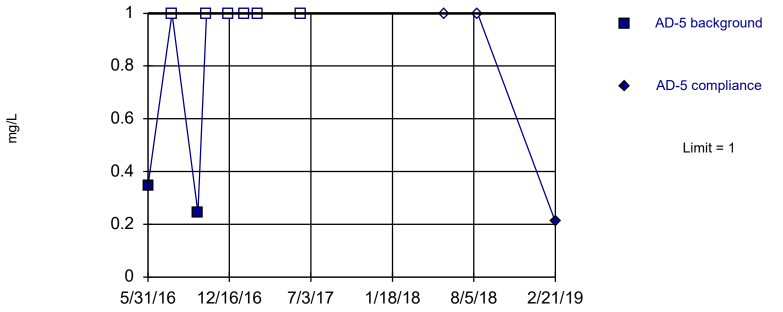
Constituent: Fluoride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 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. 75% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

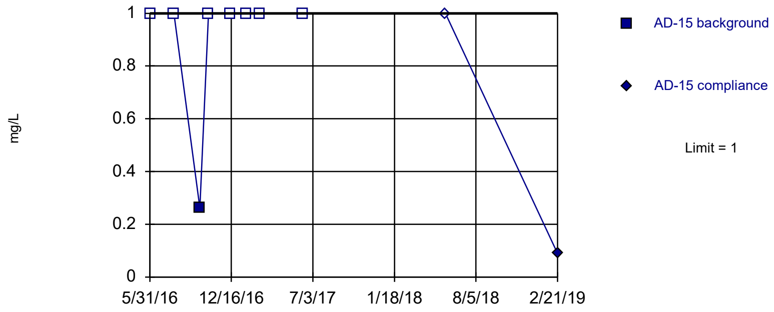
Constituent: Fluoride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 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).

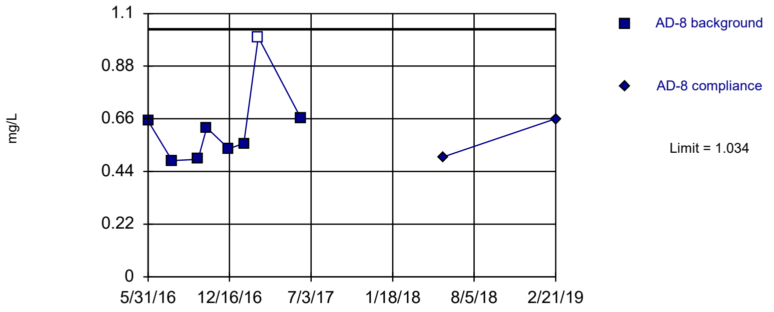
Constituent: Fluoride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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=0.6258, Std. Dev.=0.166, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7879, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

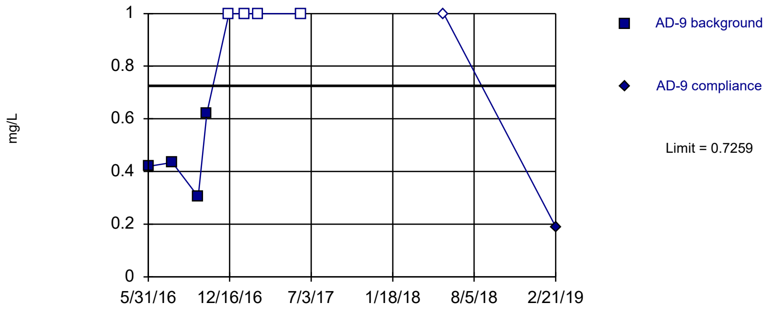
Constituent: Fluoride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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 (after Kaplan-Meier Adjustment): Mean=0.4449, Std. Dev.=0.1143, n=8, 50% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.786, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

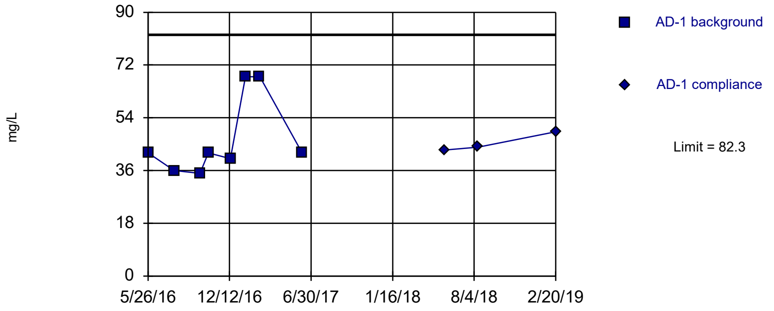
Constituent: Fluoride, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=6.772, Std. Dev.=0.9358, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7528, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

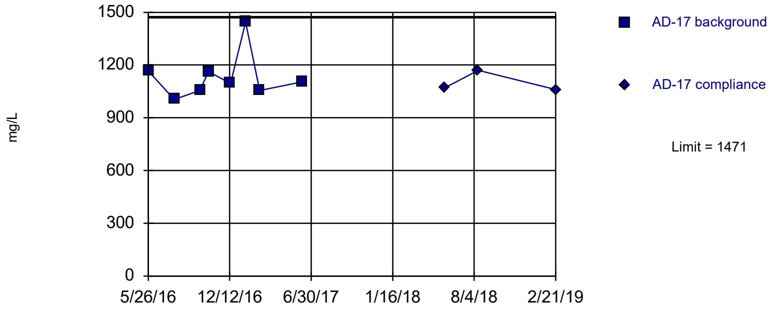
Constituent: Sulfate, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1136, Std. Dev.=136.3, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7916, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

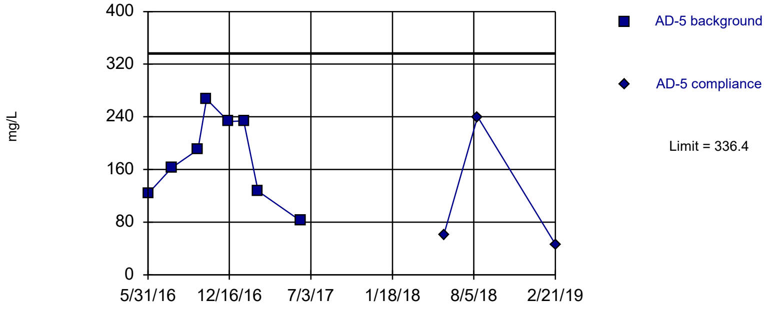
Constituent: Sulfate, total Analysis Run 6/30/2019 7:02 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=177.4, Std. Dev.=64.69, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.953, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

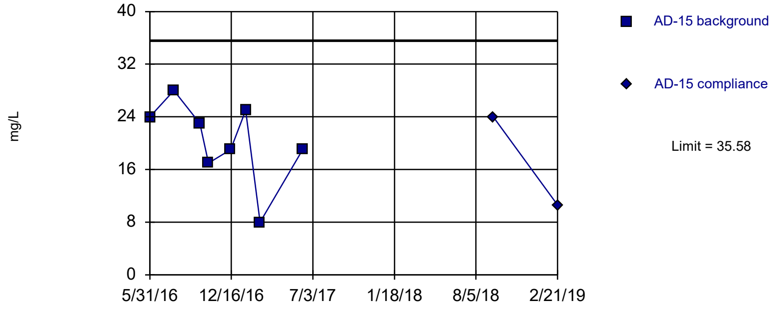
Constituent: Sulfate, total Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=20.38, Std. Dev.=6.186, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9238, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

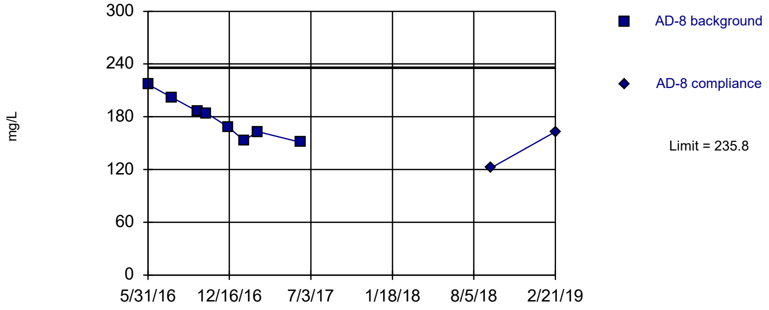
Constituent: Sulfate, total Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=178, Std. Dev.=23.53, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9398, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

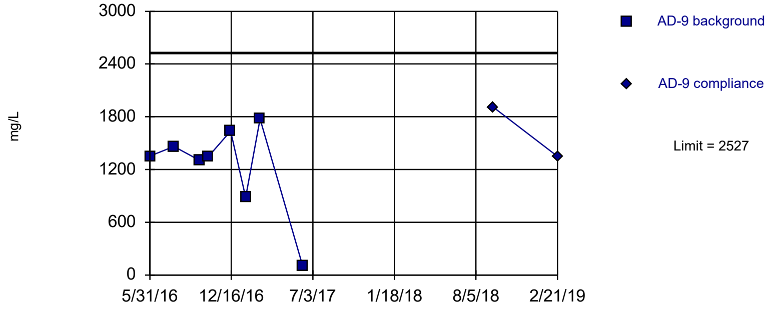
Constituent: Sulfate, total Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1234, Std. Dev.=526.1, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8423, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

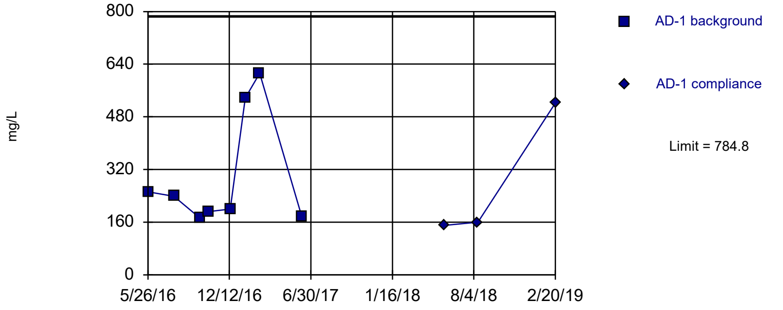
Constituent: Sulfate, total Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=16.71, Std. Dev.=4.598, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.756, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

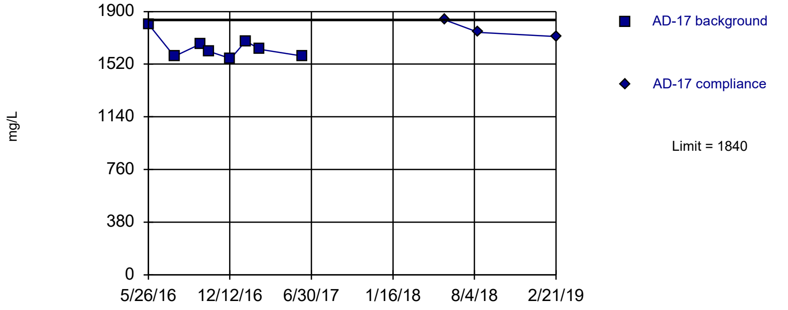
Constituent: Total Dissolved Solids Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1639, Std. Dev.=81.77, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8702, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

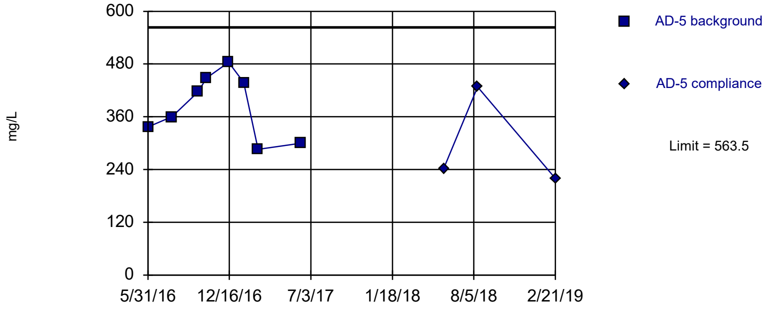
Constituent: Total Dissolved Solids Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=383.6, Std. Dev.=73.17, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.937, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

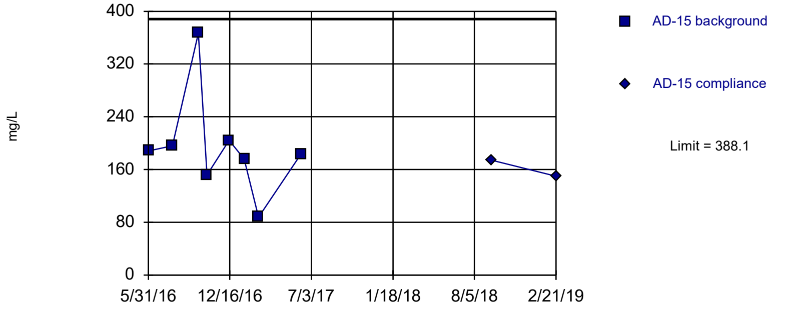
Constituent: Total Dissolved Solids Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



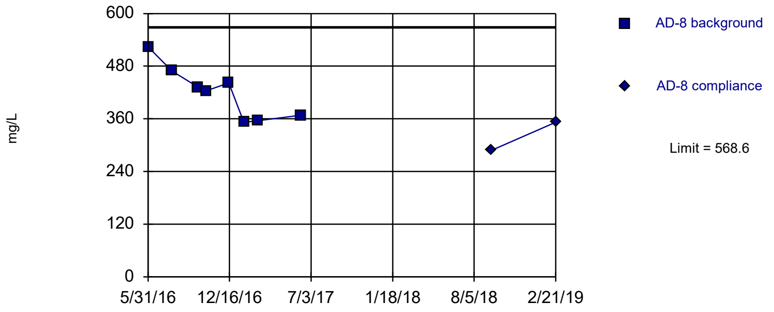
Background Data Summary: Mean=194.4, Std. Dev.=78.82, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8214, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Within Limit

Prediction Limit

Intrawell Parametric



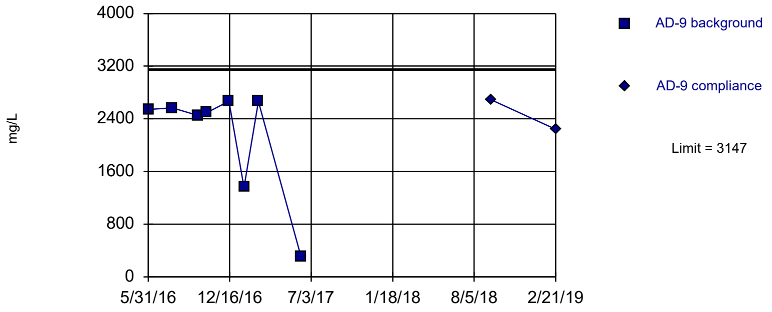
Background Data Summary: Mean=420.9, Std. Dev.=60.09, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9284, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on cube transformation): Mean=1.3e10, Std. Dev.=7.4e9, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.759, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

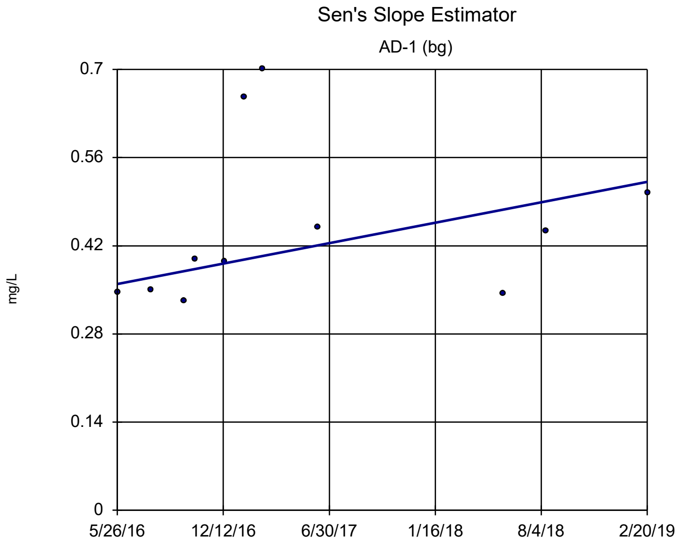
Constituent: Total Dissolved Solids Analysis Run 6/30/2019 7:03 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Trend Test Summary Table - All Results (No Significant)

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 7/5/2019, 3:38 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-1 (bg)	0.05932	21	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-17 (bg)	0.01094	15	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-5 (bg)	0.001099	14	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8	-0.02807	-5	-38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-9	-0.005594	-5	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-1 (bg)	-2.915	-5	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-17 (bg)	-2.239	-14	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-5 (bg)	-3.095	-9	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-1 (bg)	0	-11	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-17 (bg)	1.822	5	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-5 (bg)	2.719	15	34	No	11	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

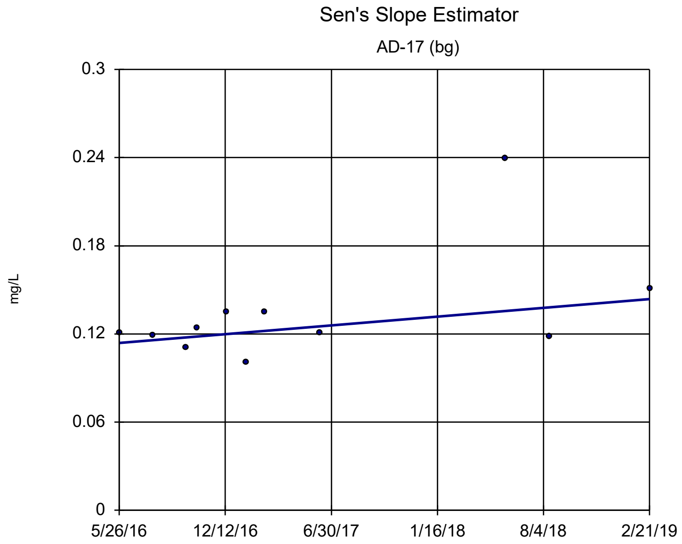
Slope = 0.05932
units per year.

Mann-Kendall
statistic = 21
critical = 34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:37 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

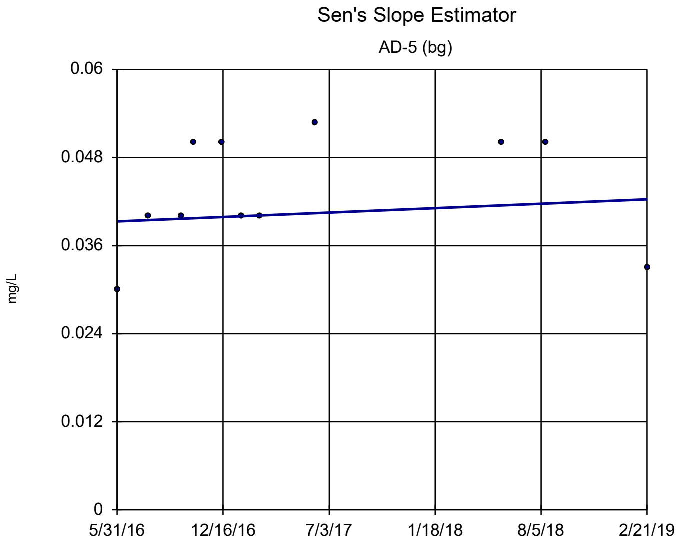
Slope = 0.01094
units per year.

Mann-Kendall
statistic = 15
critical = 34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:37 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

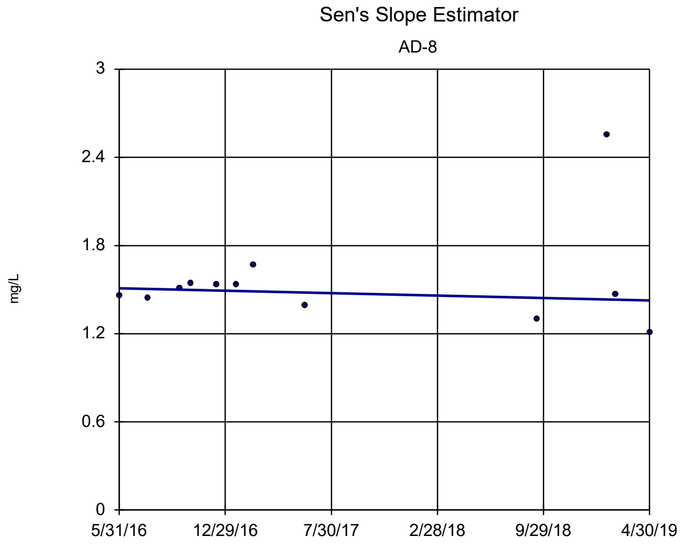
Slope = 0.001099
units per year.

Mann-Kendall
statistic = 14
critical = 34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:37 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

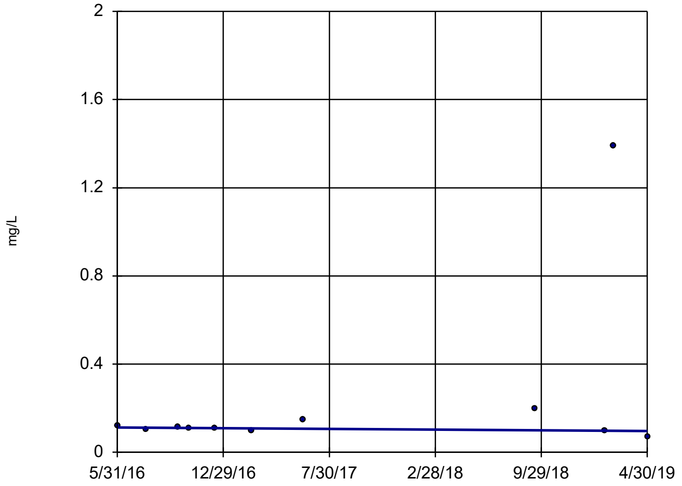
Slope = -0.02807
units per year.

Mann-Kendall
statistic = -5
critical = -38

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:37 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-9

n = 11

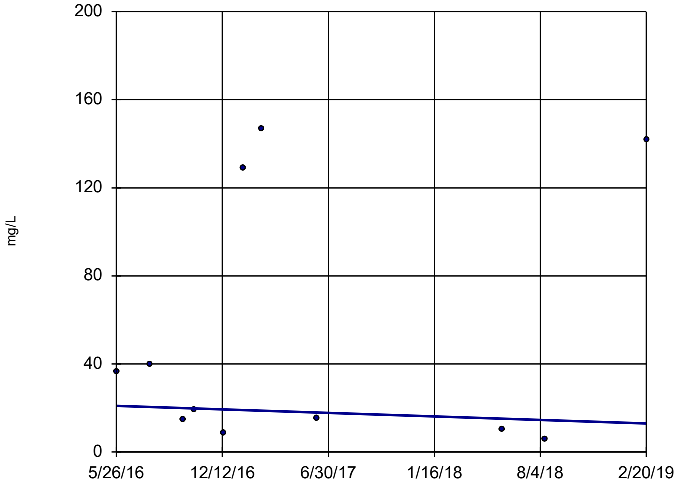
Slope = -0.005594
units per year.

Mann-Kendall
statistic = -5
critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 7/5/2019 3:37 PM   View: Trend Tests
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-1 (bg)

n = 11

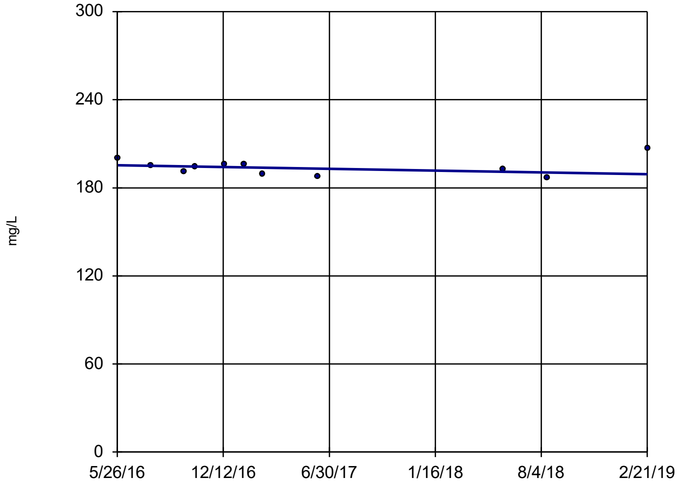
Slope = -2.915
units per year.

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 3:37 PM   View: Trend Tests
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-17 (bg)

n = 11

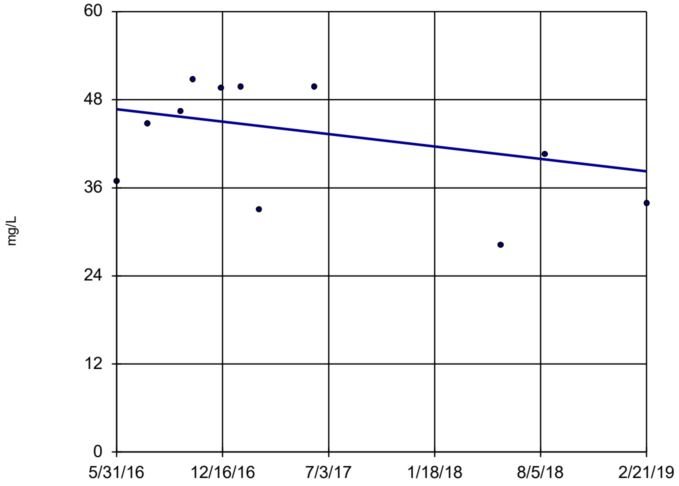
Slope = -2.239
units per year.

Mann-Kendall
statistic = -14
critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total   Analysis Run 7/5/2019 3:38 PM   View: Trend Tests
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-5 (bg)

n = 11

Slope = -3.095
units per year.

Mann-Kendall
statistic = -9
critical = -34

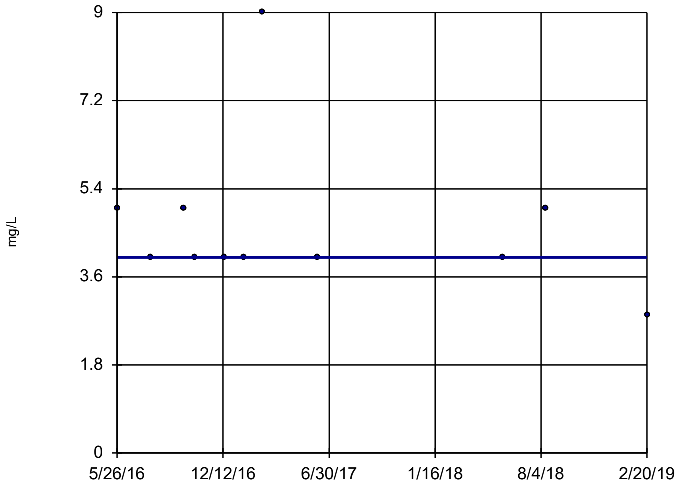
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total   Analysis Run 7/5/2019 3:38 PM   View: Trend Tests
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-1 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -11
critical = -34

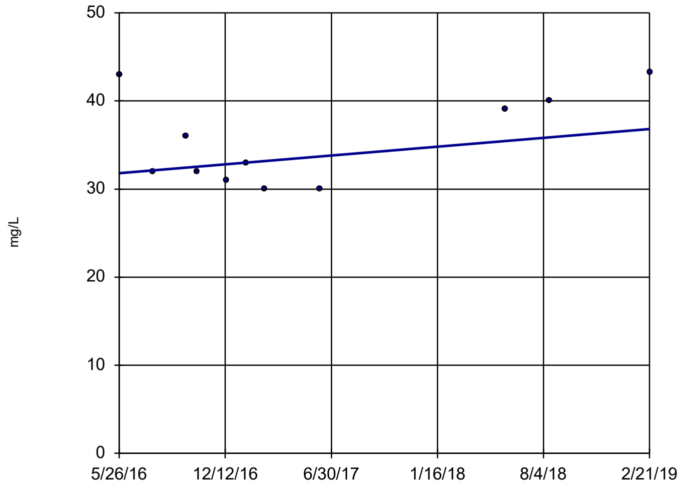
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:38 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-17 (bg)



n = 11

Slope = 1.822
units per year.

Mann-Kendall
statistic = 5
critical = 34

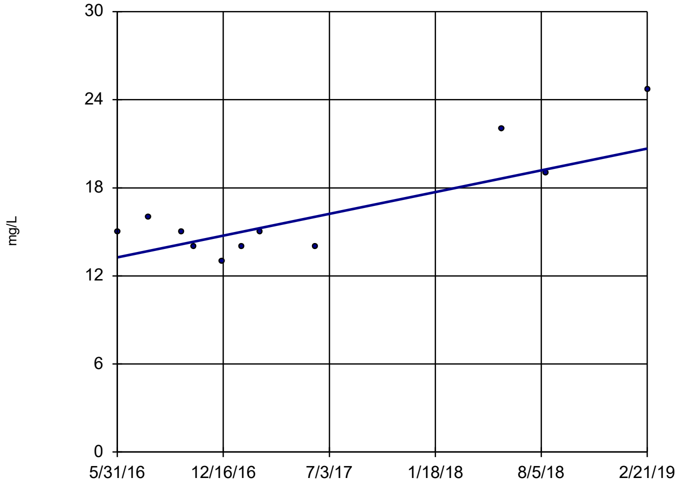
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:38 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-5 (bg)



n = 11

Slope = 2.719
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 7/5/2019 3:38 PM View: Trend Tests
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Tolerance Limit Summary Table

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 6/25/2019, 9:04 AM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.005	33	n/a	n/a	72.73	n/a	n/a	0.184	NP Inter(normality)
Arsenic, total (mg/L)	n/a	0.005	33	n/a	n/a	57.58	n/a	n/a	0.184	NP Inter(normality)
Barium, total (mg/L)	n/a	0.5818	33	-2.809	1.037	0	None	ln(x)	0.05	Inter
Beryllium, total (mg/L)	n/a	0.0007276	33	0.01425	0.005818	12.12	None	sqrt(x)	0.05	Inter
Cadmium, total (mg/L)	n/a	0.01047	33	-8.594	1.844	30.3	Kaplan-Meier	ln(x)	0.05	Inter
Chromium, total (mg/L)	n/a	0.003606	32	-7.582	0.8902	28.13	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	n/a	0.0748	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	4.182	33	2.033	0.9825	0	None	No	0.05	Inter
Fluoride, total (mg/L)	n/a	1	33	n/a	n/a	69.7	n/a	n/a	0.184	NP Inter(normality)
Lead, total (mg/L)	n/a	0.005	33	n/a	n/a	78.79	n/a	n/a	0.184	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.394	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000033	33	n/a	n/a	48.48	n/a	n/a	0.184	NP Inter(normality)
Molybdenum, total (mg/L)	n/a	0.002	33	n/a	n/a	69.7	n/a	n/a	0.184	NP Inter(normality)
Selenium, total (mg/L)	n/a	0.005	33	n/a	n/a	48.48	n/a	n/a	0.184	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.001251	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 6/25/2019, 9:18 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Lithium, total (mg/L)	**AD-9**	**1.38**	**0.9572**	**0.39**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

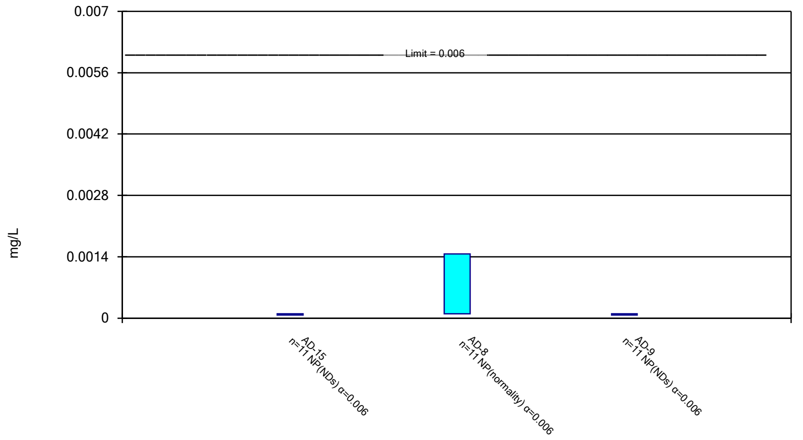
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 6/25/2019, 9:18 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-15	0.0001	0.0001	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-8	0.001461	0.0001	0.006	n/a	No	11	72.73	No	0.006	NP (normality)
Antimony, total (mg/L)	AD-9	0.0001	0.0001	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-15	0.02347	0.003302	0.01	n/a	No	11	0	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-8	0.005	0.00057	0.01	n/a	No	11	72.73	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-9	0.005	0.00168	0.01	n/a	No	11	81.82	No	0.006	NP (NDs)
Barium, total (mg/L)	AD-15	0.4354	0.09415	2	n/a	No	11	0	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-8	0.02717	0.01965	2	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-9	0.05186	0.0249	2	n/a	No	11	0	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-15	0.002289	0.0001508	0.004	n/a	No	11	0	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-8	0.001	0.00002876	0.004	n/a	No	11	54.55	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-9	0.0009934	0.0003242	0.004	n/a	No	11	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-15	0.00108	0.00004499	0.01	n/a	No	11	9.091	ln(x)	0.01	Param.
Cadmium, total (mg/L)	AD-8	0.001	0.00003	0.01	n/a	No	11	81.82	No	0.006	NP (NDs)
Cadmium, total (mg/L)	AD-9	0.001965	0.0003576	0.01	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-15	0.06035	0.00143	0.1	n/a	No	11	0	x^(1/3)	0.01	Param.
Chromium, total (mg/L)	AD-8	0.001262	0.0004447	0.1	n/a	No	11	45.45	No	0.01	Param.
Chromium, total (mg/L)	AD-9	0.001	0.000313	0.1	n/a	No	11	72.73	No	0.006	NP (normality)
Cobalt, total (mg/L)	AD-15	0.02411	0.004157	0.075	n/a	No	11	0	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-8	0.007411	0.004278	0.075	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-9	0.02945	0.01487	0.075	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-15	4.165	1.202	5	n/a	No	11	0	x^(1/3)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-8	2.41	0.4166	5	n/a	No	11	0	x^(1/3)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-9	2.823	1.738	5	n/a	No	11	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-15	1	0.2621	4	n/a	No	9	88.89	No	0.002	NP (NDs)
Fluoride, total (mg/L)	AD-8	1	0.485	4	n/a	No	9	11.11	No	0.002	NP (normality)
Fluoride, total (mg/L)	AD-9	1	0.304	4	n/a	No	9	55.56	No	0.002	NP (normality)
Lead, total (mg/L)	AD-15	0.022	0.000438	0.015	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Lead, total (mg/L)	AD-8	0.005	0.000223	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-9	0.005	0.000262	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-15	0.04141	0.004534	0.39	n/a	No	11	0	x^(1/3)	0.01	Param.
Lithium, total (mg/L)	AD-8	0.1169	0.08297	0.39	n/a	No	11	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-9**	**1.38**	**0.9572**	**0.39**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-15	0.0001	0.00001932	0.002	n/a	No	10	20	No	0.011	NP (normality)
Mercury, total (mg/L)	AD-8	0.000025	0.00000859	0.002	n/a	No	10	60	No	0.011	NP (normality)
Mercury, total (mg/L)	AD-9	0.00003658	0.000008656	0.002	n/a	No	10	30	No	0.01	Param.
Molybdenum, total (mg/L)	AD-15	0.00309	0.0008551	0.1	n/a	No	11	36.36	No	0.01	Param.
Molybdenum, total (mg/L)	AD-8	0.002	0.0008389	0.1	n/a	No	11	63.64	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-9	0.002	0.002	0.1	n/a	No	11	90.91	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-15	0.005	0.0009	0.05	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-8	0.005	0.0001	0.05	n/a	No	11	54.55	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-9	0.007246	0.001409	0.05	n/a	No	11	36.36	No	0.01	Param.
Thallium, total (mg/L)	AD-15	0.00137	0.0005	0.002	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-8	0.001185	0.0005	0.002	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-9	0.001776	0.0001	0.002	n/a	No	11	54.55	No	0.006	NP (Cohens/xfrm)

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

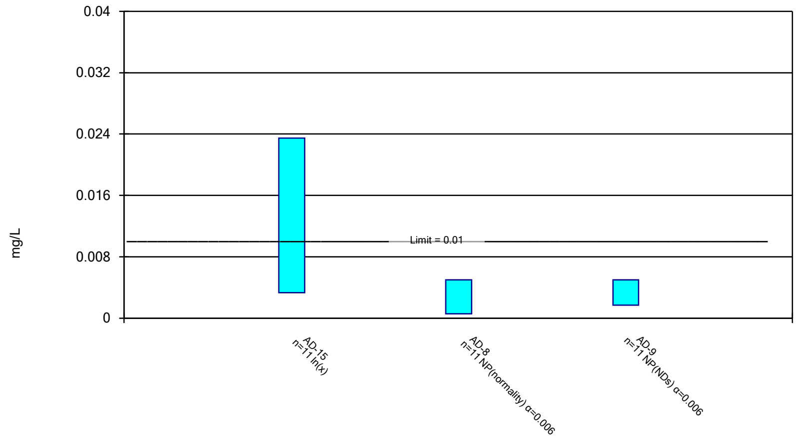


Constituent: Antimony, total Analysis Run 6/25/2019 9:15 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

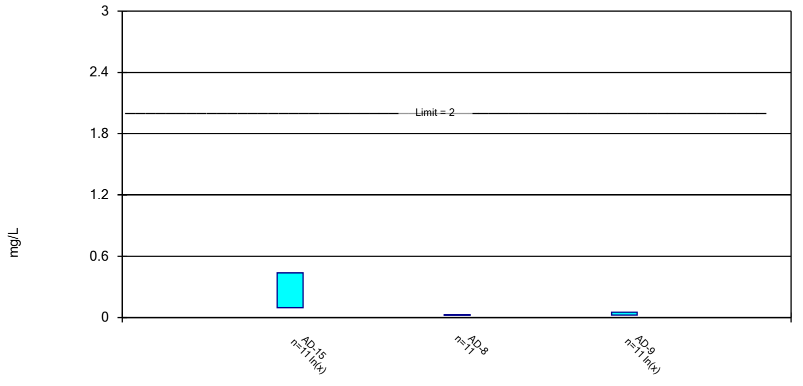


Constituent: Arsenic, total Analysis Run 6/25/2019 9:15 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

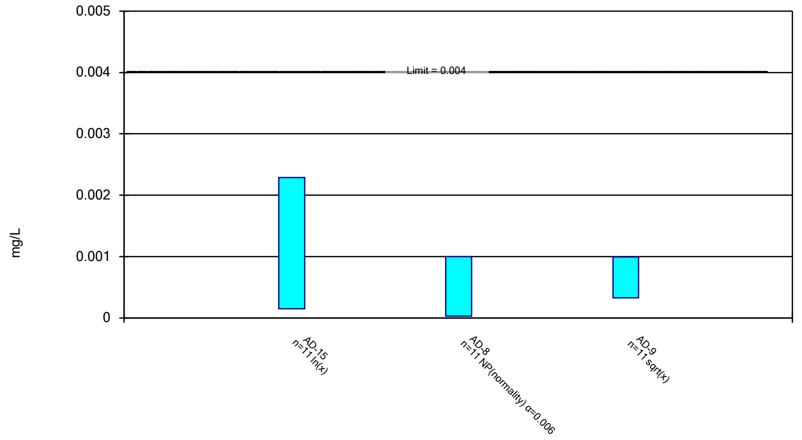


Constituent: Barium, total Analysis Run 6/25/2019 9:15 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

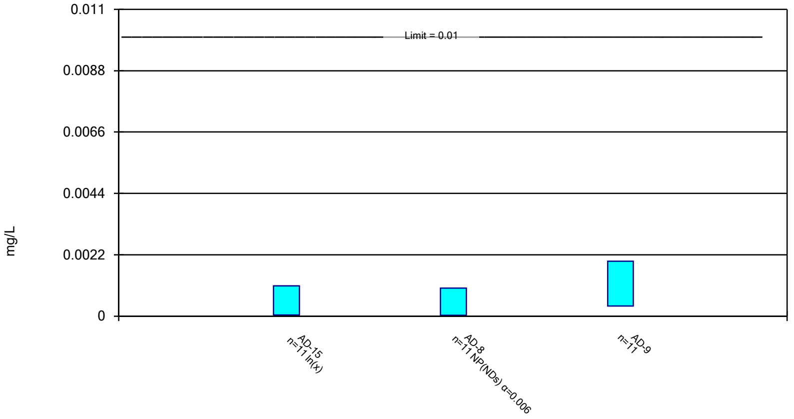


Constituent: Beryllium, total Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

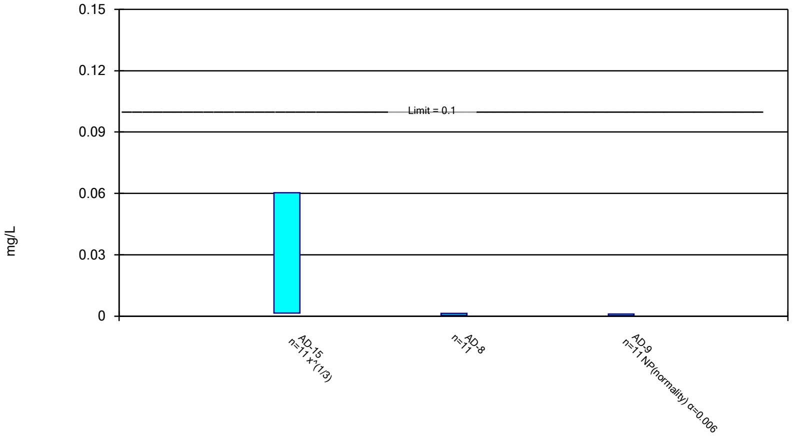


Constituent: Cadmium, total Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

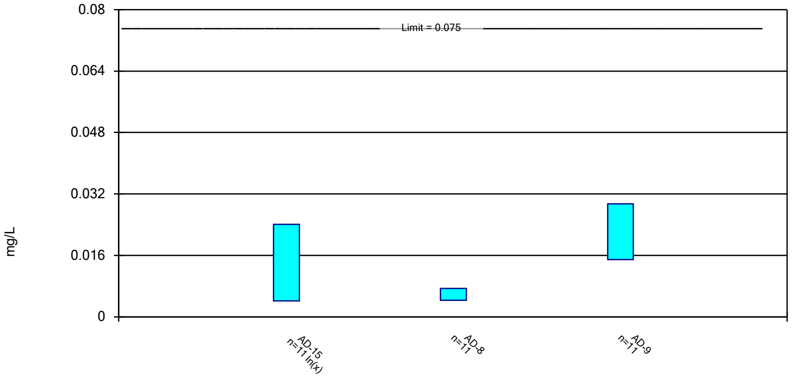


Constituent: Chromium, total Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

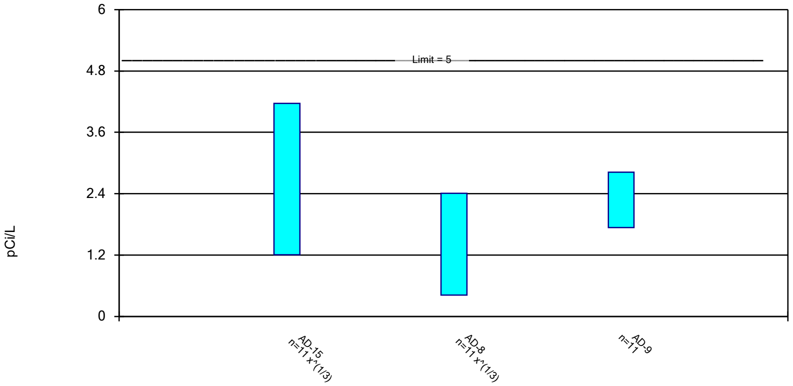


Constituent: Cobalt, total Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

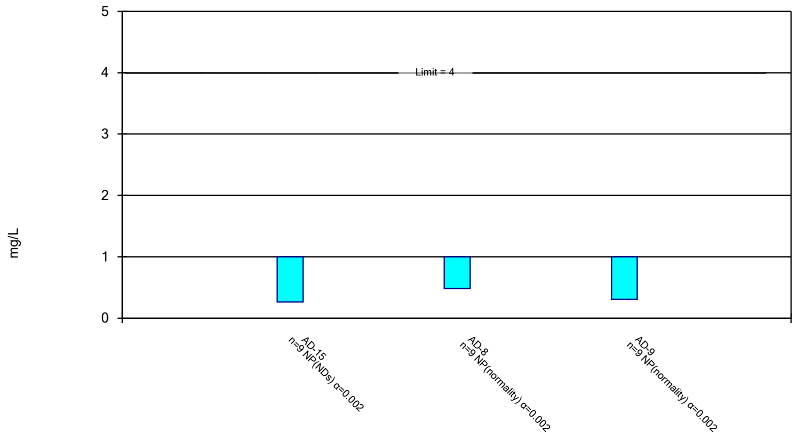


Constituent: Combined Radium 226 + 228 Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals -
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

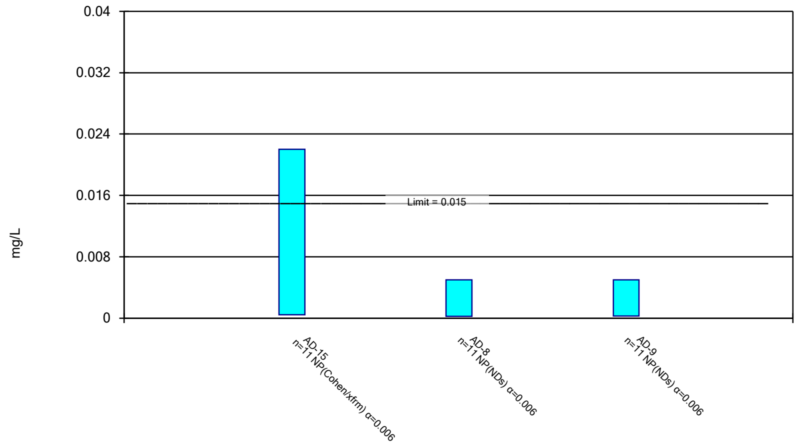


Constituent: Fluoride, total   Analysis Run 6/25/2019 9:16 AM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

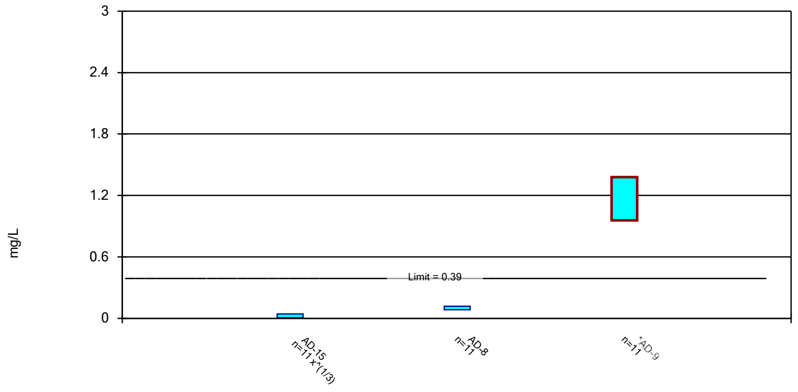


Constituent: Lead, total   Analysis Run 6/25/2019 9:16 AM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.18 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.

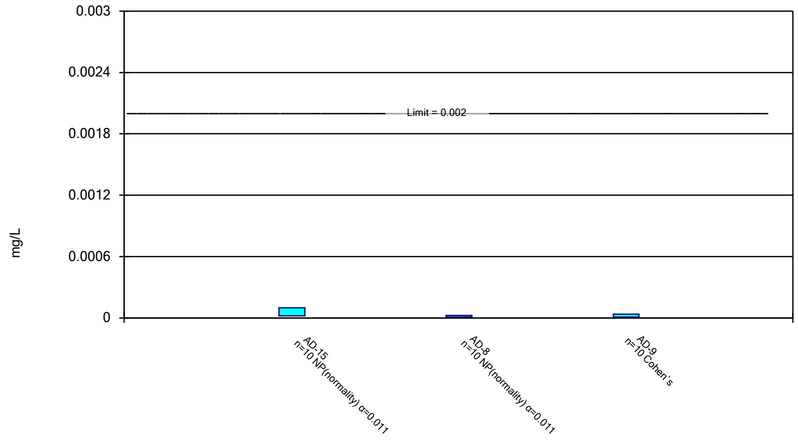


Constituent: Lithium, total   Analysis Run 6/25/2019 9:16 AM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

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.

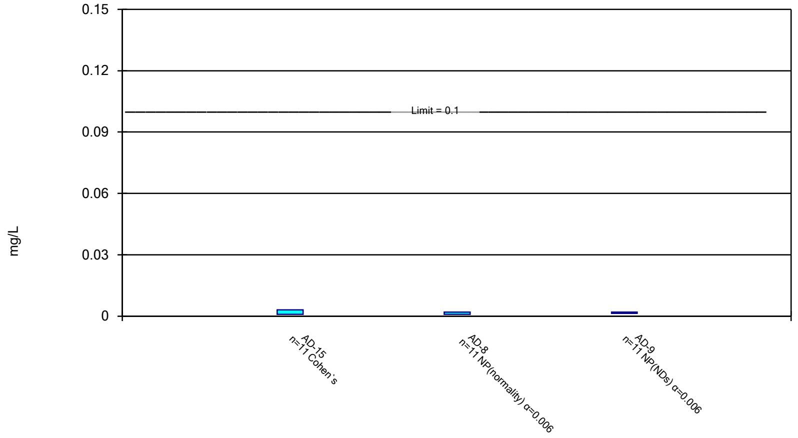


Constituent: Mercury, total   Analysis Run 6/25/2019 9:16 AM   View: Confidence Intervals - App IV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

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.

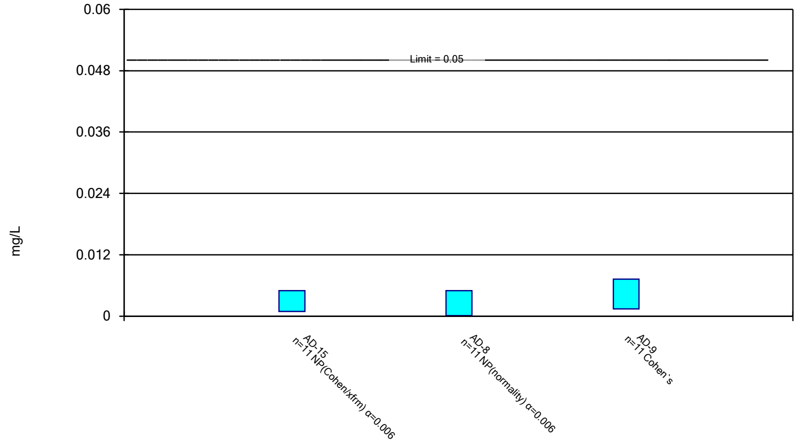


Constituent: Molybdenum, total Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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.

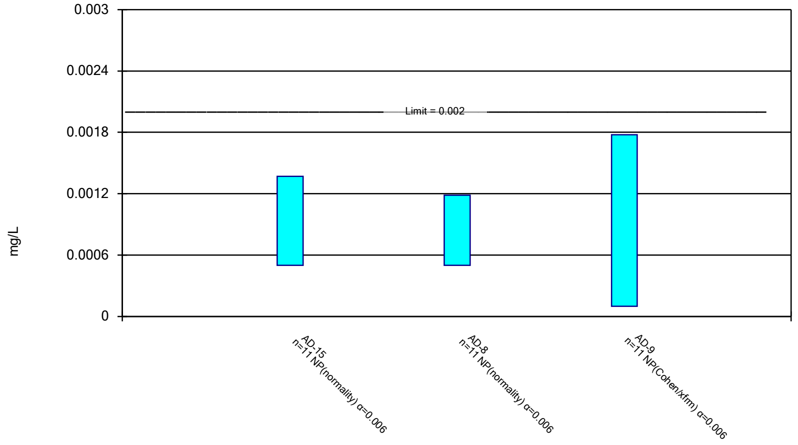


Constituent: Selenium, total Analysis Run 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

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 6/25/2019 9:16 AM View: Confidence Intervals - App IV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

STATISTICAL ANALYSIS SUMMARY
PRIMARY BOTTOM ASH POND
J. Robert Welsh Plant
Pittsburg, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

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December 16, 2019

CHA8473

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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
PBAP	Primary Bottom Ash Pond
QA	Quality Assurance
QC	Quality Control
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 Primary Bottom Ash Pond (PBAP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron at the PBAP. An alternative source was not identified at the time, so the PBAP has been in assessment monitoring since. Groundwater protection standards (GWPS) were set in accordance with 40 CFR 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. During the most recent assessment monitoring event, completed in February 2019, an SSL was identified for lithium at well AD-9. A successful alternative source demonstration (ASD) was completed per 40 CFR 257.95(g)(3); therefore, the PBAP remained in assessment monitoring. Two assessment monitoring events were conducted at the PBAP in May and July 2019, in accordance with 40 CFR 257.95(b) and (d) respectively. 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 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

PRIMARY 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) (July 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 PBAP 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 July 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. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for barium, beryllium, cadmium, and combined radium. Non-parametric tolerance limits were calculated for antimony, arsenic, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, and selenium due to apparent non-normal distributions and for 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 Welsh PBAP:

- The LCL for lithium exceeded the GWPS of 0.390 mg/L at AD-9 (0.916 mg/L).

As a result, the Welsh PBAP 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, chloride, fluoride, sulfate, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron and pH. 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 PBAP. 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 - June 2017) to the new compliance samples (October 2017 – February 2019) for calcium, chloride, fluoride, 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 chloride in upgradient well AD-5. However, because AD-5 is an upgradient monitoring well and more recent data are similar to background and better represent the groundwater quality upgradient of the facility, the background dataset was updated to include the compliance data for chloride at AD-5.

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, chloride, fluoride, sulfate, and TDS, whereas interwell tests continued to be used to evaluate potential SSIs for boron and pH. 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.

Appendix III data collected during the July 2019 assessment monitoring event in accordance with 257.95(d) were compared to the prediction limits to evaluate results above background values. The results from the May and July 2019 events 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 0.700 mg/L at AD-8 (1.21 mg/L).

- The pH measurements were recorded below the interwell LPL of 4.8 SU at AD-15 (3.2 SU).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Welsh PBAP 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 July 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 lithium. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron and pH measurements recorded below the LPL.

Based on this evaluation, the Welsh PBAP 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 – Welsh Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Primary Bottom Ash Pond, J. Robert Welsh Plant, Pittsburg, Texas. January 15, 2018.

TABLES

Table 1 - Groundwater Data Summary
Welsh - Primary Bottom Ash Pond

Component	Unit	AD-1		AD-5		AD-8		AD-9		AD-15		AD-17	
		5/30/2019	**7/24/2019**	**5/30/2019**	**7/24/2019**	**5/29/2019**	**7/23/2019**	**5/29/2019**	**7/23/2019**	**5/29/2019**	**7/23/2019**	**5/30/2019**	**7/24/2019**
Antimony	µg/L	0.160	0.0800 J	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U	0.0500 J	0.0300 J	0.100 U	0.100 U
Arsenic	µg/L	0.600	0.390	3.05	2.48	0.370	0.410	0.200	1.39	2.95	2.10	0.410	1.07
Barium	µg/L	512	245	60.5	77.4	30.3	31.0	49.7	32.1	203	113	19.6	14.3
Beryllium	µg/L	0.244	0.540	0.0800 J	0.0500 J	0.100 U	0.100 U	0.941	0.361	1.50	0.573	0.0200 J	0.130
Boron	mg/L	0.689	0.644	0.0300 J	0.0400 J	1.07	1.21	0.0600 J	0.0810	0.100 U	0.306	0.158	0.113
Cadmium	µg/L	0.0100 J	0.0200 J	0.0500 U	0.0500 U	0.0200 J	0.0200 J	0.210	0.0600	0.0800	0.0400 J	0.0300 J	0.0300 J
Calcium	mg/L	138	62.7	30.0	41.1	16.9	20.8	10.1	222	2.97	3.45	202	216
Chloride	mg/L	1.59	2.00	22.3	18.0	19.5	15.0	44.0	77.0	21.4	28.0	41.7	37.0
Chromium	µg/L	0.100 J	0.100 J	0.0600 J	0.0500 J	0.100 J	0.0900 J	0.346	0.200 J	9.31	2.26	0.246	0.228
Cobalt	µg/L	0.756	0.789	11.8	8.38	6.03	7.07	15.9	12.7	5.49	5.41	51.1	57.7
Combined Radium	pCi/L	2.72	1.82	1.43	2.53	0.911	0.720	1.36	1.69	3.55	2.25	2.51	3.45
Fluoride	mg/L	0.290	0.106 J	0.290	0.112 J	0.890	0.559 J	0.160	0.574 J	0.0600 J	0.0860 J	0.200 U	0.0850 J
Lead	µg/L	0.197	0.100 J	0.0500 J	0.200 U	0.0700 J	0.0800 J	0.0700 J	0.200 J	9.85	2.87	0.0300 J	0.263
Lithium	mg/L	0.0300 U	0.00557	0.104	0.108	0.0670	0.0641	0.225	1.11	0.0100 J	0.00414	0.341	0.283
Mercury	mg/L	0.0000250 U	0.0000250 U	0.00000600 J	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.0000810	0.0000250	0.0000250 U	0.0000250 U
Molybdenum	µg/L	2.43	2.00 J	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Selenium	µg/L	1.40	3.40	0.0500 J	0.0600 J	0.0600 J	0.0800 J	0.200	0.400	5.10	1.60	0.0600 J	0.100 J
Total Dissolved Solids	mg/L	588	180	238	354	324	392	1760	2460	34.0	214	1550	1860
Sulfate	mg/L	43.3	58.0	51.3	90.0	150	145	503	1700	2.10	18.0	1120	1130
Thallium	µg/L	0.500 U	0.500 U	0.500 U	0.500 U	0.100 J	0.100 J	0.200 J	0.500 U	0.100 J	0.500 U	0.500 U	0.500 U
pH	SU	6.71	5.97	6.33	6.30	5.45	6.58	3.61	6.28	4.85	3.17	6.06	5.96

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
Welsh Plant - Primary 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		0.62
Beryllium, Total (mg/L)	0.004		0.00079
Cadmium, Total (mg/L)	0.005		0.0037
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.075
Combined Radium, Total (pCi/L)	5		4.11
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.39
Mercury, Total (mg/L)	0.002		0.000033
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
Welsh Plant - Primary Bottom Ash Pond

Parameter	Unit	Description	AD-8	AD-9	AD-15
Boron	mg/L	Interwell Background Value (UPL)	0.700		
Calcium	mg/L	Intrawell Background Value (UPL)	32.4	299	5.40
Chloride	mg/L	Intrawell Background Value (UPL)	35.5	138	38.8
Fluoride	mg/L	Intrawell Background Value (UPL)	0.737	1.00	1.00
pH	SU	Interwell Background Value (UPL)	7.0		
		Interwell Background Value (LPL)	4.8		
Sulfate	mg/L	Intrawell Background Value (UPL)	230	2530	33.2
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	553	3070	249

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Welsh Plant - Primary Bottom Ash Pond

Parameter	Unit	Description	AD-8		AD-9		AD-15	
			5/29/2019*	7/23/2019	5/29/2019*	7/23/2019	5/29/2019*	7/23/2019
Boron	mg/L	Interwell Background Value (UPL)	0.700					
		Detection Monitoring Result	1.07	**1.21**	0.0600	0.0810	0.0200	0.306
Calcium	mg/L	Intrawell Background Value (UPL)	32.4		299		5.40	
		Detection Monitoring Result	16.9	20.8	10.1	222	2.97	3.45
Chloride	mg/L	Intrawell Background Value (UPL)	35.5		138		38.8	
		Detection Monitoring Result	19.5	15.0	44.0	77.0	21.4	28.0
Fluoride	mg/L	Intrawell Background Value (UPL)	0.737		1.00		1.00	
		Detection Monitoring Result	0.890	0.559	0.160	0.574	0.0600	0.0860
pH	SU	Interwell Background Value (UPL)	7.0					
		Interwell Background Value (LPL)	4.8					
		Detection Monitoring Result	5.5	6.6	3.6	6.3	4.9	**3.2**
Sulfate	mg/L	Intrawell Background Value (UPL)	230		2530		33.2	
		Detection Monitoring Result	150	145	503	1700	2.10	18.0
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	553		3070		249	
		Detection Monitoring Result	324	392	1760	2460	34.0	214

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
*257.95(b) results not used to determine SSI

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 Welsh Primary Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

12.17.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 8, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Welsh PBAP - 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 statistical analysis and background update of the groundwater data for American Electric Power Inc.'s Welsh PBAP. 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-1, AD-5, and AD-17; and
- **Downgradient wells:** AD-8, AD-9, and AD-15.

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 prepared by GSC and 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 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). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells. Values flagged as outliers may be seen in the Outlier Summary following this letter (Figure C) and are plotted in a lighter font and disconnected symbol on the time series graphs. Note that the measured concentrations of most metals for September 30, 2016 at well AD-15 are very high compared to the rest of the observations, which suggests a possible laboratory problem. These values were flagged as outliers as they do not appear to represent the population at this well.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium, chloride, fluoride, sulfate, and TDS; and
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron and pH.

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 is 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.

Tukey's outlier test noted a few outliers that were flagged as outliers and a summary of those values was submitted with the screening. The outliers identified by Tukey's test for TDS in well AD-15, however, were not flagged as these values were not unusual to the data set at the time and were similar to observations reported in neighboring wells. Flagged values may be seen in a lighter font on the time series graphs. Note that reporting limits have recently decreased; therefore, no nondetect substitution was made for the data. During the next background update, the more historical and higher reporting limits may be deselected providing there are sufficient samples to construct statistical limits.

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. It was noted that for each constituent evaluated, the highest concentrations are reported in the upgradient wells.

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 showed a couple statistically significant decreasing trends that were relatively low in magnitude when compared to average concentrations; therefore, no adjustments were required.

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.

All Appendix III parameters except pH exhibited variation when evaluated using the ANOVA. Therefore, these parameters 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. 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. 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 all Appendix III parameters with the exception of boron. Therefore, intrawell methods are recommended for calcium, chloride, fluoride, sulfate and TDS; and interwell methods are initially recommended for boron as well as pH which the ANOVA identified as having no variation among upgradient wells. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through June 2017 at each well were used to establish intrawell background limits for the parameters identified above 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 boron and pH.

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 included in background during each sample event after screening the upgradient well data for any new outliers. Data will also be periodically evaluated for statistically significant trends, and earlier data may be deselected prior to construction of statistical limits so that limits represent present-day conditions. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases as well, 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.

November 2019 - Background Update

Data were re-evaluated using Tukey’s outlier test and visual screening with the February 2019 samples. Boron and pH are tested using interwell prediction limits and, therefore, only upgradient wells were tested for outliers for these constituents (Figure C). All other Appendix III parameters, which use intrawell prediction limits, were tested for outliers at each well (Figure C). Tukey’s test did not identify any outliers except for TDS at well AD-15. This value was not flagged as an outlier during the initial background screening due to the limited number of samples. However, as more samples have been collected, it does not appear to represent the population at this well and was flagged accordingly as an outlier. Due to data transformations used in Tukey’s test, several values were not identified as outliers. However, several values were flagged in the database as outliers because the measurements were significantly different that remaining measurements in the record. A list of all outliers flagged may be seen in the outlier summary (Figure C). The previously flagged outliers at this well were not included during this analysis.

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through June 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 not be updated with more recent compliance data (Figure D). No statistically significant differences were found except for chloride in upgradient well AD-5.

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. The chloride concentrations in upgradient well AD-5 are lower than those noted in upgradient well AD-17 and follow a similar pattern. Therefore, the background record was updated with more recent data through February 2019 for chloride in well AD-5 as these data represent natural variability in groundwater quality upgradient of the facility. All data will be reevaluated during the next background update, and earlier measurements will be deselected if they no longer represent present-day groundwater quality. Therefore, all records were updated with data through February 2019. A summary of these results follows this letter and the significant test results are included with the Mann Whitney test section at the end of this report.

Intrawell prediction limits using all historical data reported through February 2019, combined with a 1-of-2 resample plan, were constructed and a summary of the updated limits follows this letter (Figure E).

The Sen's Slope/Mann Kendall trend test was used to evaluate data at upgradient wells for boron and pH 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 boron and pH (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

Upper 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. Any flagged values may be seen on the Outlier Summary following this letter. Parametric tolerance 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 and compared to the highest limit of the MCL, CCR-Rule specified level, 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. No confidence intervals exceedances were found except for lithium in well AD-9. A summary of the confidence interval results follows this letter.

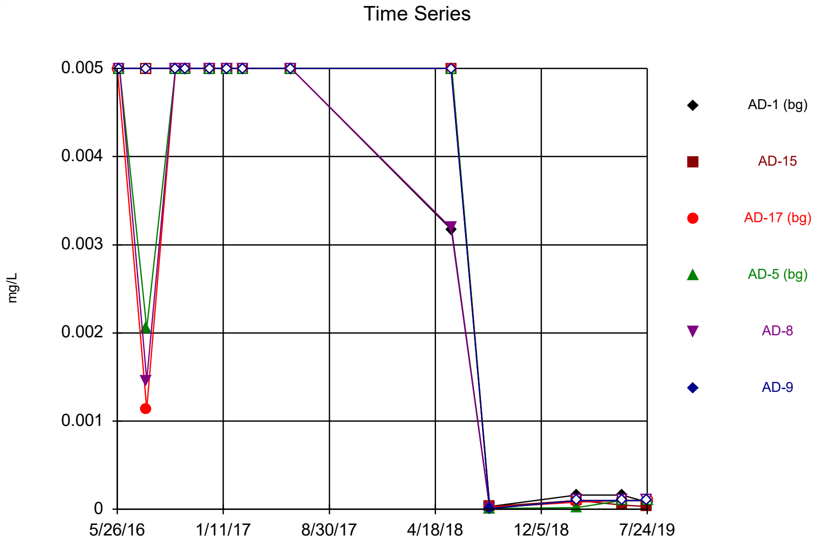
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Welsh PBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.



Constituent: Antimony, total   Analysis Run 11/22/2019 8:47 PM
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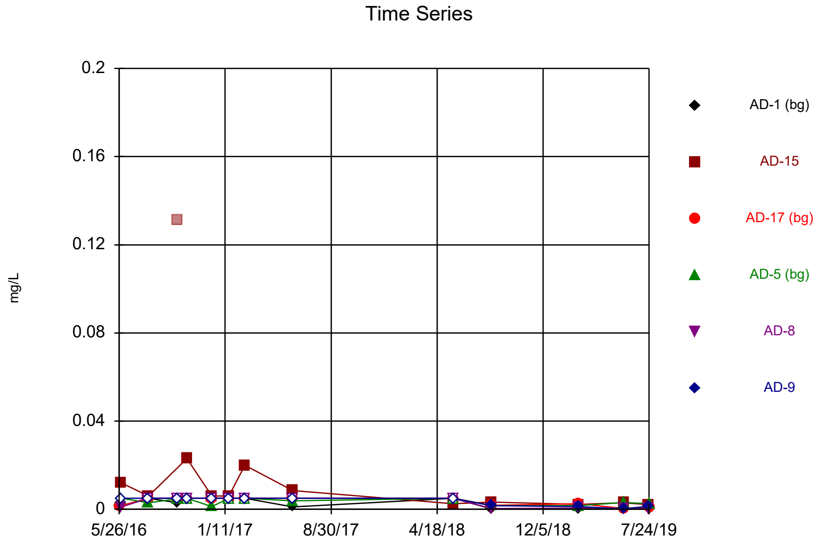

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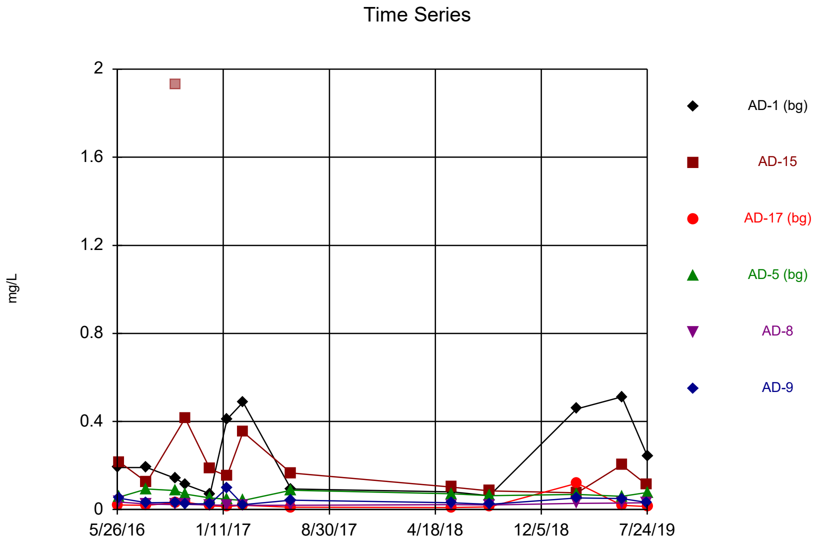

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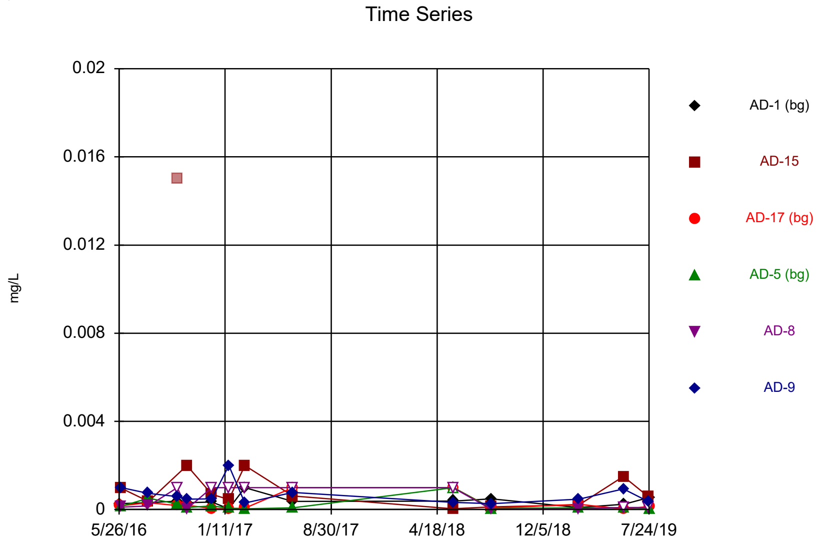

Constituent: Beryllium, total   Analysis Run 11/22/2019 8:48 PM
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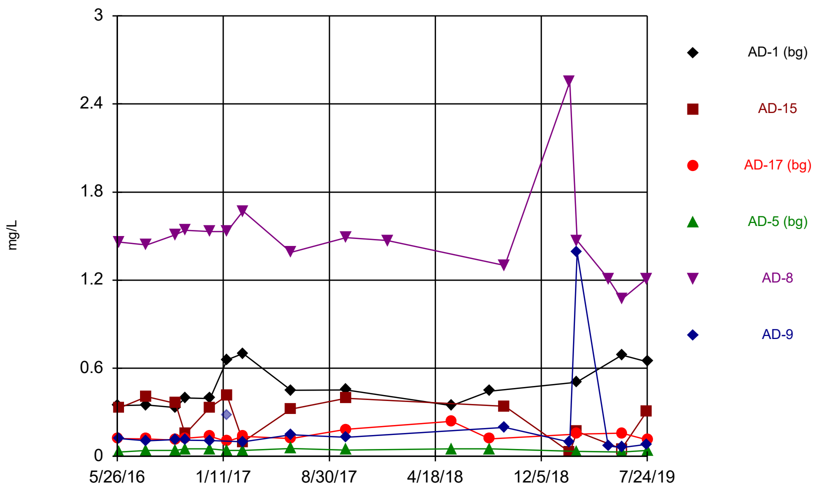
Hollow symbols indicate censored values.

Time Series



Constituent: Boron, total   Analysis Run 11/22/2019 8:48 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

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Hollow symbols indicate censored values.

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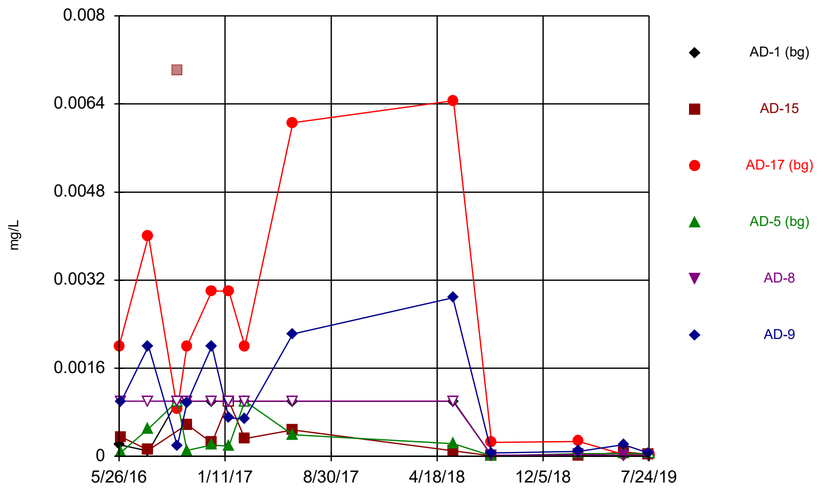

Constituent: Cadmium, total   Analysis Run 11/22/2019 8:48 PM
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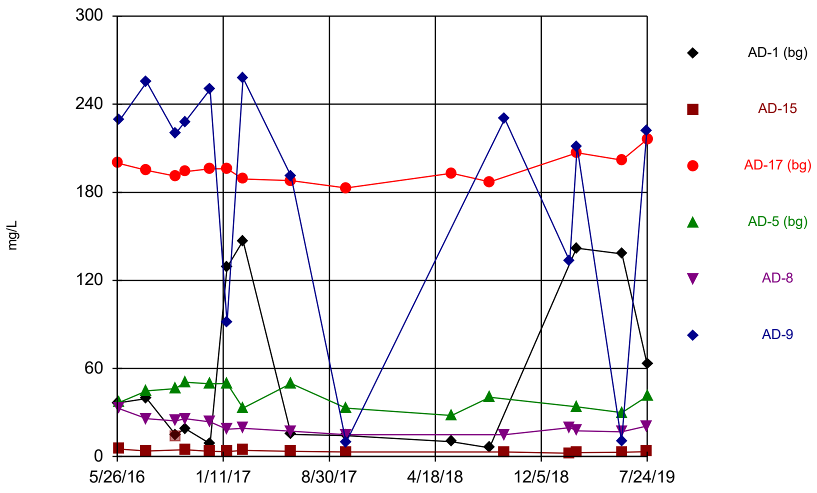
Sanitas™ v.9.6.23 . UG

Time Series



Constituent: Calcium, total   Analysis Run 11/22/2019 8:48 PM
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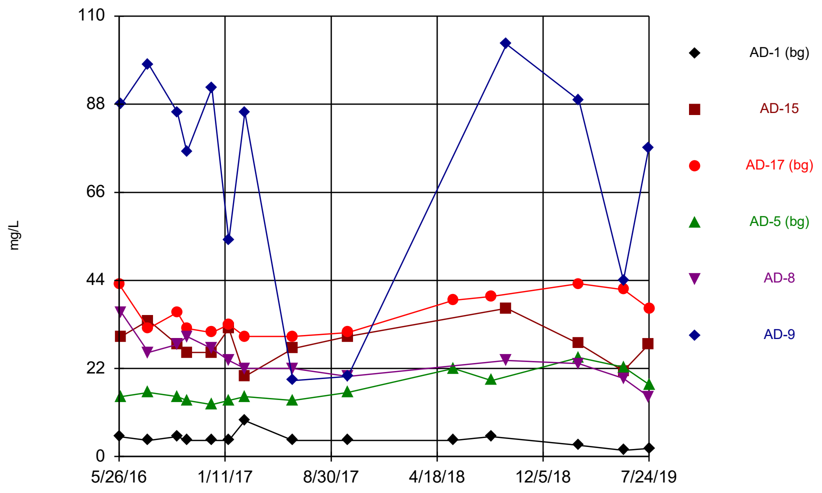

Constituent: Chloride, total   Analysis Run 11/22/2019 8:48 PM
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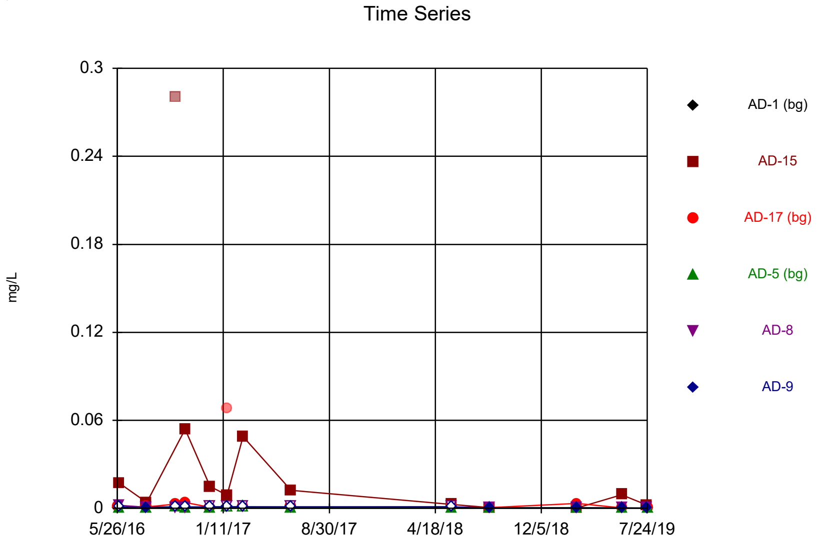

Constituent: Chromium, total   Analysis Run 11/22/2019 8:48 PM
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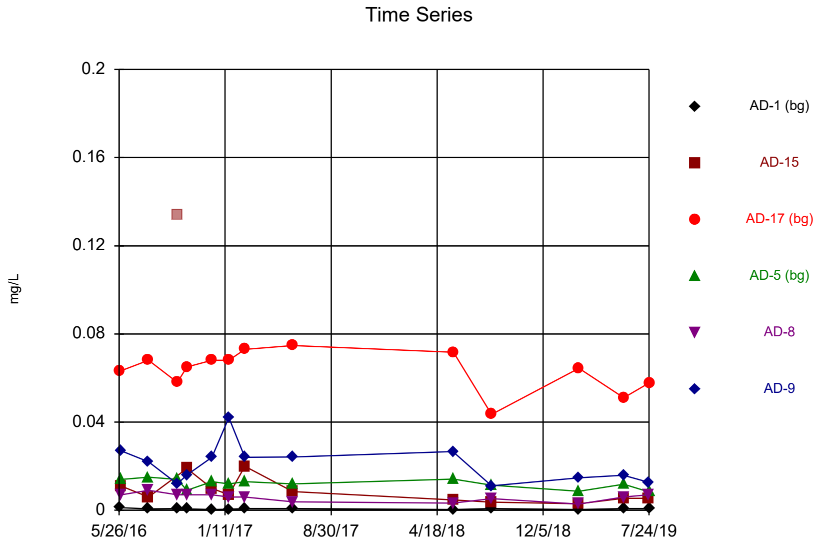

Constituent: Cobalt, total   Analysis Run 11/22/2019 8:48 PM
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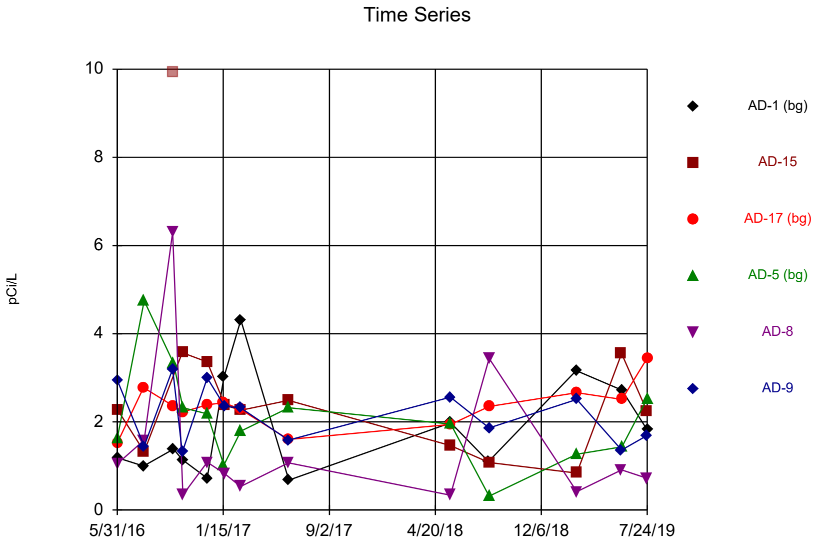
Sanitas™ v.9.6.23 . UG



Constituent: Combined Radium 226 + 228   Analysis Run 11/22/2019 8:48 PM
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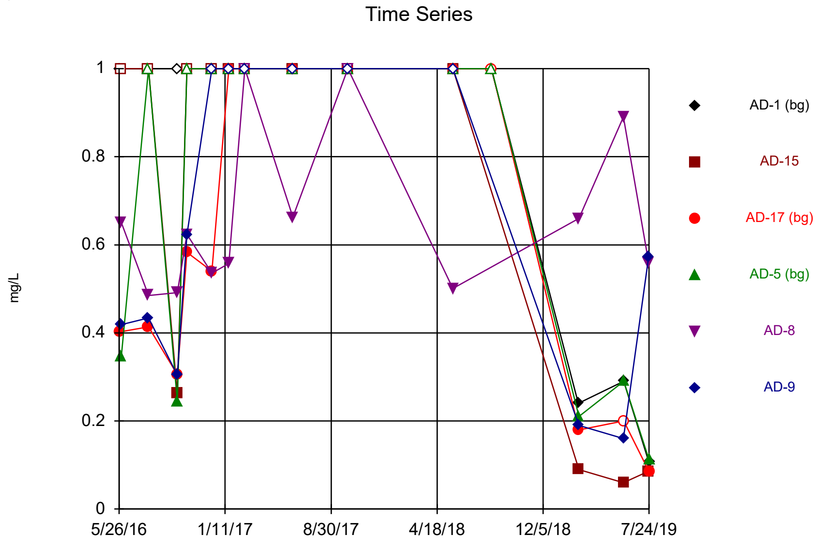

Constituent: Fluoride, total   Analysis Run 11/22/2019 8:48 PM
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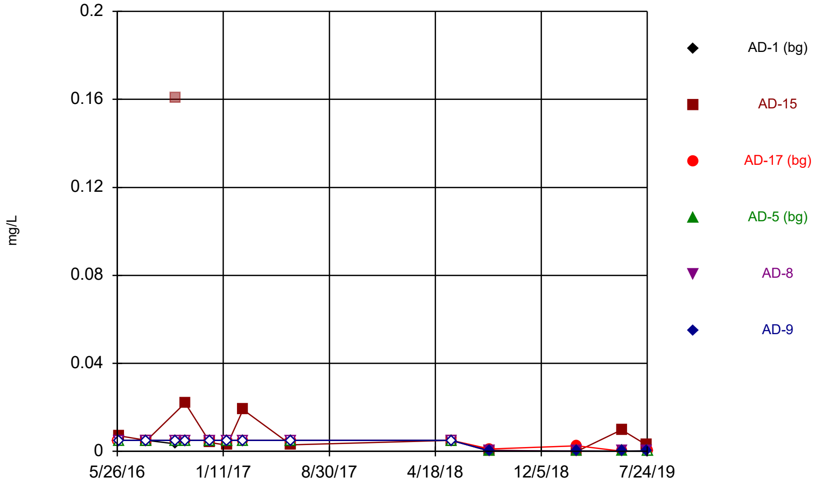
Time Series



Constituent: Lead, total Analysis Run 11/22/2019 8:48 PM
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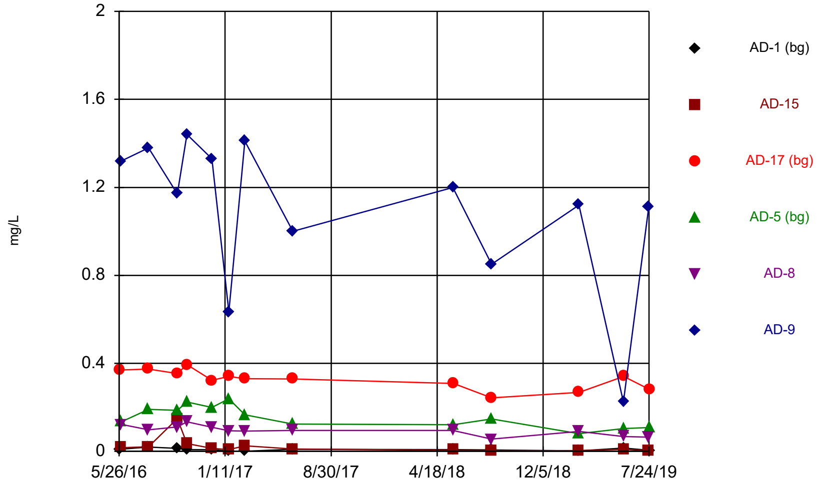
Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lithium, total Analysis Run 11/22/2019 8:48 PM
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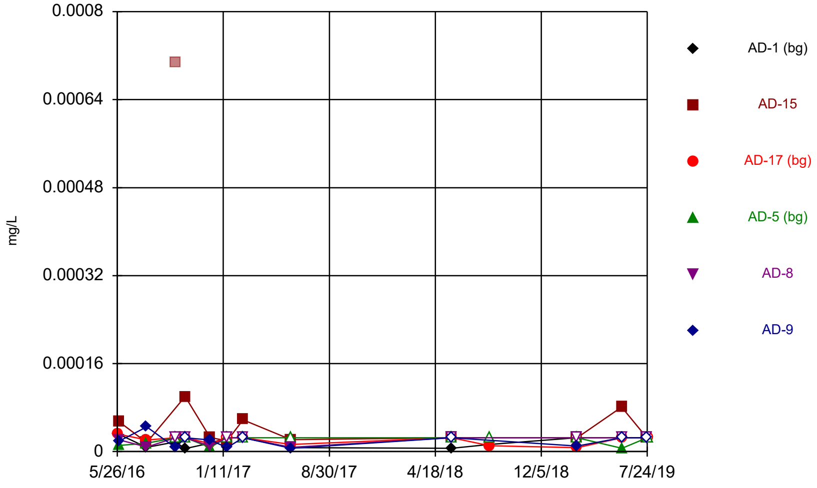
Time Series



Constituent: Mercury, total Analysis Run 11/22/2019 8:48 PM
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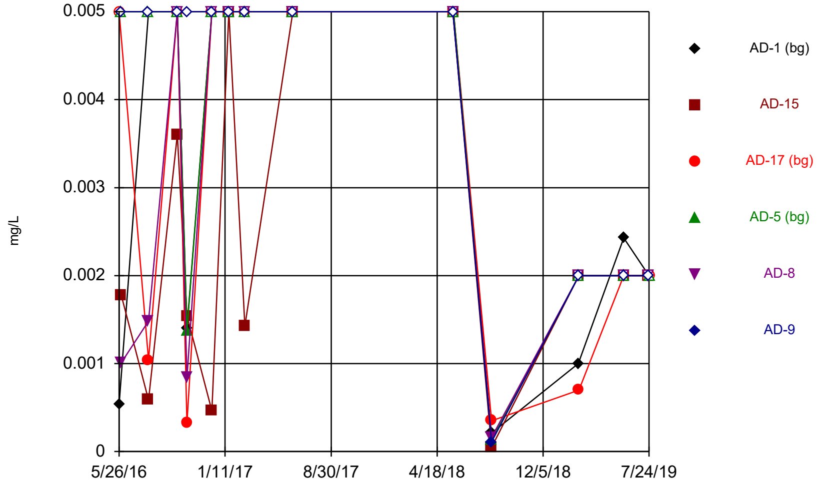
Hollow symbols indicate censored values.

Time Series



Constituent: Molybdenum, total Analysis Run 11/22/2019 8:48 PM
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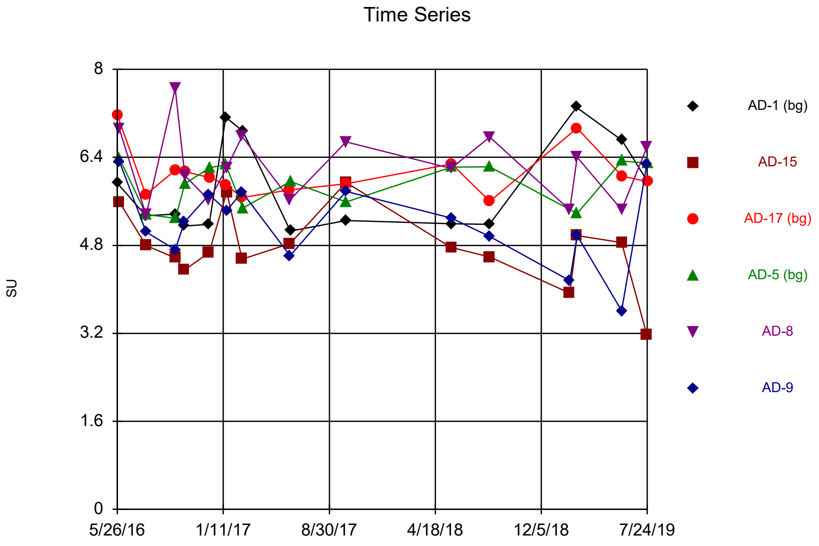
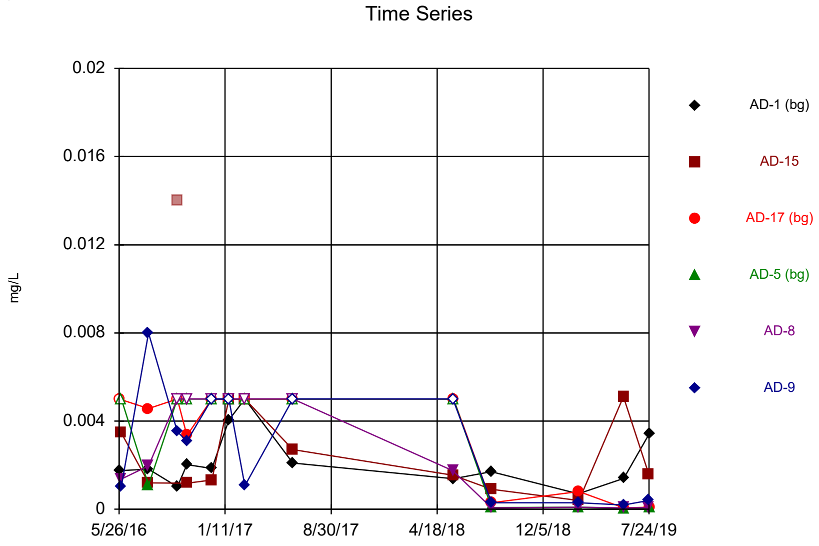
Sanitas™ v.9.6.23 . UG



Constituent: pH, field Analysis Run 11/22/2019 8:48 PM

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.



Constituent: Selenium, total Analysis Run 11/22/2019 8:48 PM

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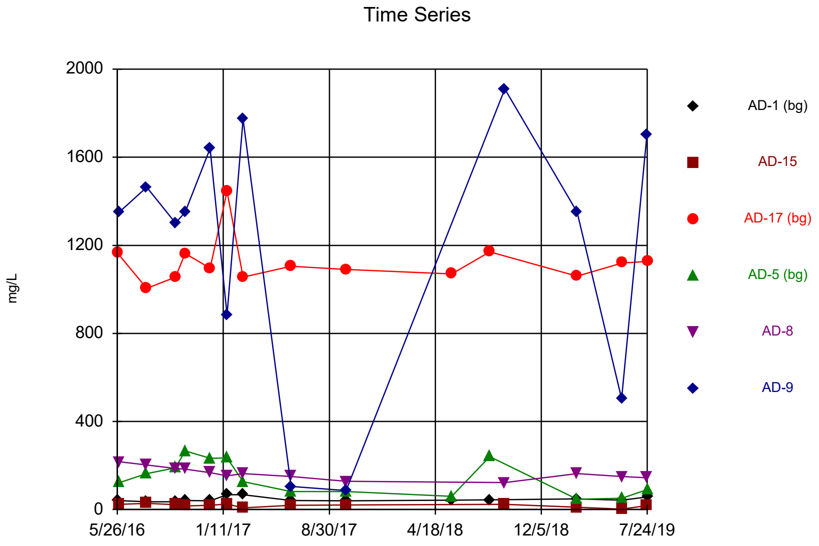
Sanitas™ v.9.6.23 . UG



Constituent: Sulfate, total Analysis Run 11/22/2019 8:48 PM

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG
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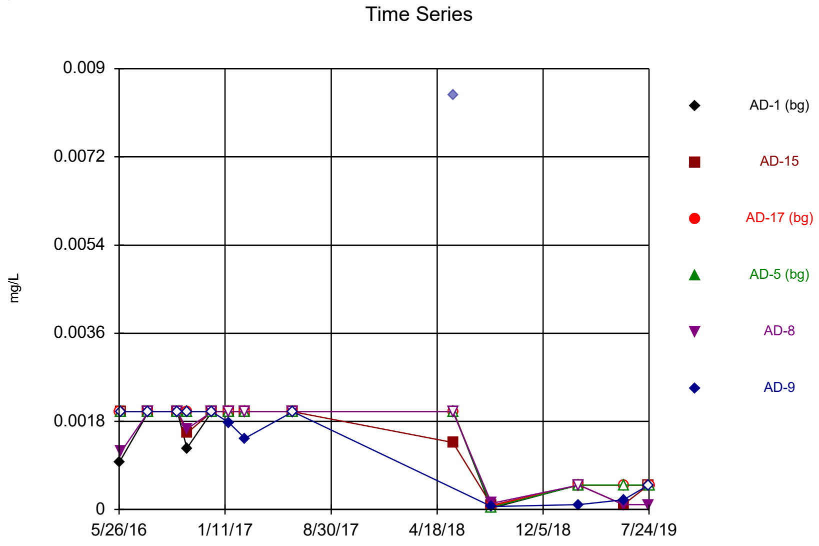

Constituent: Thallium, total Analysis Run 11/22/2019 8:48 PM

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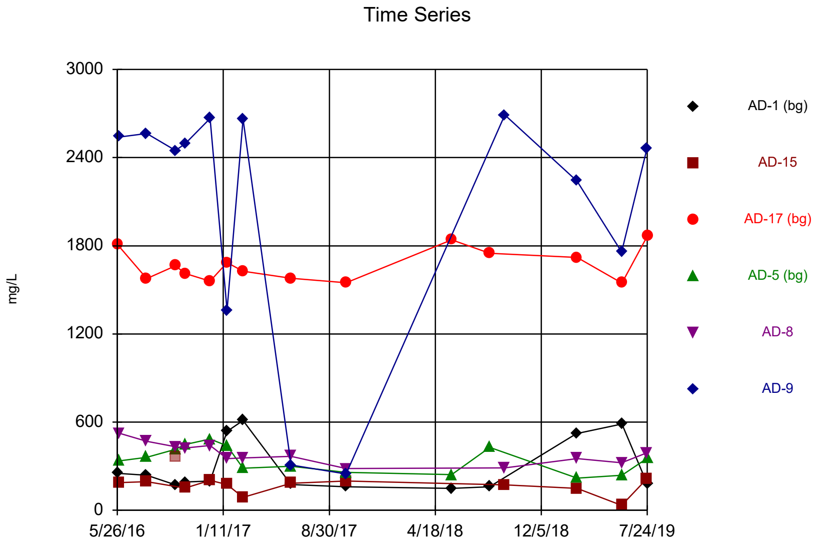
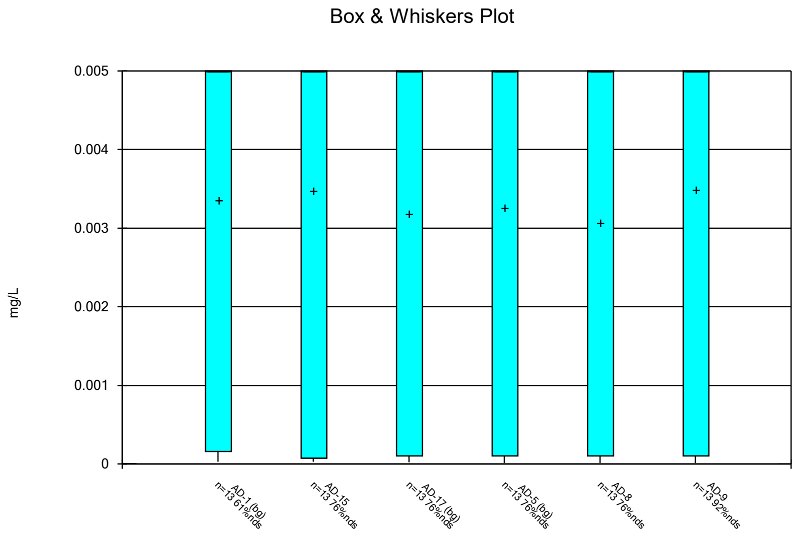


Constituent: Total Dissolved Solids Analysis Run 11/22/2019 8:48 PM
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

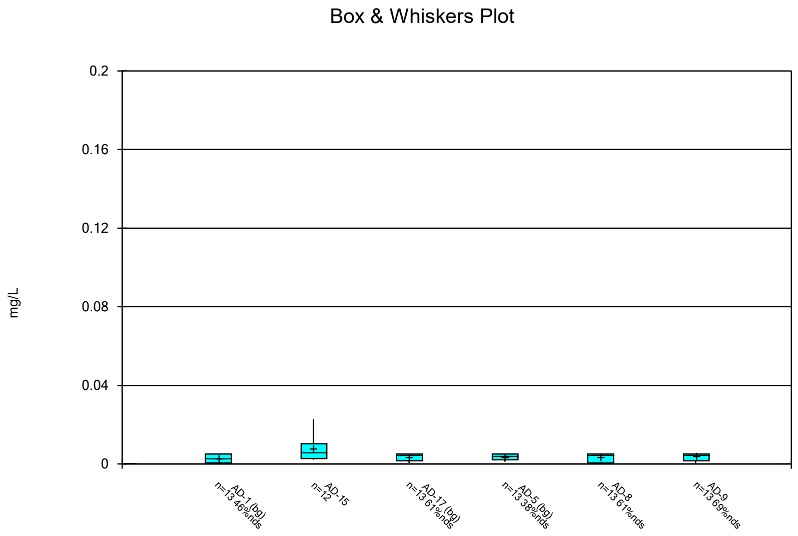
Sanitas™ v.9.6.23 . UG



Constituent: Antimony, total Analysis Run 11/22/2019 8:38 PM

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

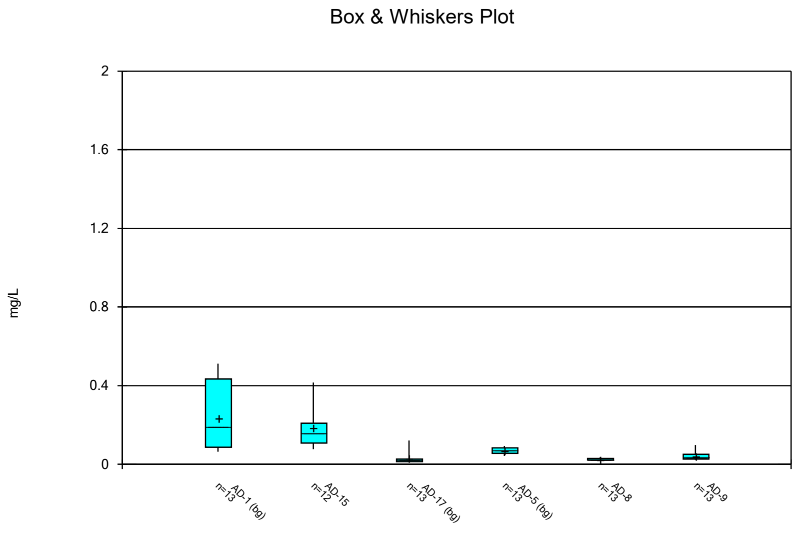
Sanitas™ v.9.6.23 . UG



Constituent: Arsenic, total Analysis Run 11/22/2019 8:38 PM

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

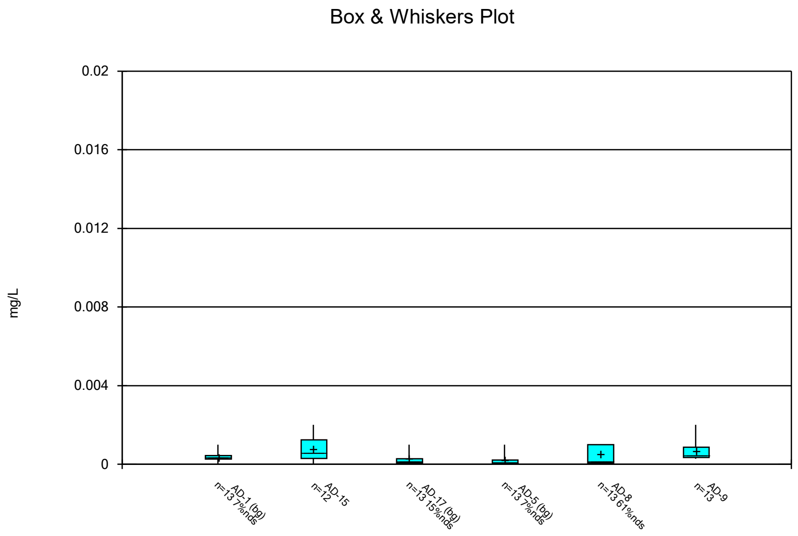
Sanitas™ v.9.6.23 . UG



Constituent: Barium, total Analysis Run 11/22/2019 8:38 PM

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

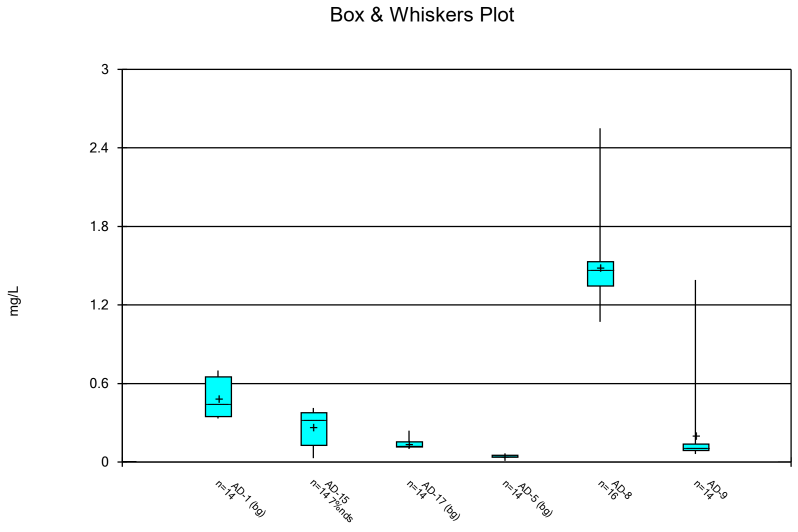
Sanitas™ v.9.6.23 . UG



Constituent: Beryllium, total Analysis Run 11/22/2019 8:38 PM

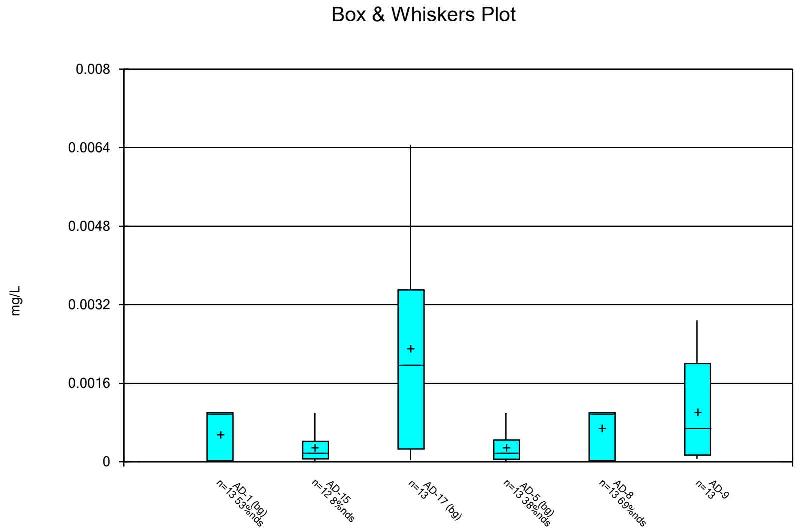
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



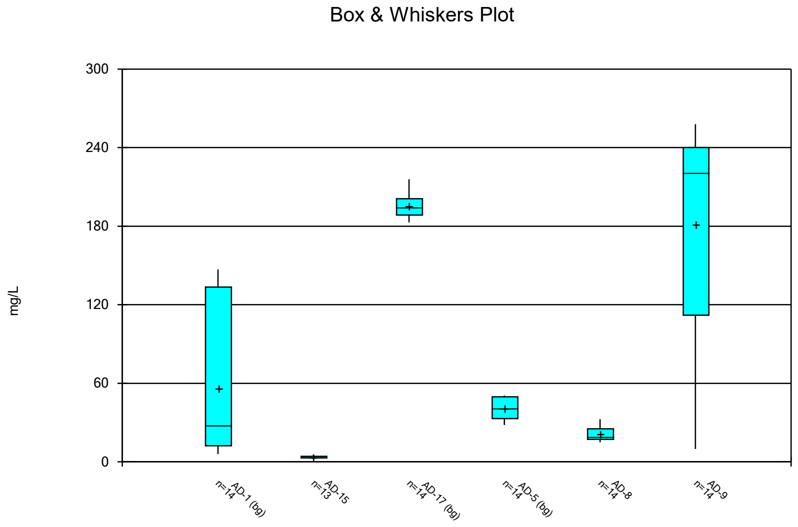
Constituent: Boron, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



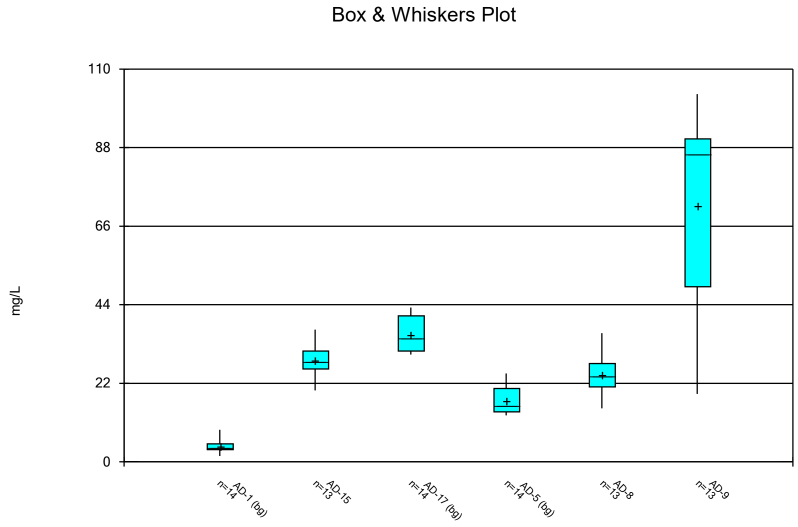
Constituent: Cadmium, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Constituent: Calcium, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

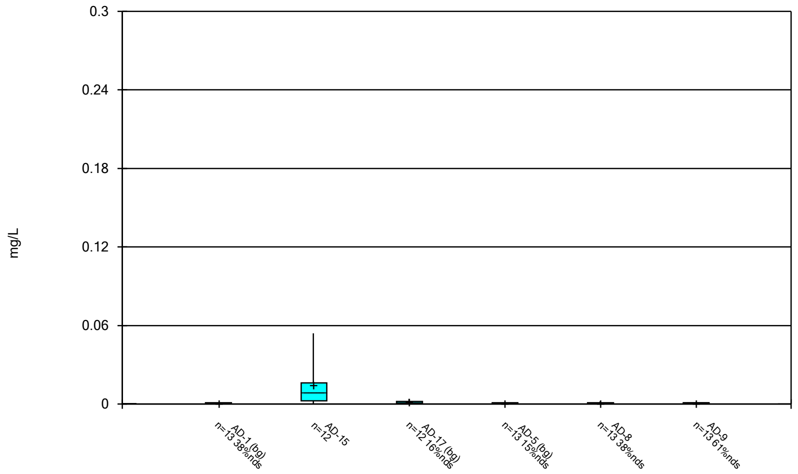
Sanitas™ v.9.6.23 . UG



Constituent: Chloride, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

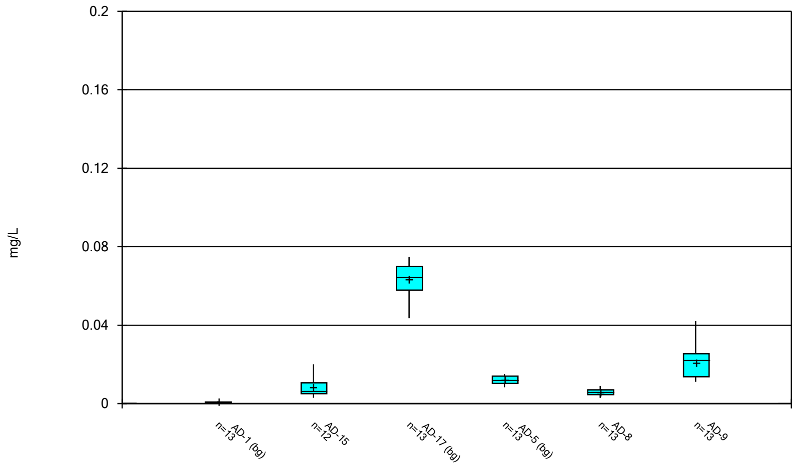


Constituent: Chromium, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

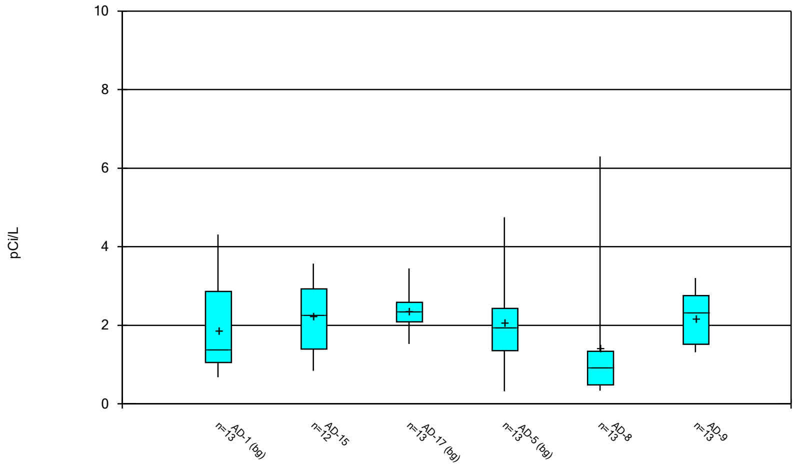


Constituent: Cobalt, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

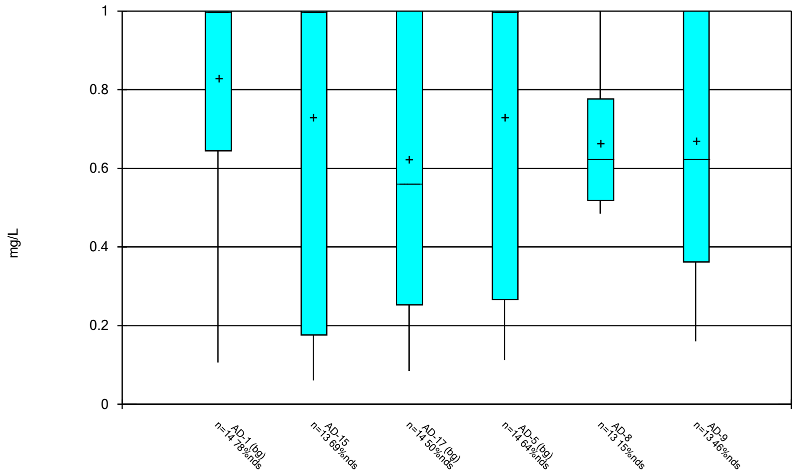


Constituent: Combined Radium 226 + 228   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

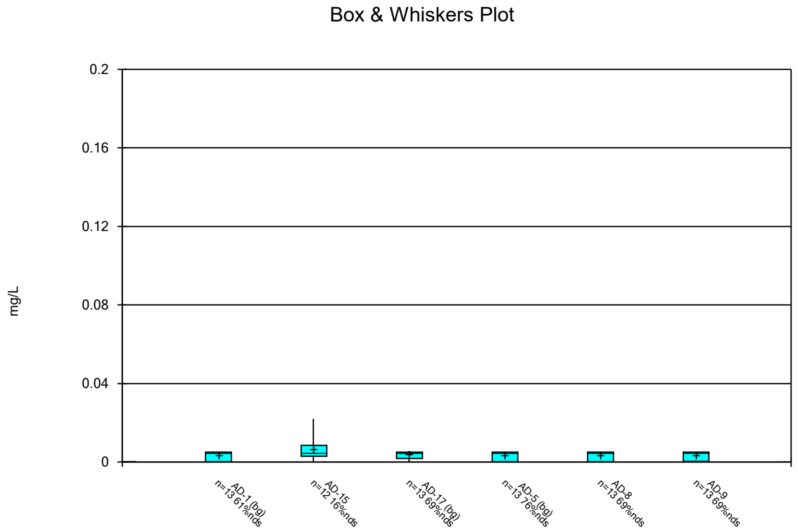
Box & Whiskers Plot



Constituent: Fluoride, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

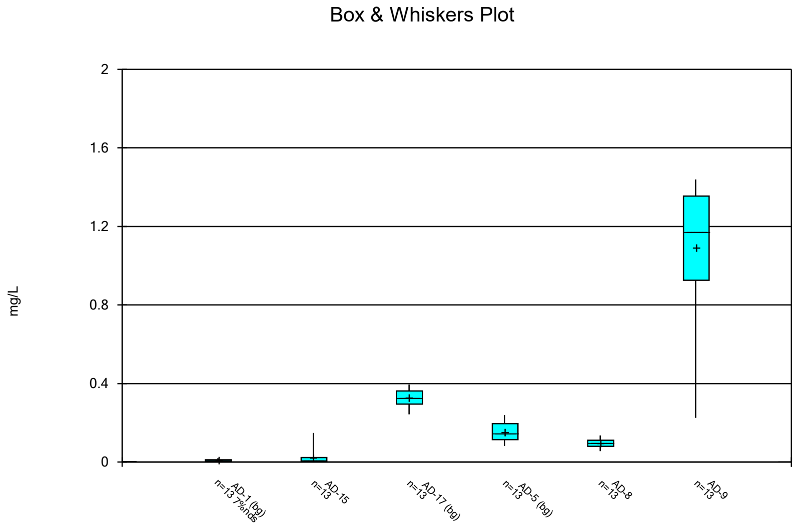
Sanitas™ v.9.6.23 . UG



Constituent: Lead, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

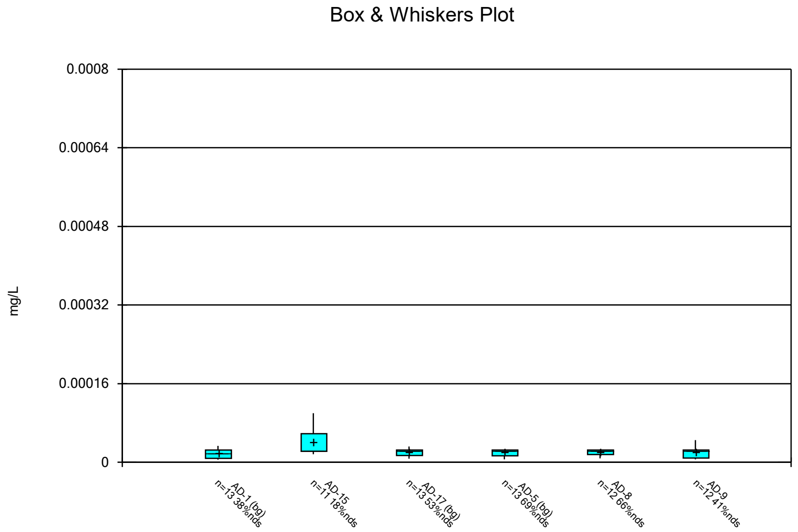
Sanitas™ v.9.6.23 . UG



Constituent: Lithium, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

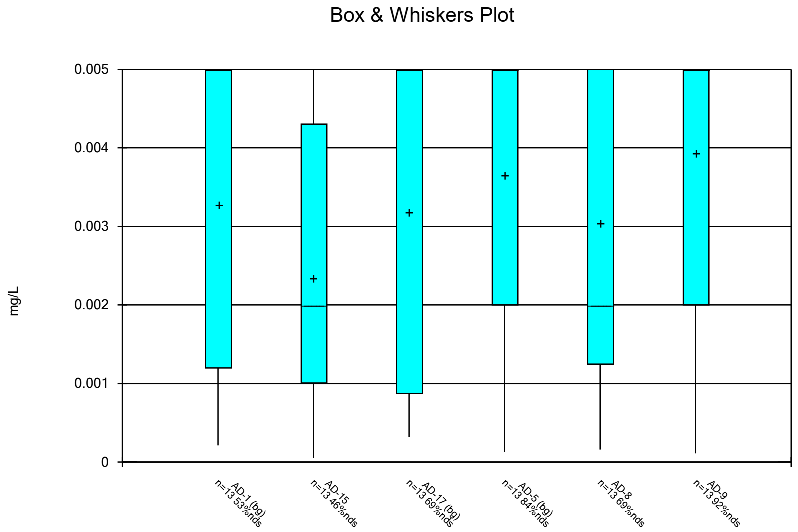
Sanitas™ v.9.6.23 . UG



Constituent: Mercury, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

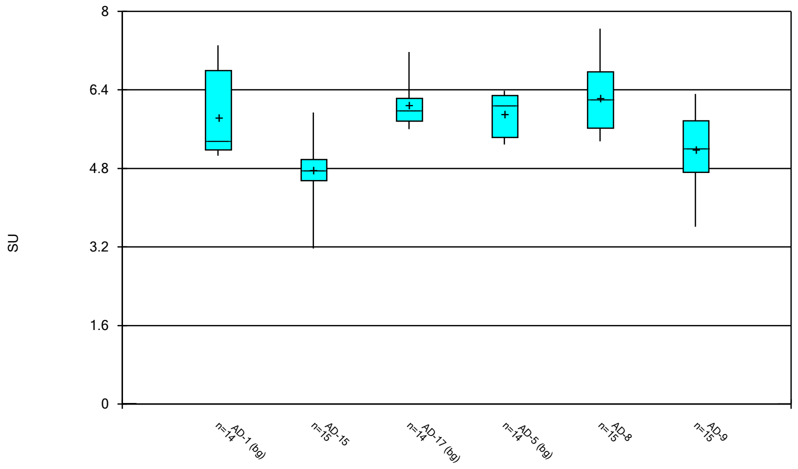


Constituent: Molybdenum, total   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

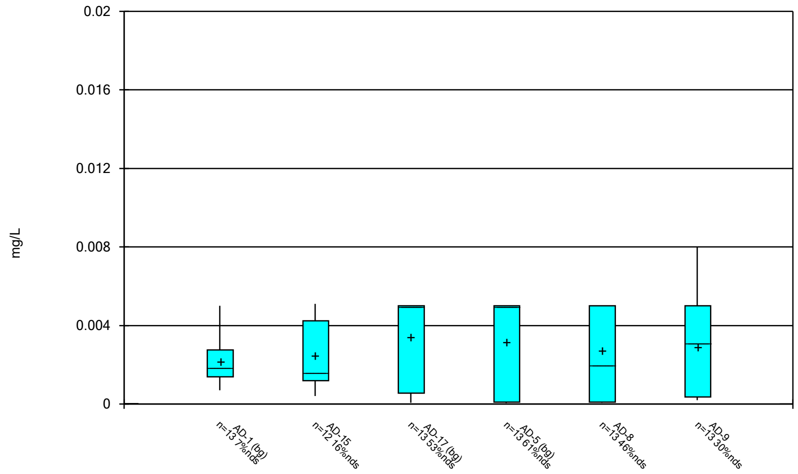
Box & Whiskers Plot



Constituent: pH, field   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

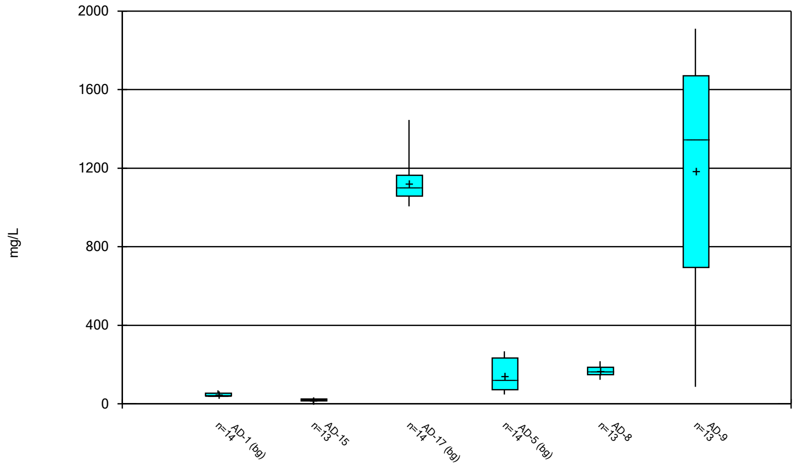
Box & Whiskers Plot



Constituent: Selenium, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

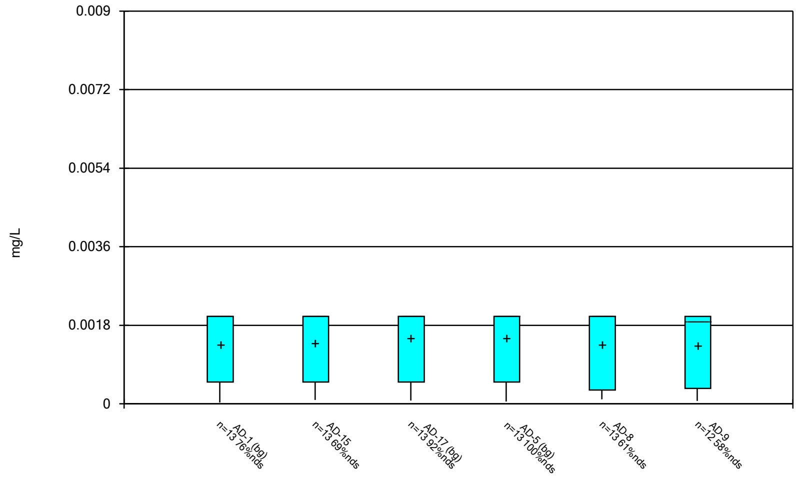
Box & Whiskers Plot



Constituent: Sulfate, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

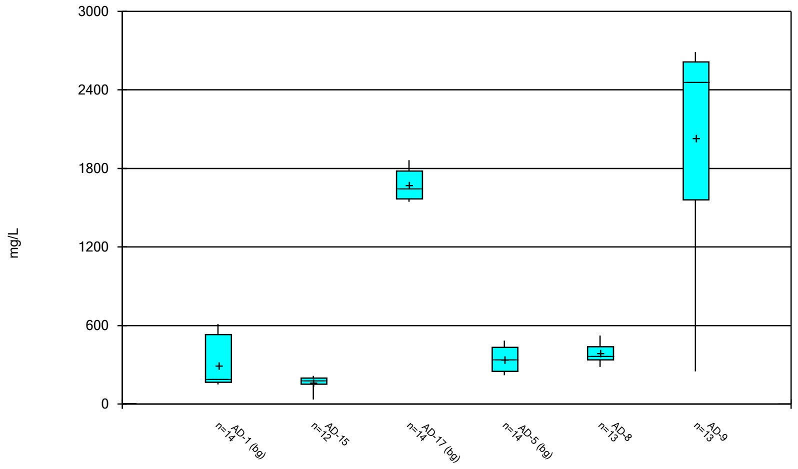
Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot



Constituent: Thallium, total   Analysis Run 11/22/2019 8:38 PM
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Box & Whiskers Plot



Constituent: Total Dissolved Solids   Analysis Run 11/22/2019 8:38 PM

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Outlier Summary

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/22/2019, 8:39 PM

	AD-15 Arsenic, total (mg/L)	AD-15 Barium, total (mg/L)	AD-15 Beryllium, total (mg/L)	AD-9 Boron, total (mg/L)	AD-15 Cadmium, total (mg/L)	AD-15 Calcium, total (mg/L)	AD-15 Chromium, total (mg/L)	AD-17 Chromium, total (mg/L)	AD-15 Cobalt, total (mg/L)	AD-15 Combined Radium 226 + 228 (pCi/L)
9/29/2016										9.92 (O)
9/30/2016	0.131 (O)	1.93 (O)	0.015 (o)		0.007 (O)	13.7 (o)	0.28 (O)		0.134 (O)	
1/20/2017				0.283 (o)				0.068 (o)		
5/23/2018										

	AD-15 Lead, total (mg/L)	AD-15 Mercury, total (mg/L)	AD-15 Selenium, total (mg/L)	AD-9 Thallium, total (mg/L)	AD-15 Total Dissolved Solids (mg/L)
9/29/2016					
9/30/2016	0.161 (O)	0.000707 (O)	0.014 (O)		367 (O)
1/20/2017					
5/23/2018				0.00846 (O)	

Downgradient Appendix IV Outlier Analysis - All Results (No Significant)

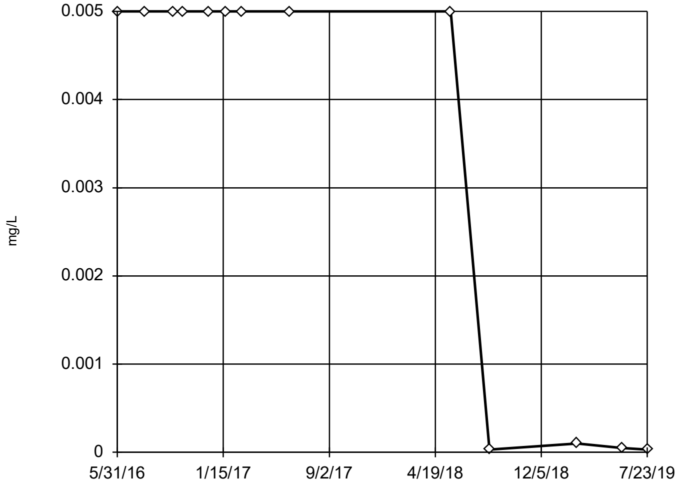
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/20/2019, 1:09 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.003478	0.002377	ln(x)	ShapiroWilk
Antimony, total (mg/L)	AD-8	n/a	n/a	n/a	NP	NaN	13	0.003074	0.002318	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-9	n/a	n/a	n/a	NP	NaN	13	0.003485	0.002365	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.01736	0.0348	ln(x)	ShapiroWilk
Arsenic, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.003286	0.002263	ln(x)	ShapiroWilk
Arsenic, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.003804	0.001895	sqrt(x)	ShapiroWilk
Barium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.3169	0.495	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.02452	0.004938	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.03994	0.02033	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.001885	0.003995	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.000...	0.0004797	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.000...	0.0004653	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.000...	0.001886	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.000...	0.0004696	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.001004	0.0009618	x^(1/3)	ShapiroWilk
Chromium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.03502	0.07563	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.000...	0.0005308	sqrt(x)	ShapiroWilk
Chromium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.000...	0.0003536	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.01828	0.03518	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.005953	0.00175	x^2	ShapiroWilk
Cobalt, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.02095	0.008543	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-15	No	n/a	n/a	NP	NaN	13	2.828	2.31	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-8	No	n/a	n/a	NP	NaN	13	1.432	1.671	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-9	No	n/a	n/a	NP	NaN	13	2.164	0.6618	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.7306	0.4231	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.6628	0.184	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.6695	0.3425	x^(1/3)	ShapiroWilk
Lead, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.01862	0.0433	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.003493	0.002353	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.003509	0.002329	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.02353	0.03892	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.09463	0.02262	normal	ShapiroWilk
Lithium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	1.092	0.3489	x^3	ShapiroWilk
Mercury, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	12	0.000...	0.0001941	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-8	n/a	n/a	n/a	NP	NaN	12	0.000...	0.0000...	unknown	ShapiroWilk
Mercury, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	12	0.000...	0.0000...	sqrt(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.002342	0.001751	sqrt(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.003038	0.001957	x^(1/3)	ShapiroWilk
Molybdenum, total (mg/L)	AD-9	n/a	n/a	n/a	NP	NaN	13	0.003932	0.001734	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.003339	0.003615	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.002723	0.002281	sqrt(x)	ShapiroWilk
Selenium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.002917	0.002549	sqrt(x)	ShapiroWilk
Thallium, total (mg/L)	AD-15	n/a	n/a	n/a	NP	NaN	13	0.001394	0.0007944	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.001358	0.0008371	x^2	ShapiroWilk
Thallium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.001888	0.002136	x^(1/3)	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

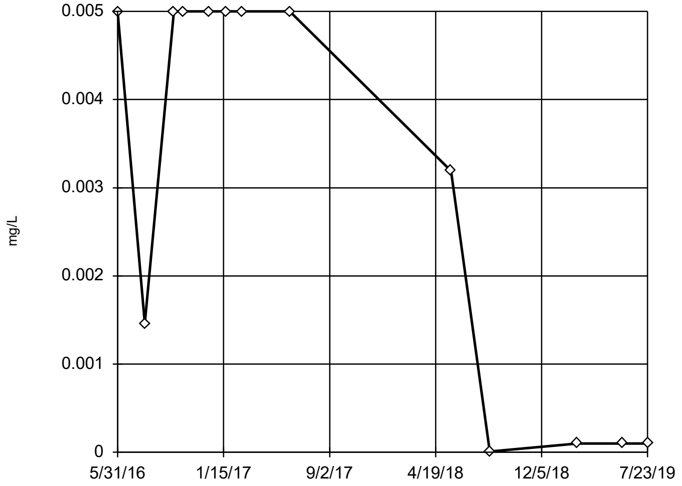
High cutoff = 1768, low cutoff = 2.0e-10, based on IQR multiplier of 3.

Constituent: Antimony, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

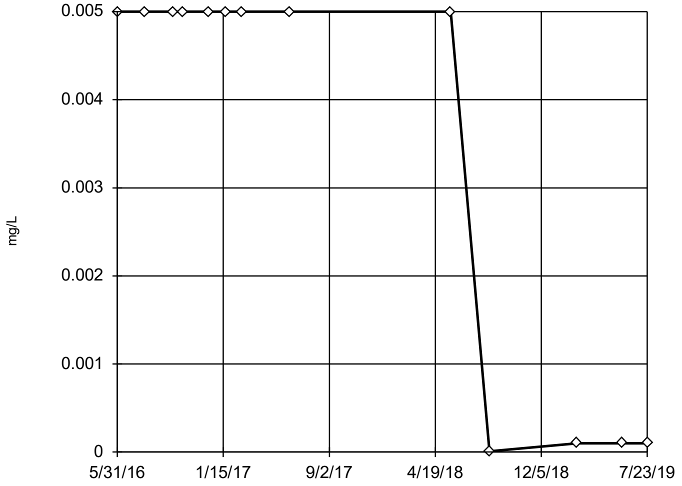
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Antimony, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

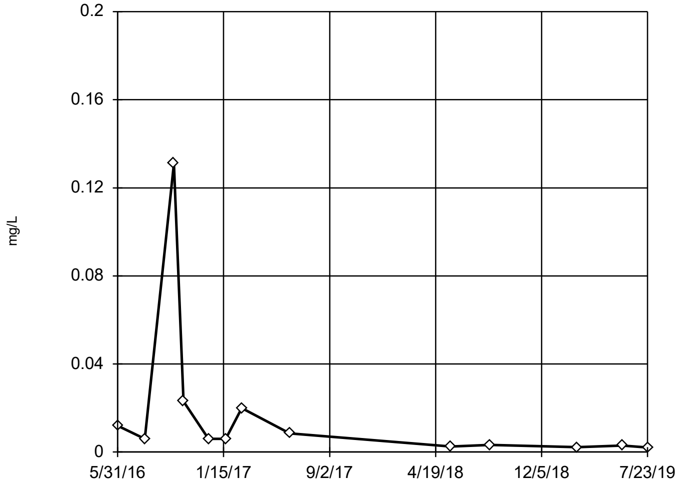
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Antimony, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

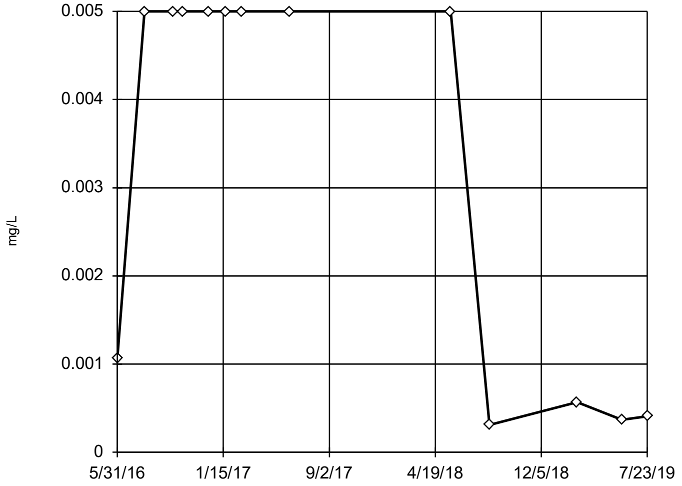
High cutoff = 2.775, low cutoff = 0.00001534, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

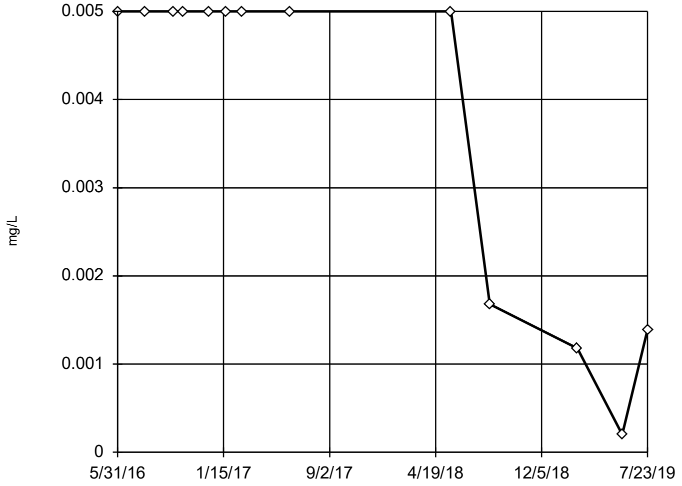
High cutoff = 5.532, low cutoff = 4.4e-7, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

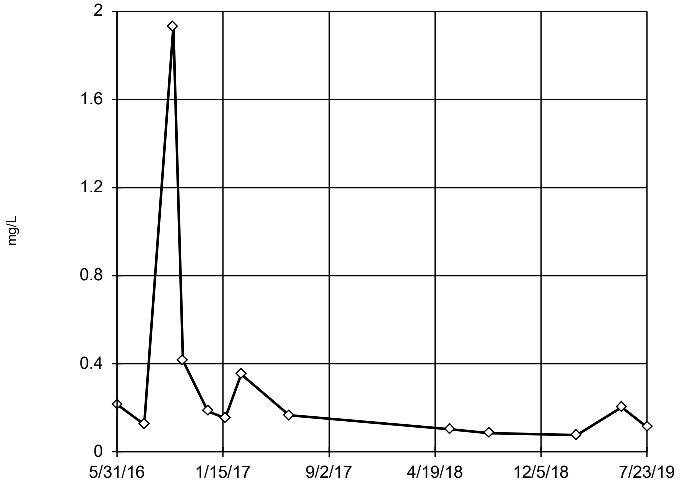
High cutoff = 0.02737, low cutoff = -0.00309, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

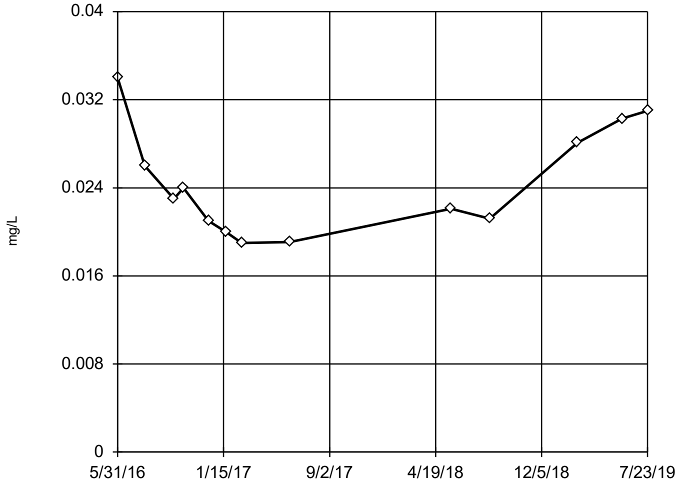
High cutoff = 4.655, low cutoff = 0.006354, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

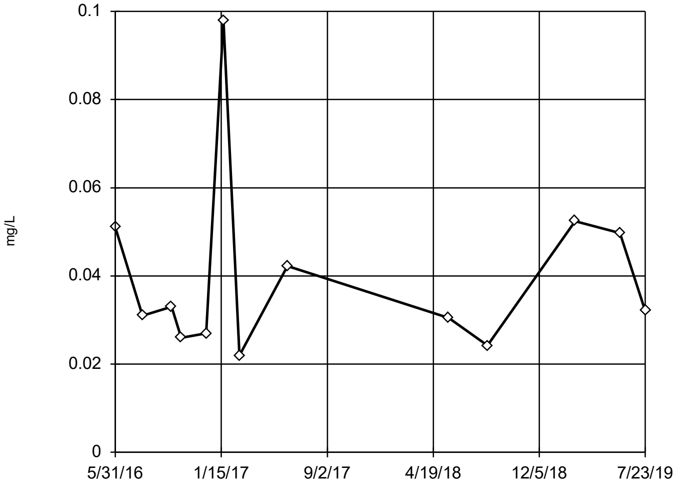
High cutoff = 0.08422, low cutoff = 0.0071, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

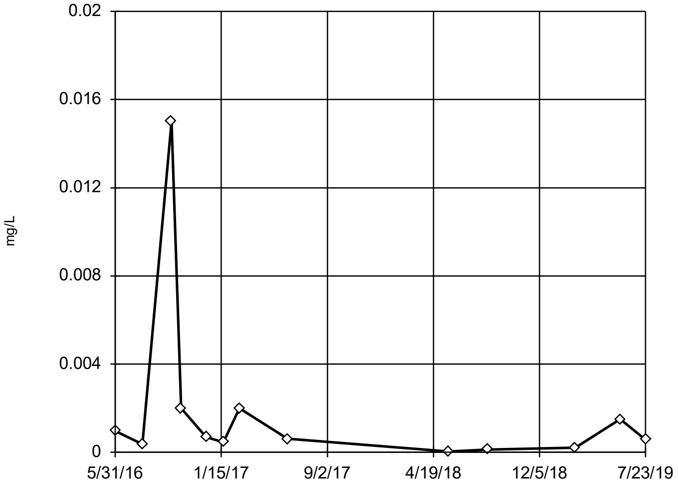
High cutoff = 0.3454, low cutoff = 0.003862, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

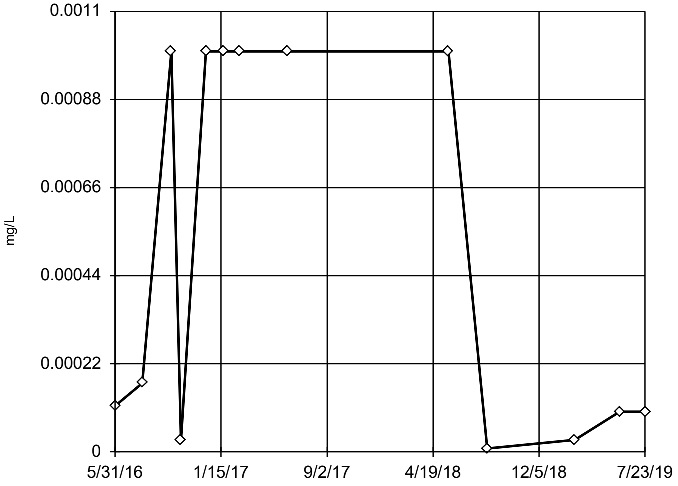
High cutoff = 0.4345, low cutoff = 0.000001095, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

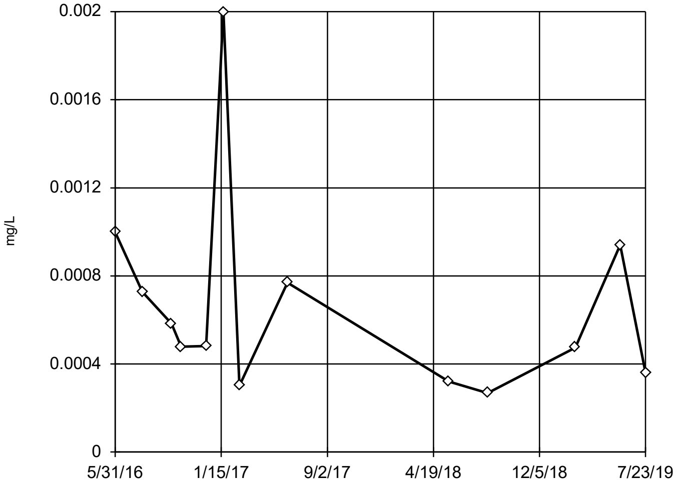
High cutoff = 6.086, low cutoff = 9.0e-9, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

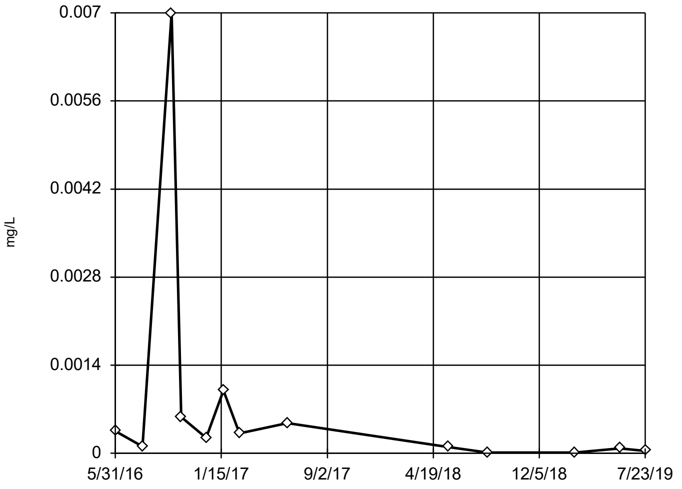
High cutoff = 0.01337, low cutoff = 0.00002164, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

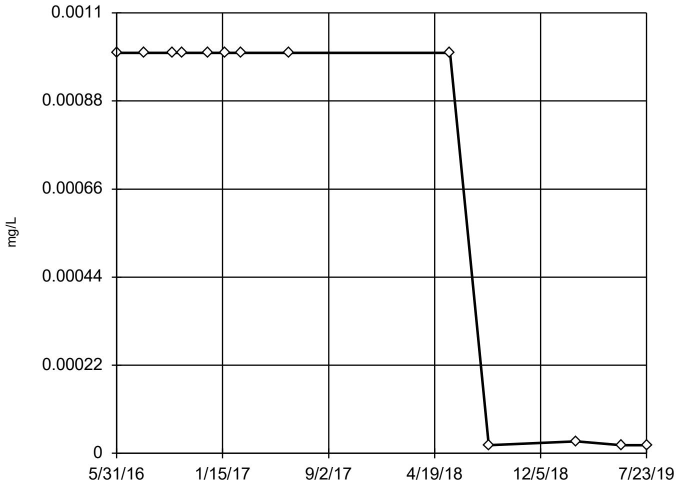
High cutoff = 0.4222, low cutoff = 7.0e-8, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

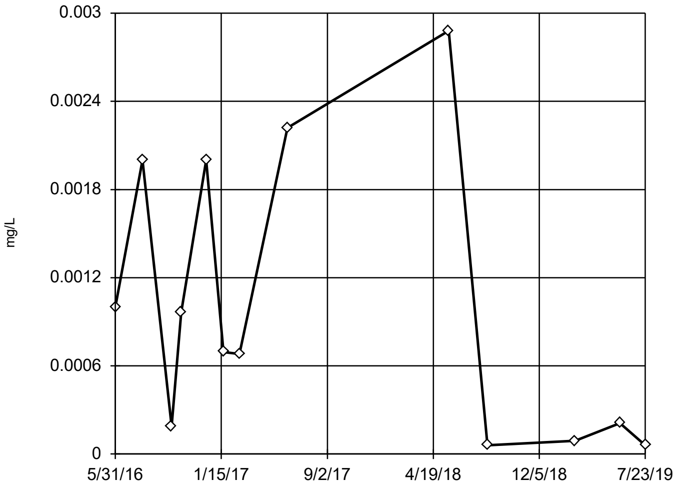
High cutoff = 68.04, low cutoff = 3.6e-10, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

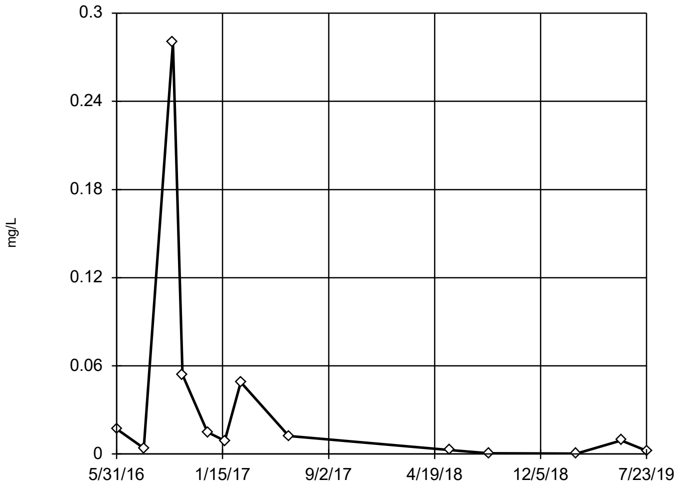
High cutoff = 0.04321, low cutoff = -0.005258, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



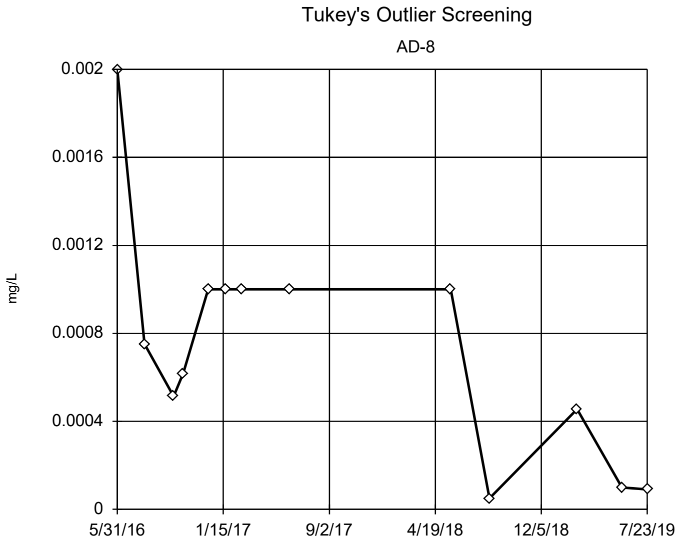
n = 13

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 = 47.88, low cutoff = 0.000001469, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP



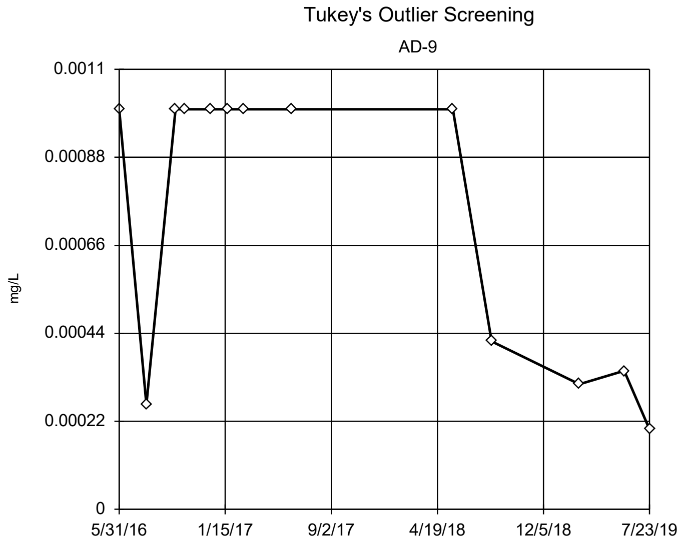
n = 13

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 = 0.006314, low cutoff = -0.001034, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP



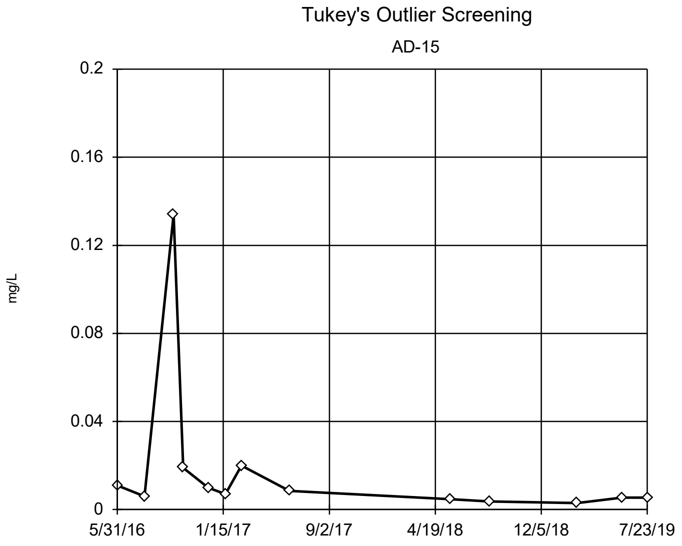
n = 13

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 = 0.02806, low cutoff = 0.00001173, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP



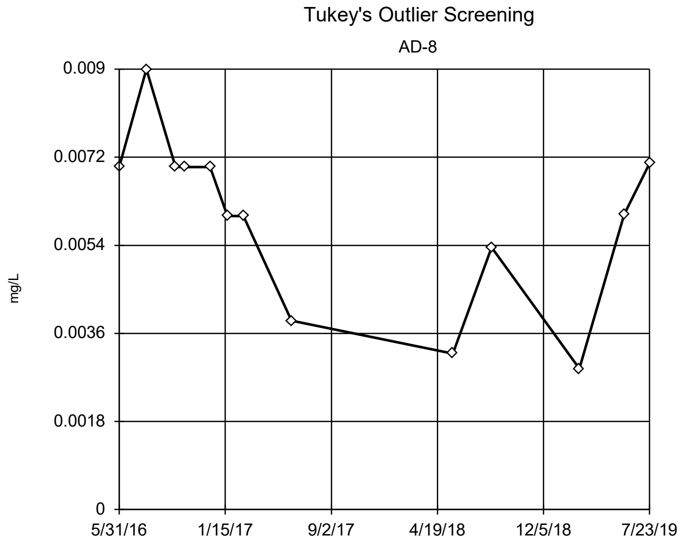
n = 13

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 = 0.3364, low cutoff = 0.0002176, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP



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).

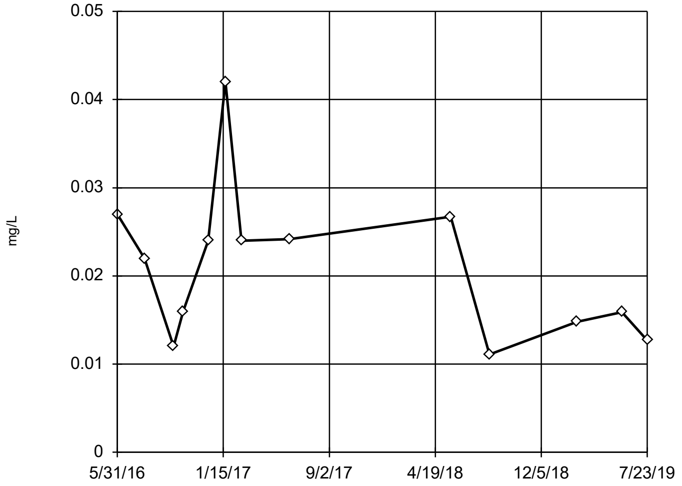
High cutoff = 0.01143, low cutoff = -0.007729, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

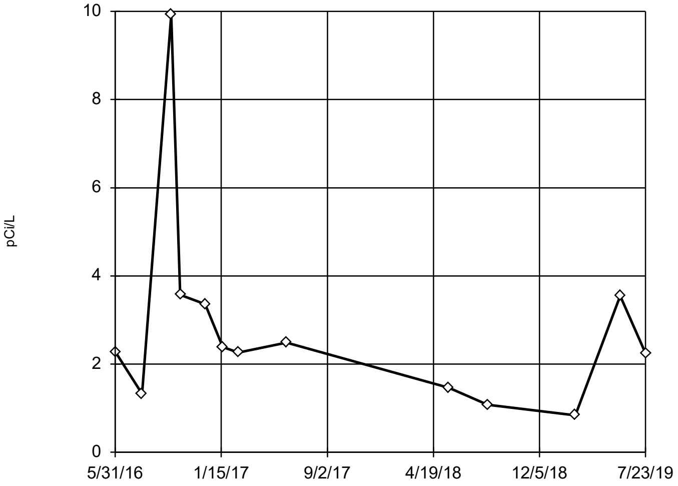
High cutoff = 0.1615, low cutoff = 0.002156, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

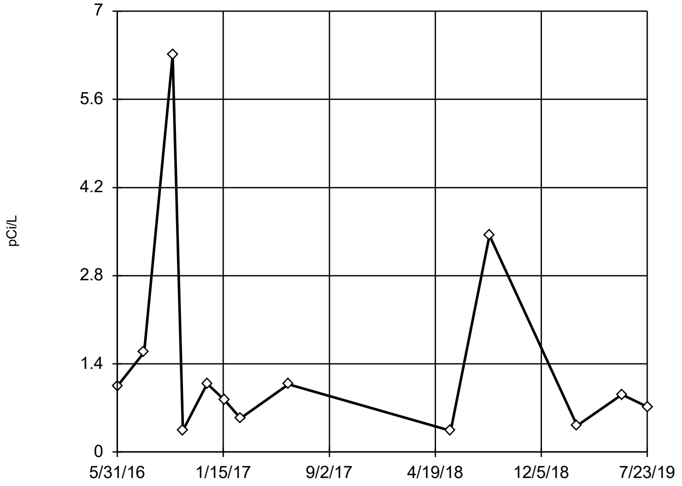
High cutoff = 53.06, low cutoff = 0.09043, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

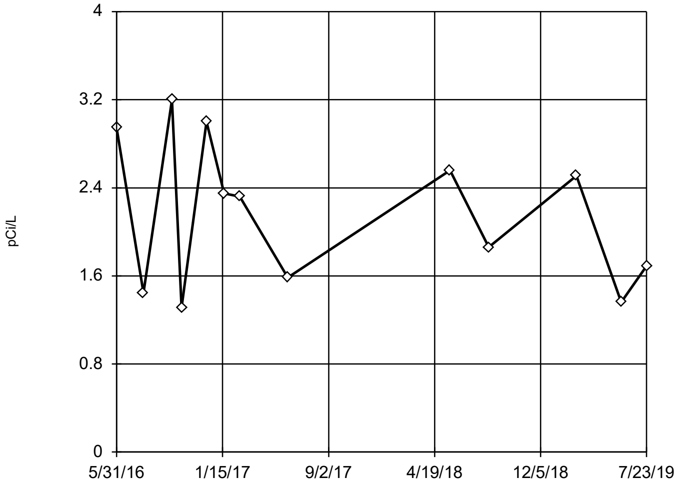
High cutoff = 27.85, low cutoff = 0.02223, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



n = 13

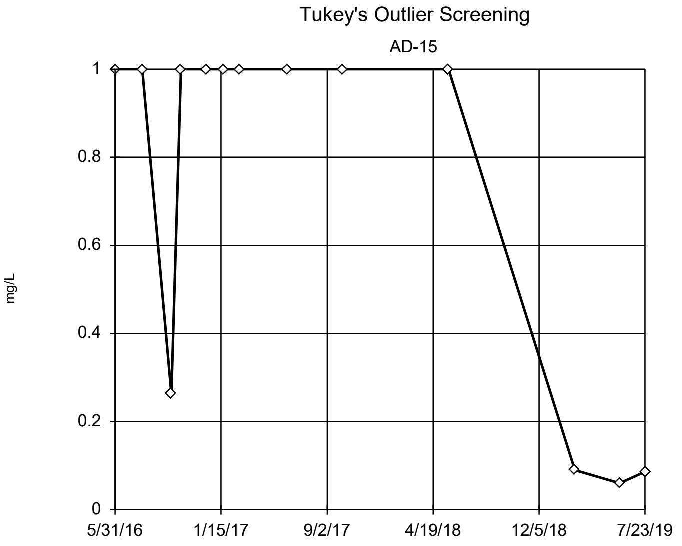
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 8.636, low cutoff = -0.00246, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

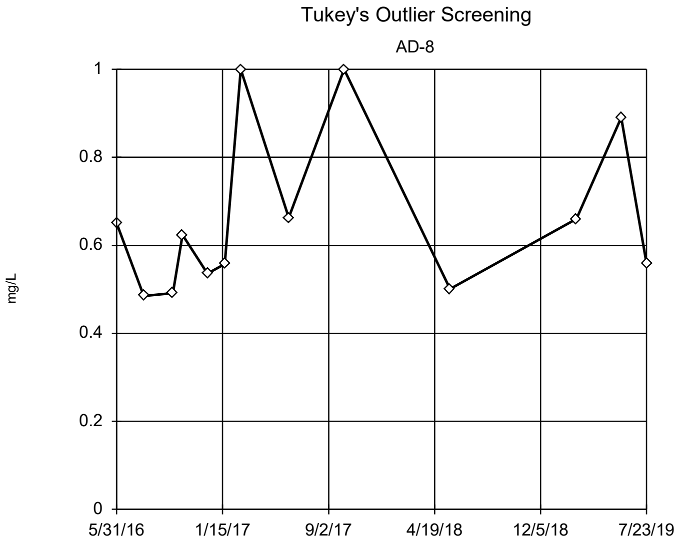
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 276, low cutoff = 0.0005564, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

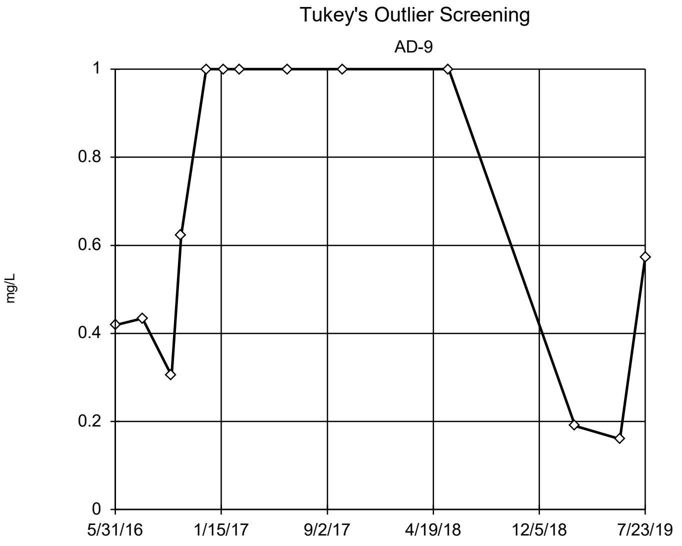
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.504, low cutoff = 0.1589, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

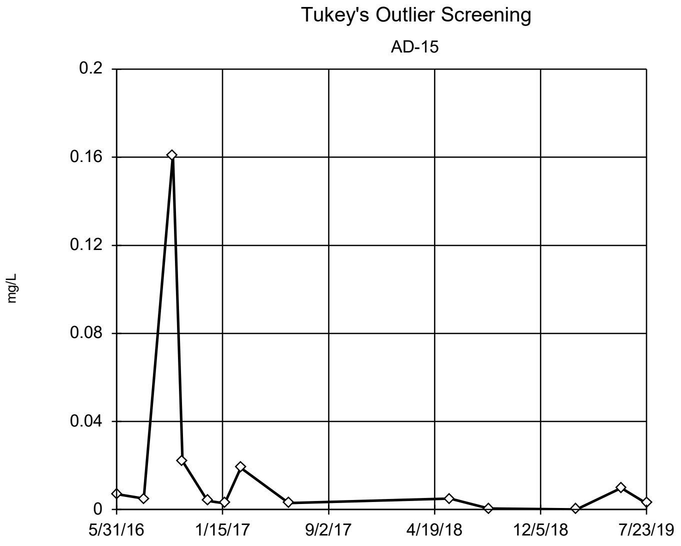
No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 6.527, low cutoff = -0.003982, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

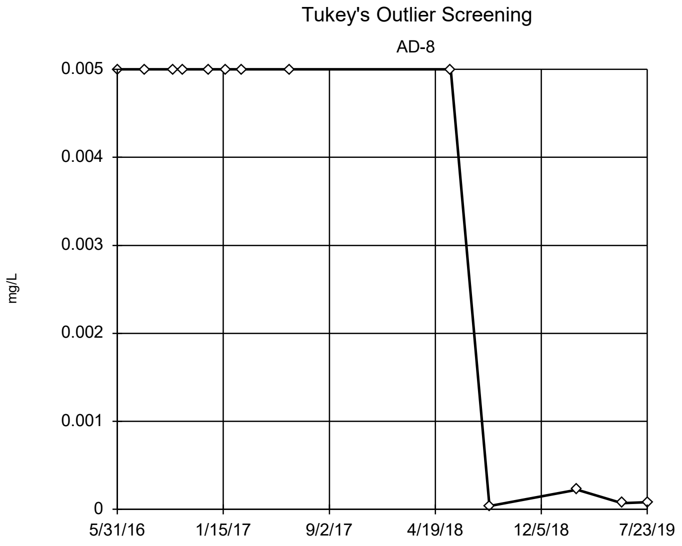
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.478, low cutoff = 0.0000266, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

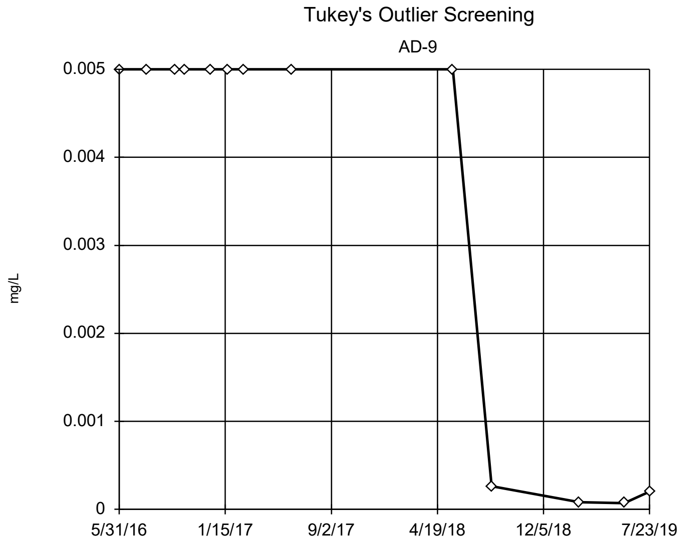
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 262.3, low cutoff = 2.5e-9, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

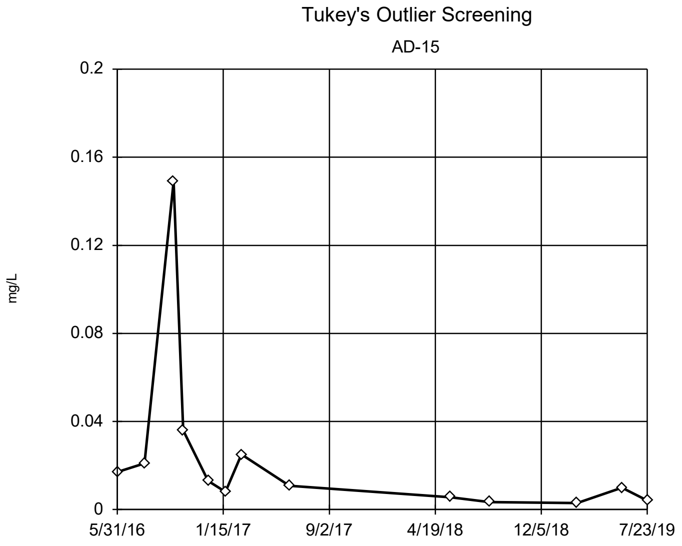
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 52.11, low cutoff = 2.2e-8, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

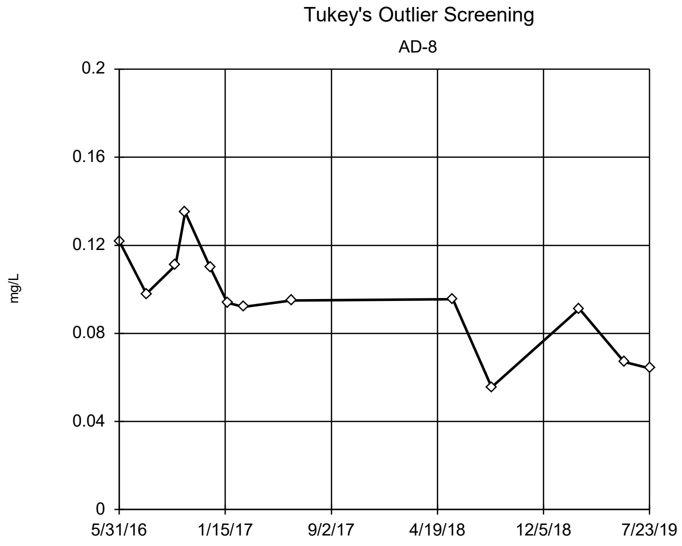
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.456, low cutoff = 0.000045, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

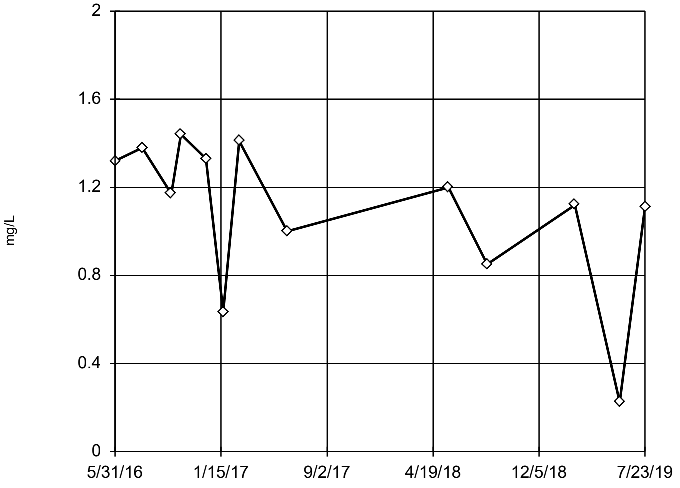
High cutoff = 0.2049, low cutoff = -0.0153, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

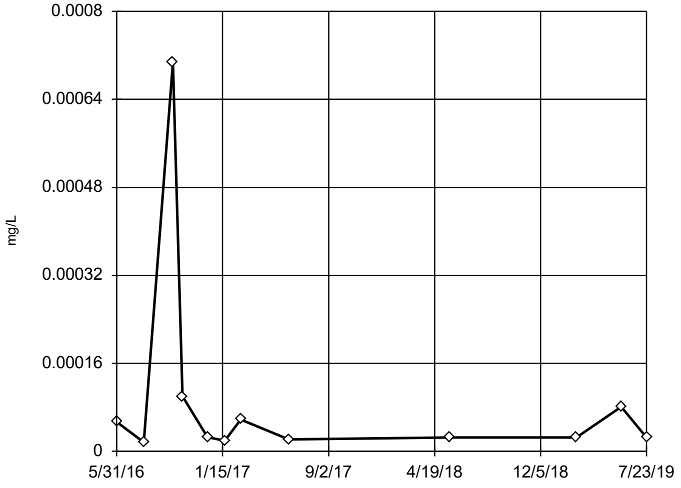
High cutoff = 1.961, low cutoff = -1.618, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

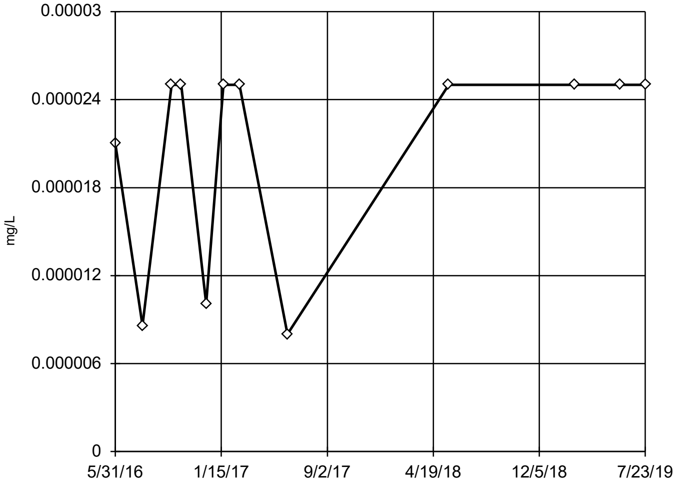
High cutoff = 0.001711, low cutoff = 9.4e-7, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

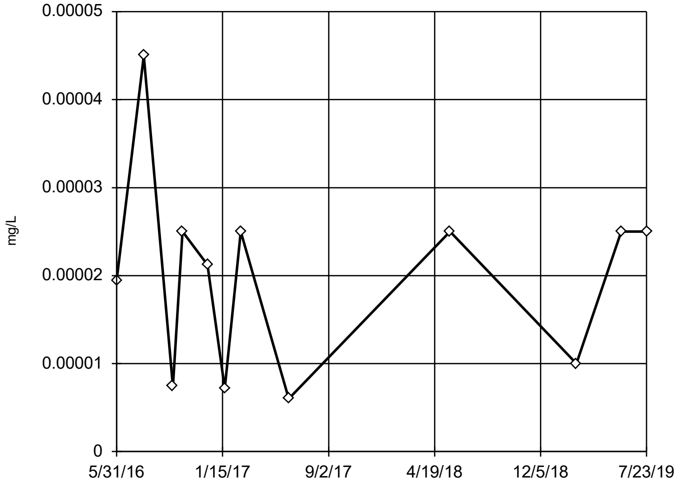
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Mercury, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



n = 12

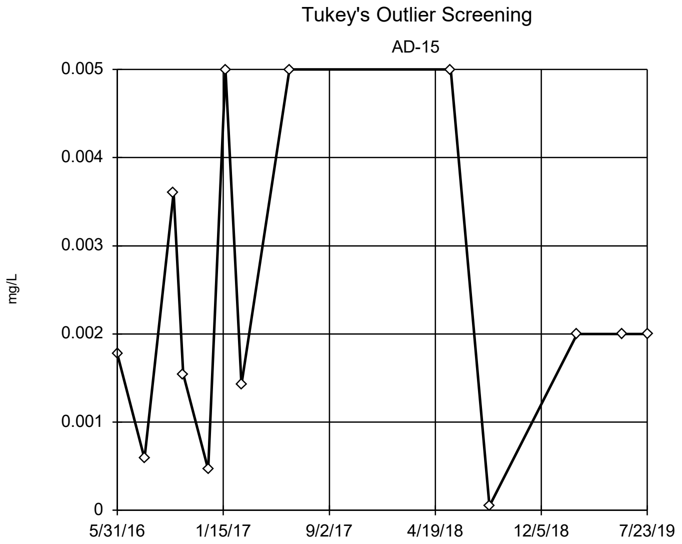
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.000125, low cutoff = -0.00001049, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-15

n = 13

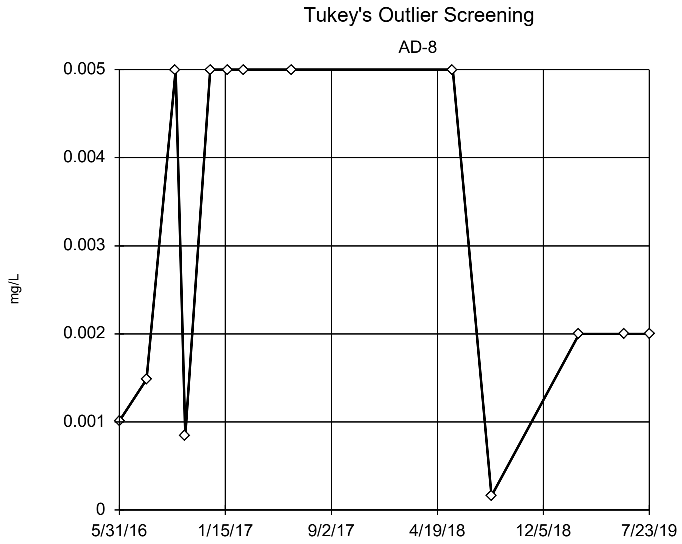
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02838, low cutoff = -0.0052, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-8

n = 13

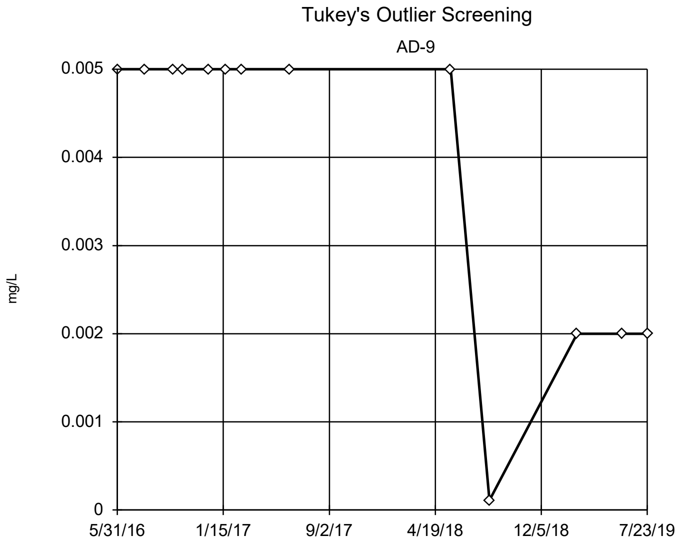
No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04755, low cutoff = -0.0005935, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-9

n = 13

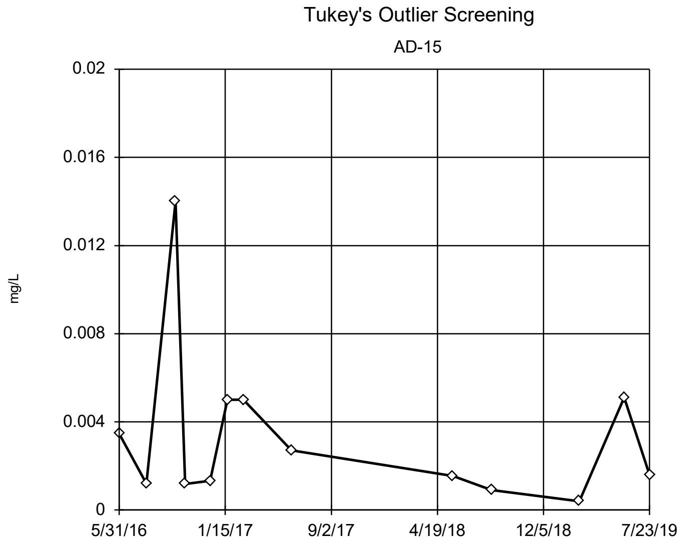
No outliers found. Tukey's method selected by user.

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: Molybdenum, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-15

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).

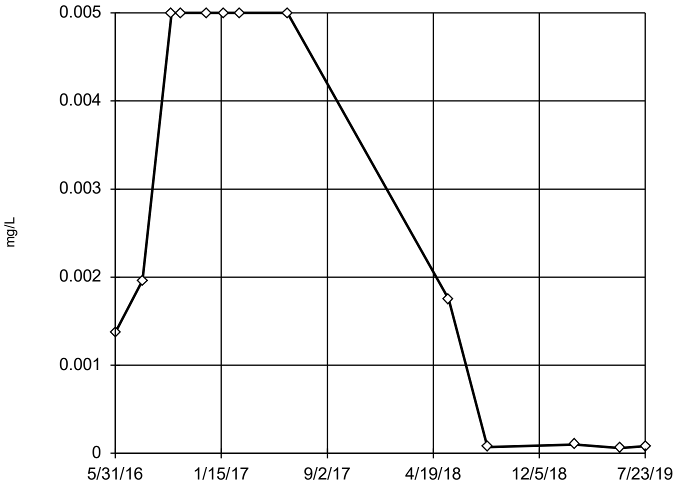
High cutoff = 0.3754, low cutoff = 0.00001579, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/20/2019 1:07 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

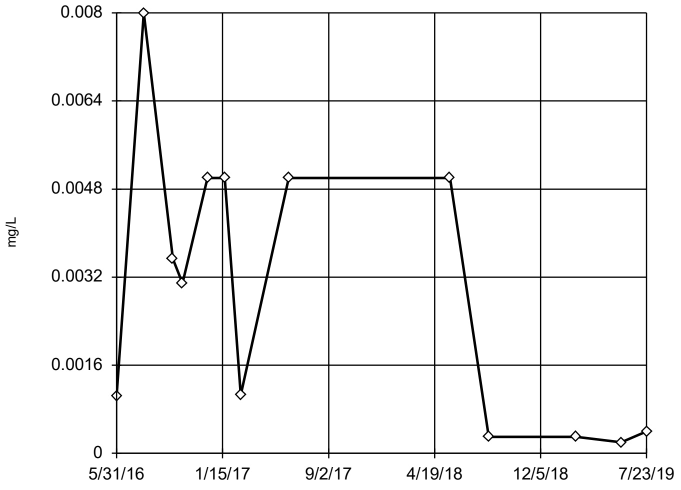
High cutoff = 0.06473, low cutoff = -0.03036, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/20/2019 1:07 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

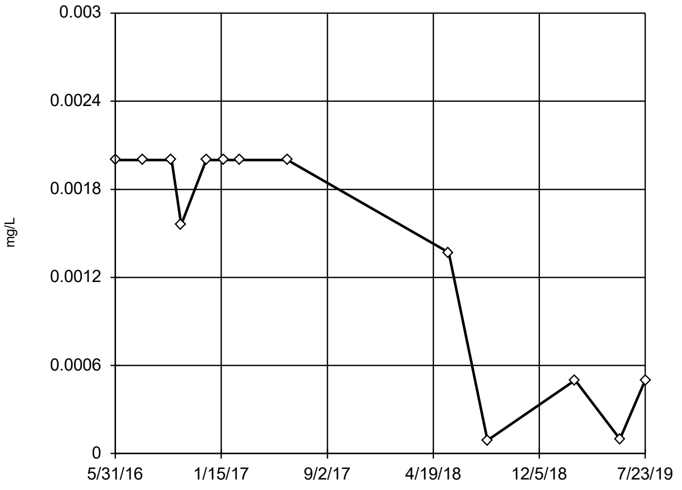
High cutoff = 0.05147, low cutoff = -0.0189, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/20/2019 1:08 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

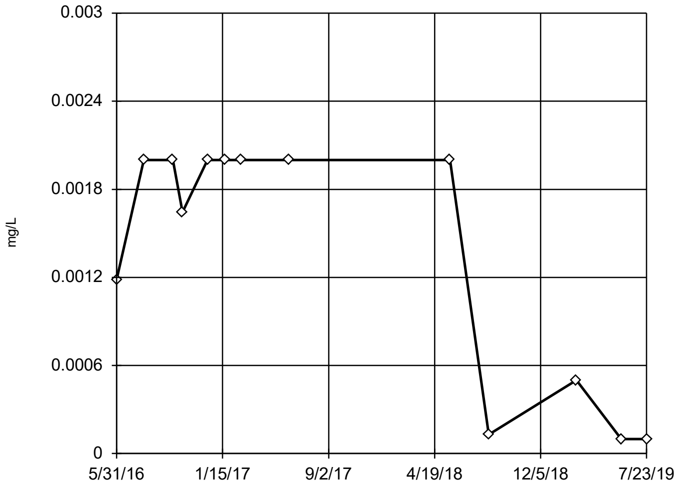
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Thallium, total   Analysis Run 11/20/2019 1:08 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



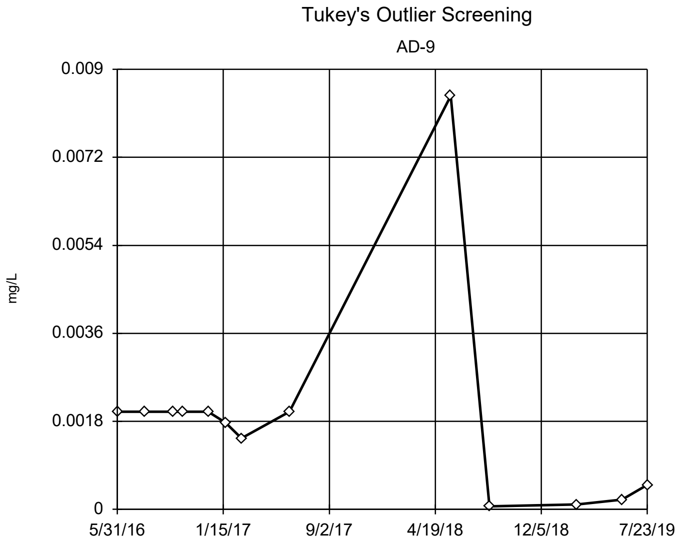
n = 13

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 = 0.00395, low cutoff = -0.003386, based on IQR multiplier of 3.

Constituent: Thallium, total   Analysis Run 11/20/2019 1:08 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP



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 = 0.02625,
low cutoff = -0.00107,
based on IQR multiplier
of 3.

Constituent: Thallium, total Analysis Run 11/20/2019 1:08 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Upgradient Appendix IV Outlier Analysis - All Results (No Significant)

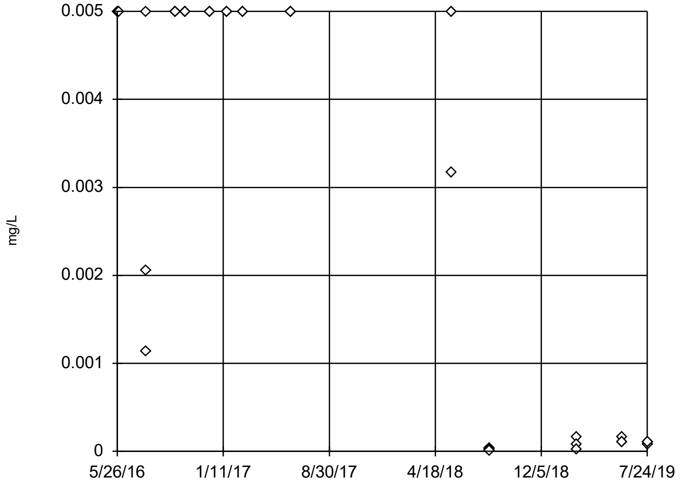
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/20/2019, 1:10 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-1,AD-1...	n/a	n/a	n/a w/com...	NP	NaN	39	0.003265	0.002294	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.003355	0.001848	sqrt(x)	ShapiroWilk
Barium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.1097	0.1337	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.000...	0.000171	x^(1/3)	ShapiroWilk
Cadmium, total (mg/L)	AD-1,AD-1...	n/a	n/a	n/a w/com...	NP	NaN	39	0.001055	0.001552	unknown	ShapiroWilk
Chromium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	38	0.000...	0.00086	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.02542	0.02821	x^(1/3)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	2.091	0.9476	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	0.7273	0.3627	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.003549	0.002164	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.1639	0.1373	normal	ShapiroWilk
Mercury, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.000...	0.0000...	x^2	ShapiroWilk
Molybdenum, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.003371	0.001944	x^(1/3)	ShapiroWilk
Selenium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.002917	0.002031	sqrt(x)	ShapiroWilk
Thallium, total (mg/L)	AD-1,AD-1...	n/a	n/a	n/a w/com...	NP	NaN	39	0.001458	0.000758	unknown	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

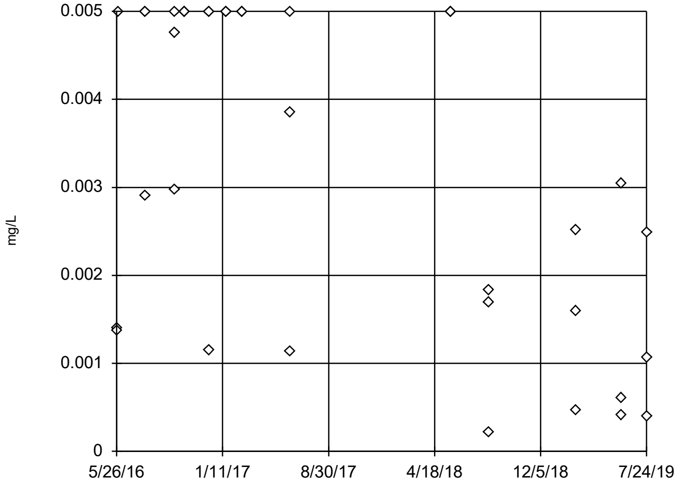
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Antimony, total Analysis Run 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

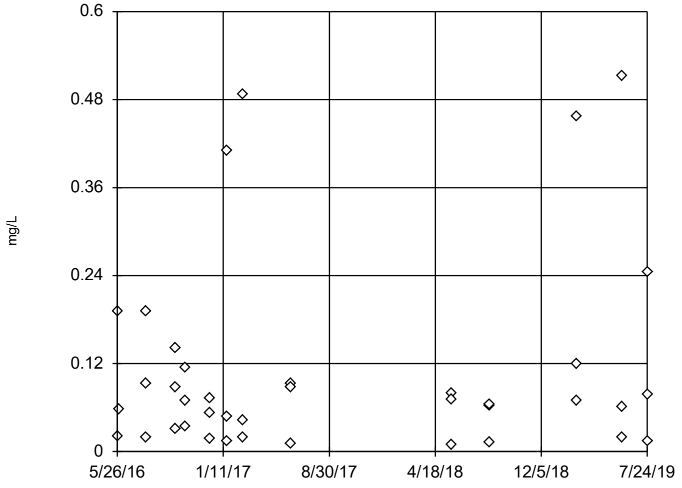
High cutoff = 0.02919, low cutoff = -0.003945, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

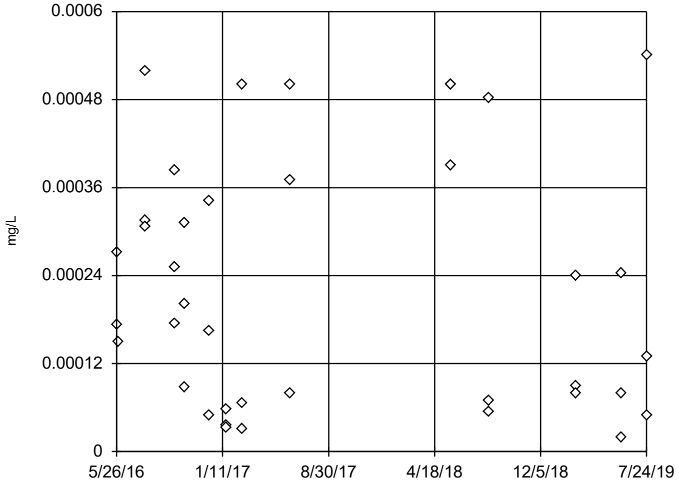
High cutoff = 18.24, low cutoff = 0.0001313, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

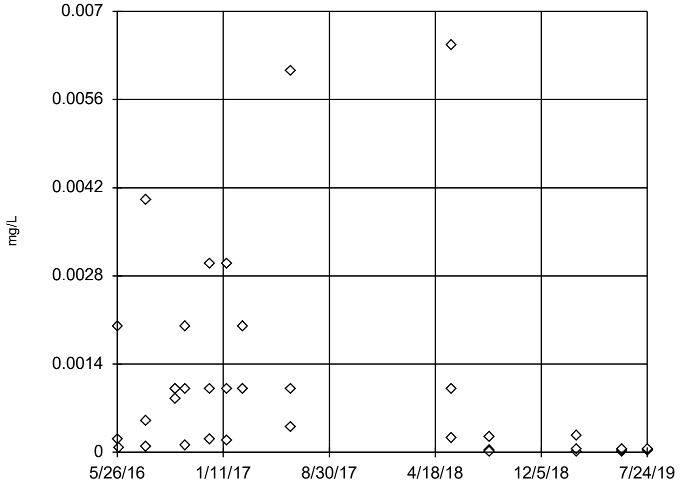
High cutoff = 0.00442, low cutoff = -0.0001351, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 both the lower and upper quartiles represent reporting limits.

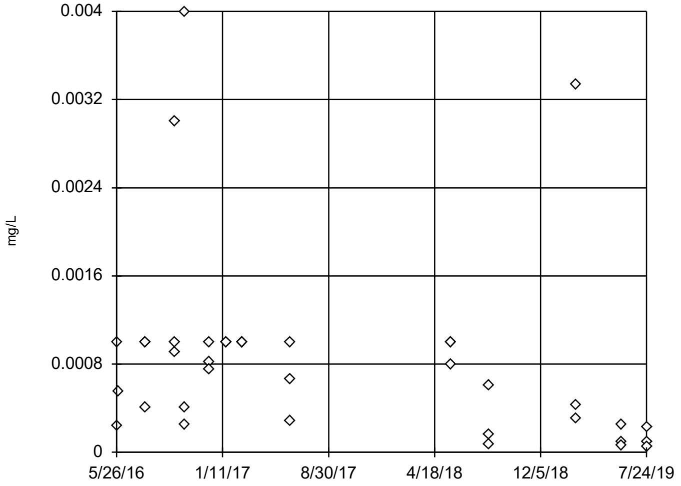
Constituent: Cadmium, total   Analysis Run 11/20/2019 1:09 PM   View: AIV

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 38

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 = 0.06633, low cutoff = 0.000003725, based on IQR multiplier of 3.

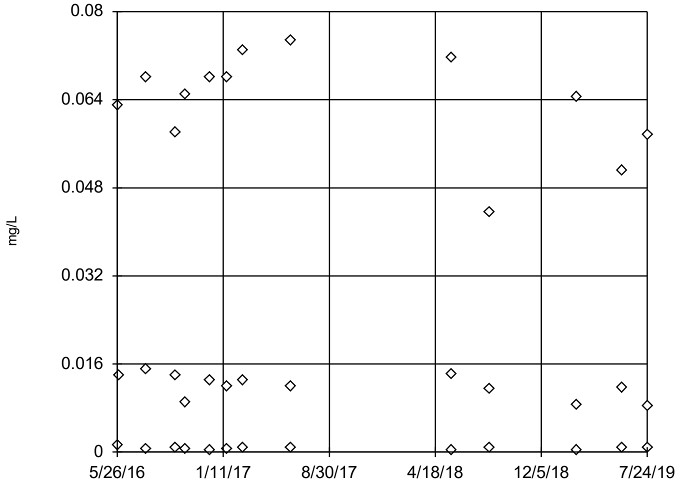
Constituent: Chromium, total   Analysis Run 11/20/2019 1:09 PM   View: AIV

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 2.054, low cutoff = -0.4961, based on IQR multiplier of 3.

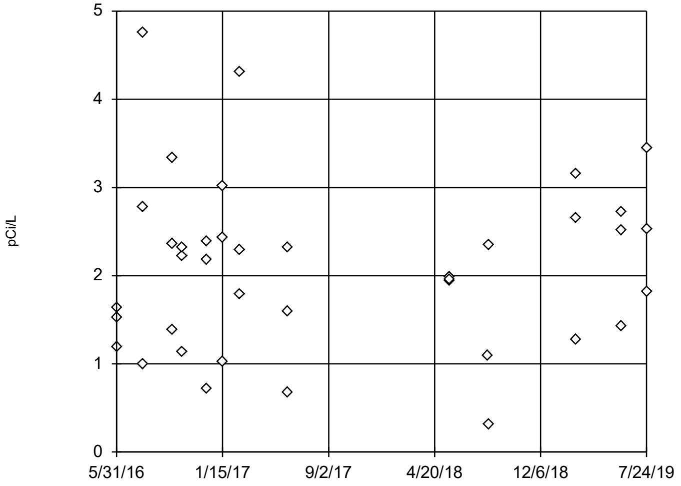
Constituent: Cobalt, total   Analysis Run 11/20/2019 1:09 PM   View: AIV

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 8.077, low cutoff = -0.005728, based on IQR multiplier of 3.

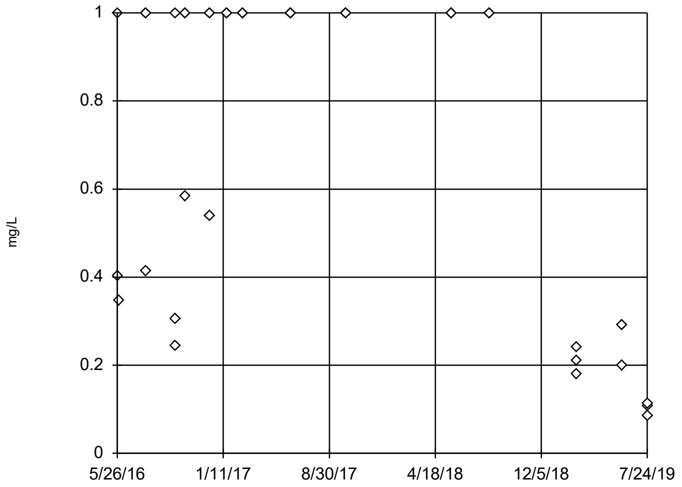
Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:09 PM   View: AIV

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



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).

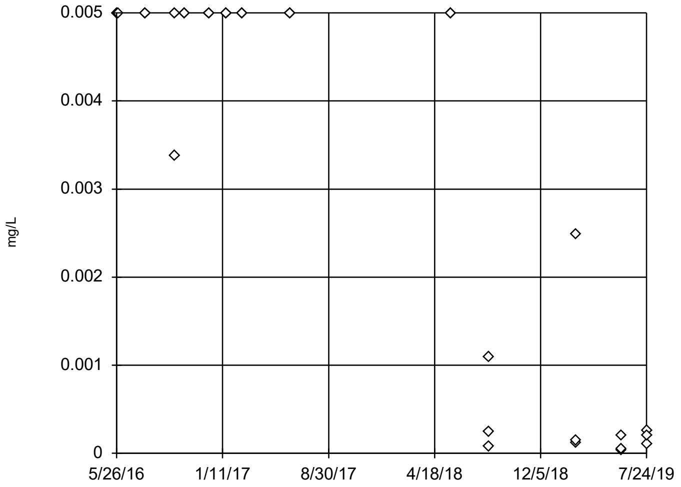
High cutoff = 37.92, low cutoff = 0.007849, based on IQR multiplier of 3.

Constituent: Fluoride, total   Analysis Run 11/20/2019 1:09 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

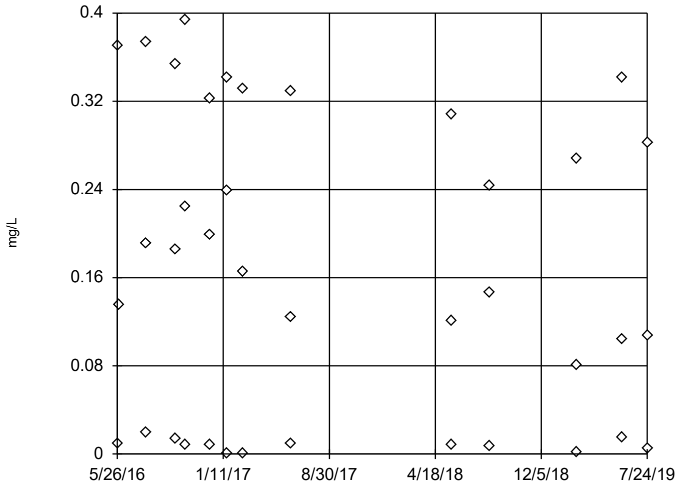
High cutoff = 34.36, low cutoff = 3.8e-8, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 11/20/2019 1:09 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

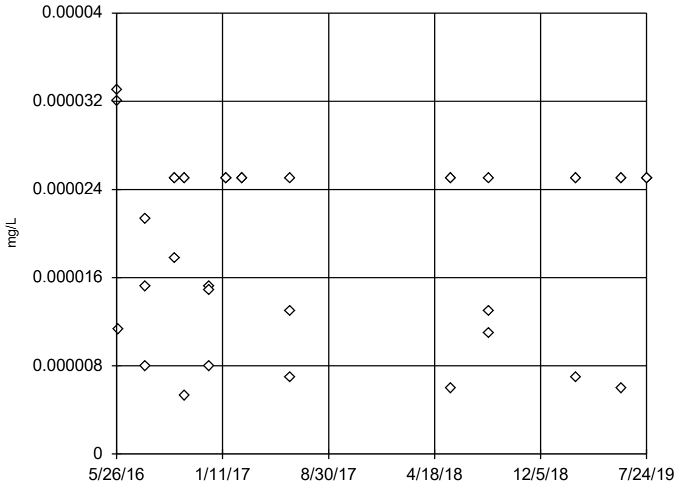
High cutoff = 1.202, low cutoff = -0.884, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/20/2019 1:09 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

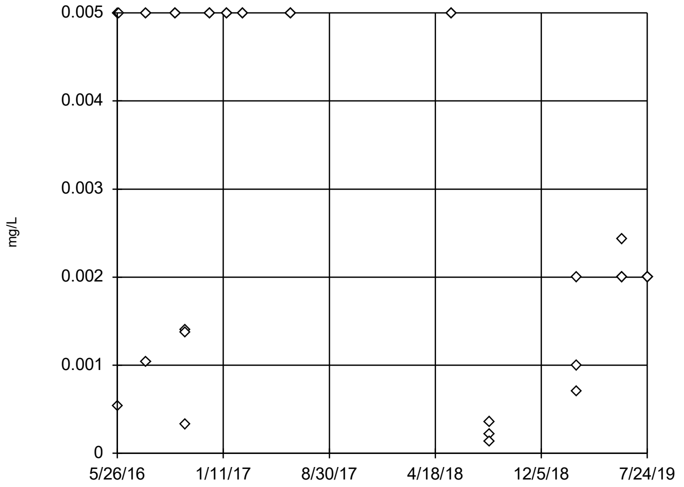
High cutoff = 0.00004464, low cutoff = -0.00003463, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/20/2019 1:09 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

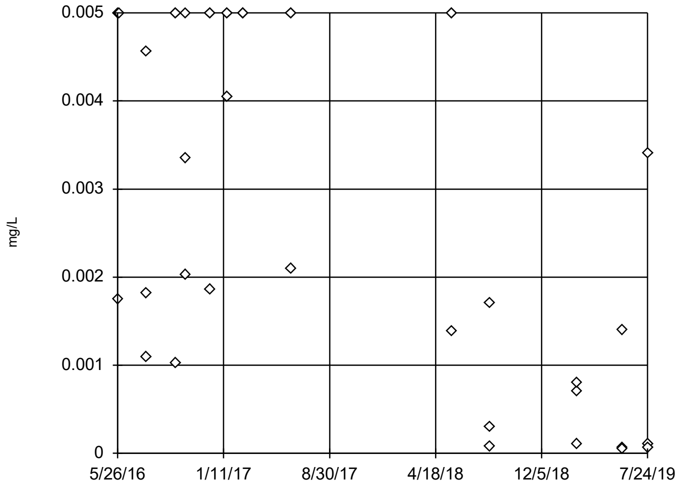
High cutoff = 0.04232, low cutoff = -0.000283, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

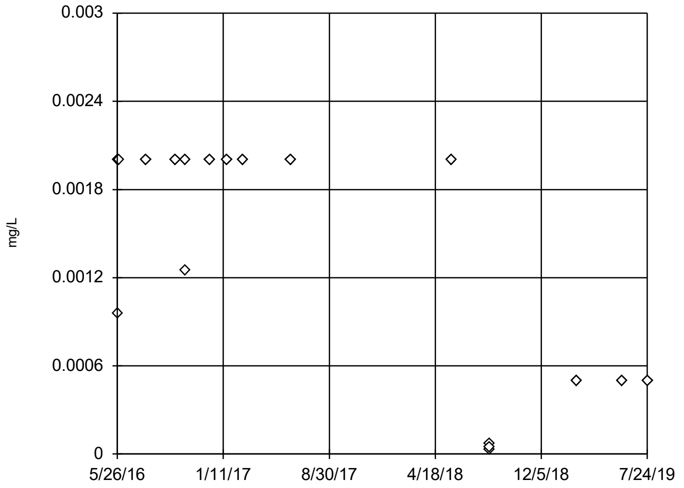
High cutoff = 0.03487, low cutoff = -0.007054, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 11/20/2019 1:09 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Interwell Appendix III Outlier Analysis - All Results (No Significant)

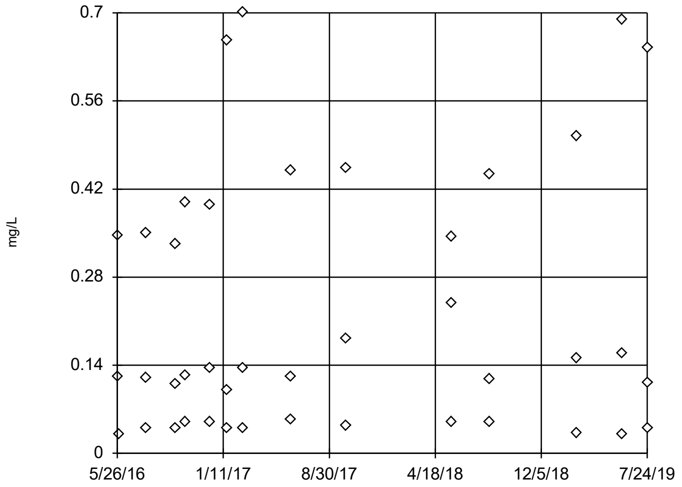
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/20/2019, 1:03 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Boron, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	0.2196	0.2058	ln(x)	ShapiroWilk
pH, field (SU)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	5.951	0.5895	ln(x)	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



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 = 152.1, low cutoff = 0.000122, based on IQR multiplier of 3.

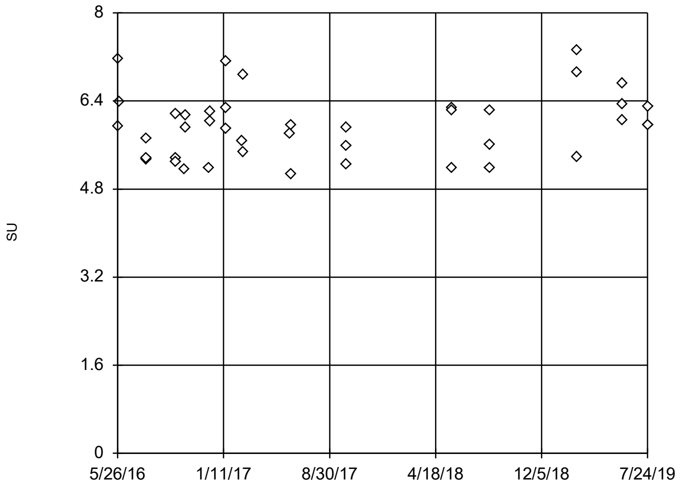
Constituent: Boron, total Analysis Run 11/20/2019 1:03 PM View: Interwell AIII

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



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 = 9.984, low cutoff = 3.378, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/20/2019 1:03 PM View: Interwell AIII

Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Intrawell Appendix III Outlier Analysis - Significant Results

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 11/20/2019, 1:07 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Total Dissolved Solids (mg/L)	**AD-15**	**Yes**	**367**	**9/30/2016**	**NP**	**NaN**	**13**	**179**	**75.8**	**normal**	**ShapiroWilk**

Intrawell Appendix III Outlier Analysis - All Results

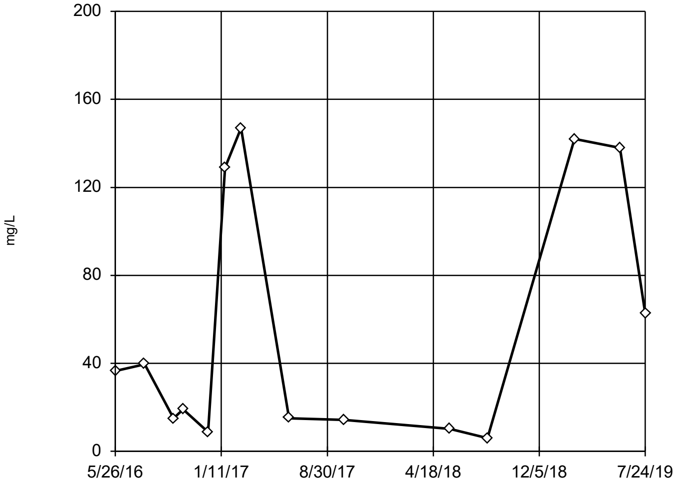
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/20/2019, 1:07 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Calcium, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	55.94	56.65	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	3.508	0.7866	x^(1/3)	ShapiroWilk
Calcium, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	195.5	8.645	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	40.53	8.044	x^(1/3)	ShapiroWilk
Calcium, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	14	20.9	4.996	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	14	181.3	86.04	x^5	ShapiroWilk
Chloride, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	4.172	1.727	x^(1/3)	ShapiroWilk
Chloride, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	28.28	4.624	normal	ShapiroWilk
Chloride, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	35.64	4.965	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	17	3.662	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	24.36	5.269	x^(1/3)	ShapiroWilk
Chloride, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	71.69	28.34	x^4	ShapiroWilk
Fluoride, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	0.8311	0.3376	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	0.7306	0.4231	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	0.6221	0.3637	x^(1/3)	ShapiroWilk
Fluoride, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	0.7288	0.3808	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	0.6628	0.184	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	0.6695	0.3425	x^(1/3)	ShapiroWilk
Sulfate, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	46.46	10.67	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-15	No	n/a	n/a	NP	NaN	13	18.36	7.438	x^2	ShapiroWilk
Sulfate, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	1123	104.3	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	142.1	78.09	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	164	27.48	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	1186	608.9	x^2	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	295.9	180	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	**AD-15**	**Yes**	**367**	**9/30/2016**	**NP**	**NaN**	**13**	**179**	**75.8**	**normal**	**ShapiroWilk**
Total Dissolved Solids (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	1670	111	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	343.5	88.41	sqrt(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-8	No	n/a	n/a	NP	NaN	13	385.2	70.74	x^(1/3)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-9	No	n/a	n/a	NP	NaN	13	2034	869.4	x^6	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-1 (bg)



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).

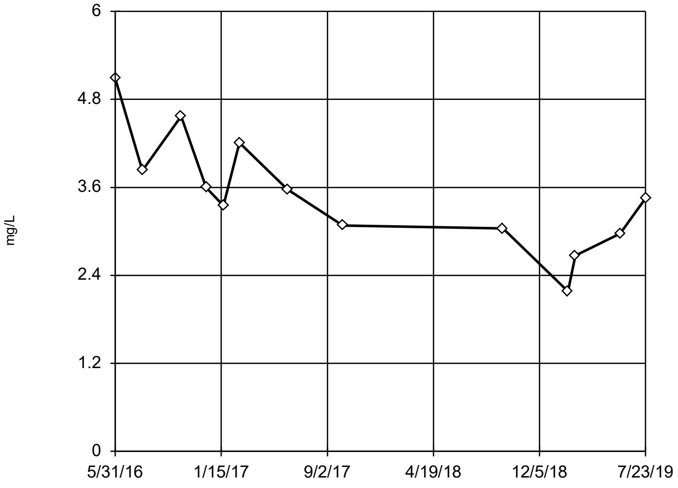
High cutoff = 179901, low cutoff = 0.008957, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

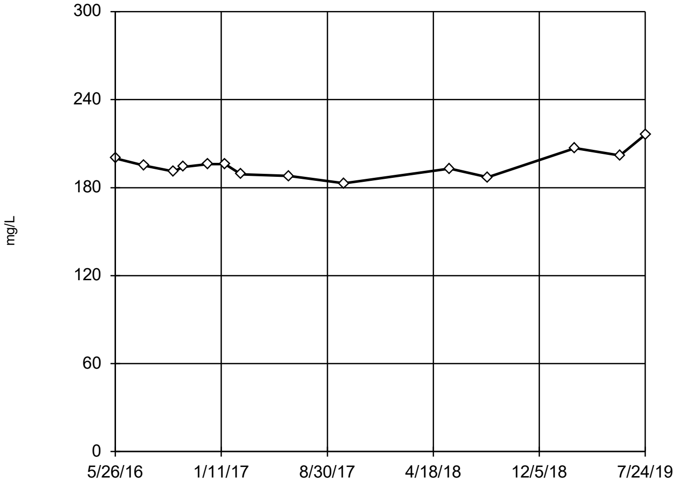
High cutoff = 8.359, low cutoff = 1.01, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-17 (bg)



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).

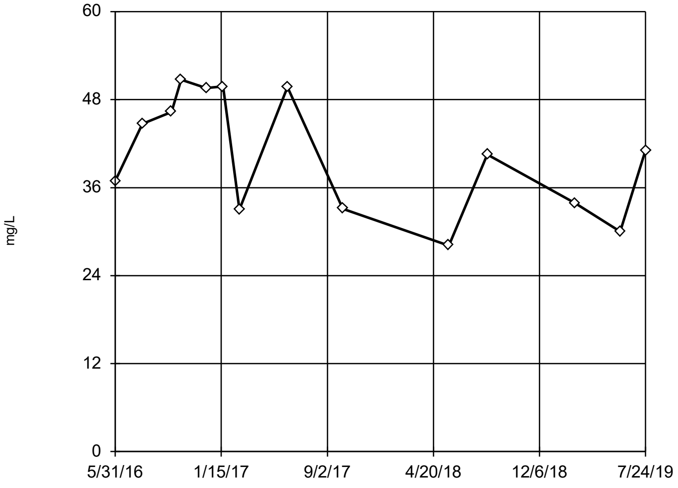
High cutoff = 243.7, low cutoff = 155.5, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-5 (bg)



n = 14

No outliers found. Tukey's method selected by user.

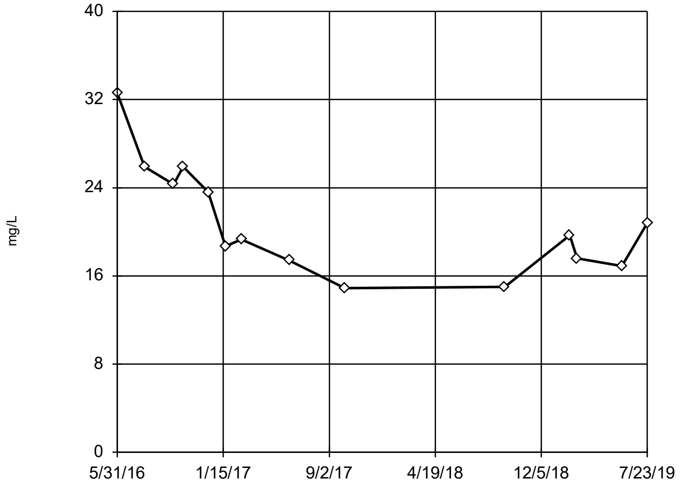
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 130.6, low cutoff = 5.933, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Tukey's Outlier Screening

AD-8



n = 14

No outliers found. Tukey's method selected by user.

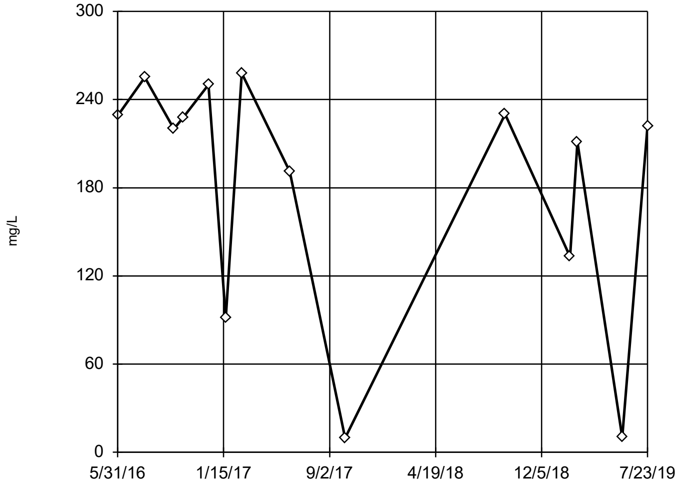
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 78.55, low cutoff = 5.477, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/20/2019 1:04 PM   View: Intrawell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Tukey's Outlier Screening

AD-9



n = 14

No outliers found. Tukey's method selected by user.

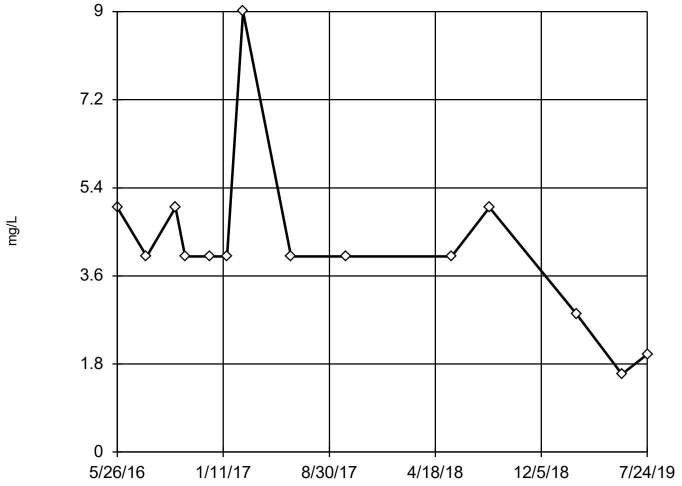
Data were x^5 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 316.4, low cutoff = -297.6, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/20/2019 1:04 PM   View: Intrawell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Tukey's Outlier Screening

AD-1 (bg)



n = 14

No outliers found. Tukey's method selected by user.

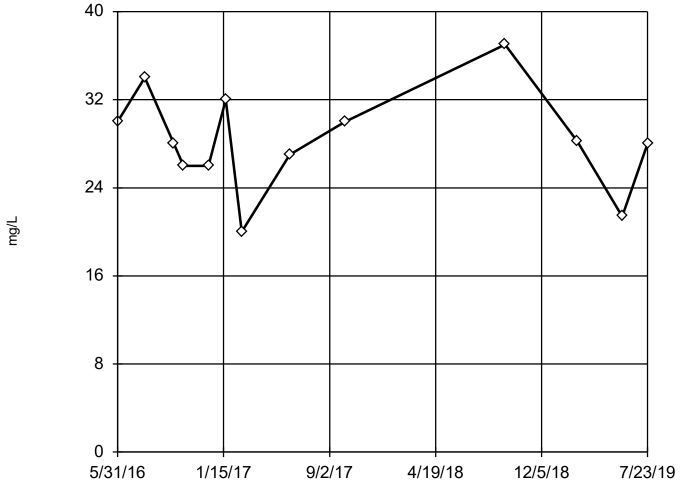
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 12.81, low cutoff = 0.6596, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/20/2019 1:04 PM   View: Intrawell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Tukey's Outlier Screening

AD-15



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

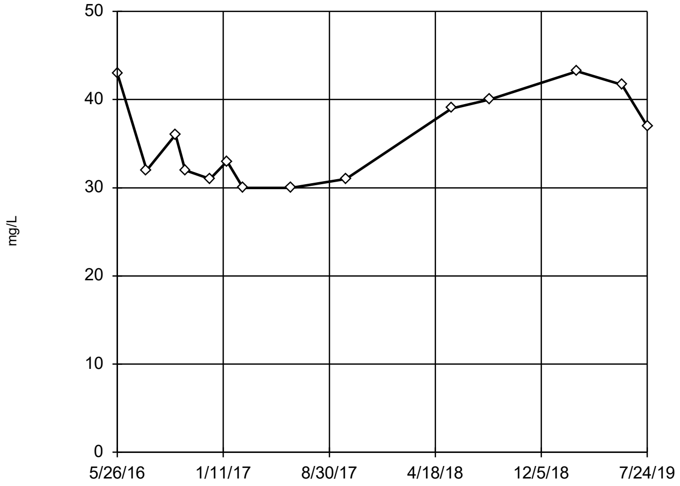
High cutoff = 46, low cutoff = 11, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/20/2019 1:04 PM   View: Intrawell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-17 (bg)



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).

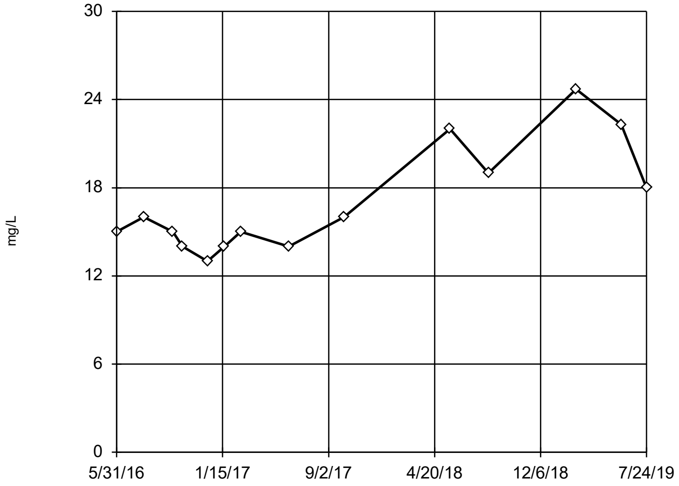
High cutoff = 93.39, low cutoff = 13.56, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-5 (bg)



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).

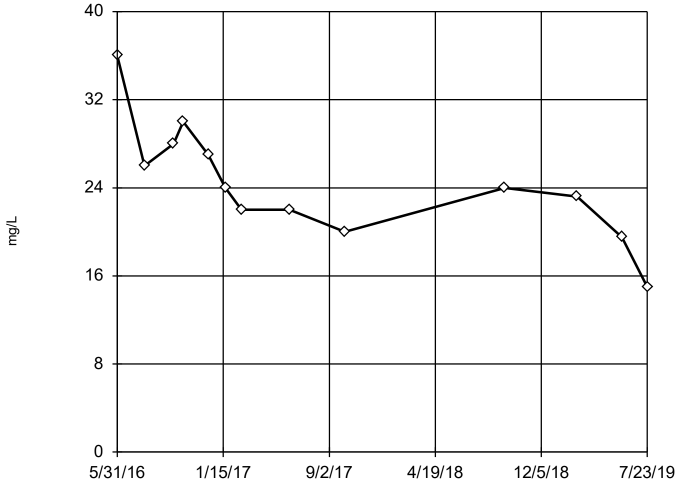
High cutoff = 63.67, low cutoff = 4.495, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

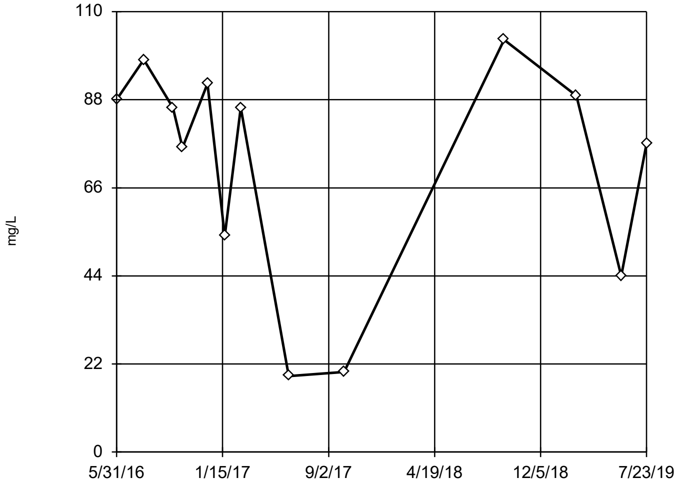
High cutoff = 54.81, low cutoff = 7.739, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

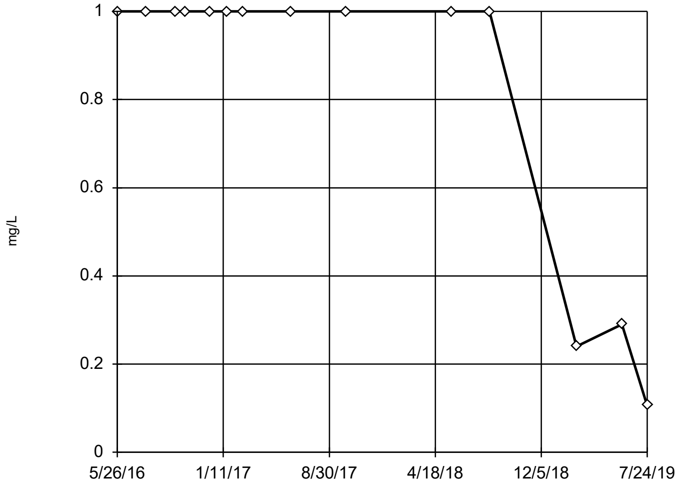
High cutoff = 125.8, low cutoff = -115.4, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-1 (bg)



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).

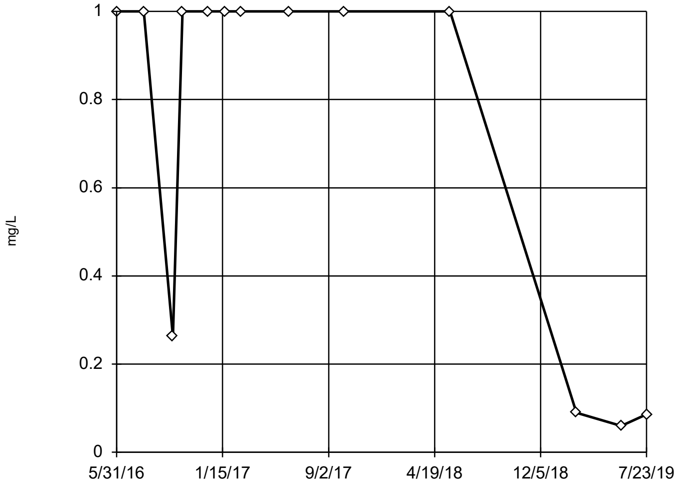
High cutoff = 6.403, low cutoff = 0.0841, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



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).

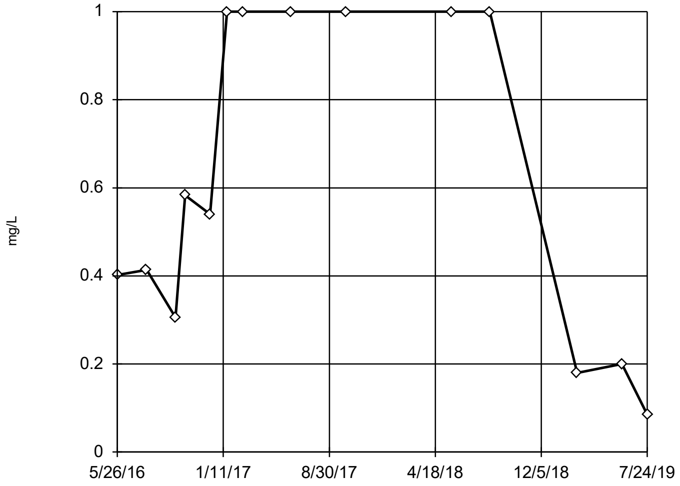
High cutoff = 276, low cutoff = 0.0005564, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-17 (bg)



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).

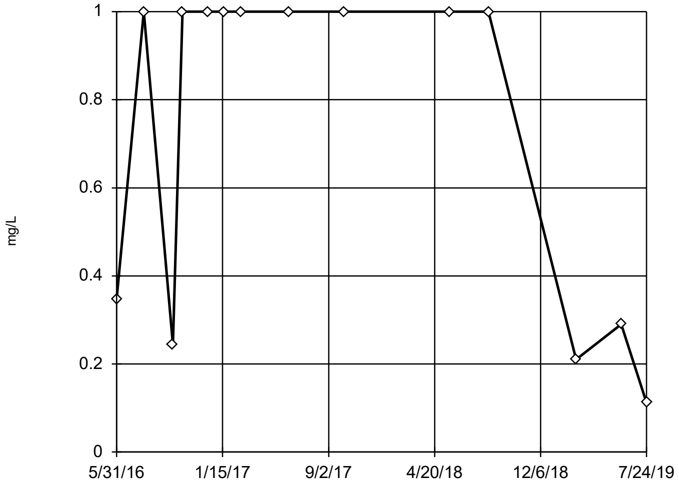
High cutoff = 9.428, low cutoff = -0.113, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-5 (bg)



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).

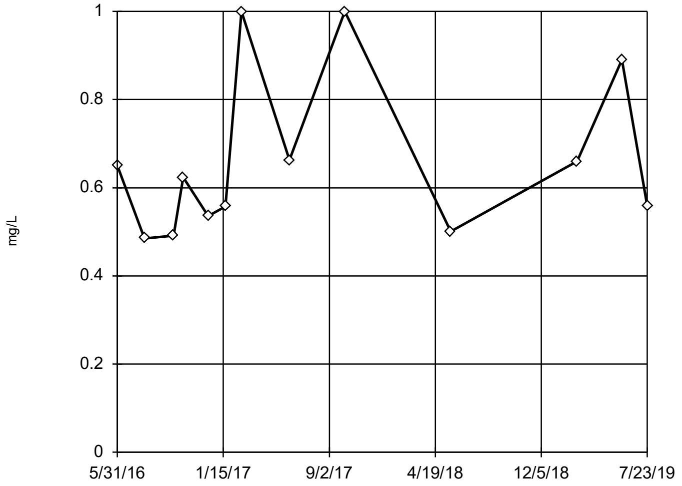
High cutoff = 53.26, low cutoff = 0.004991, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-8



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).

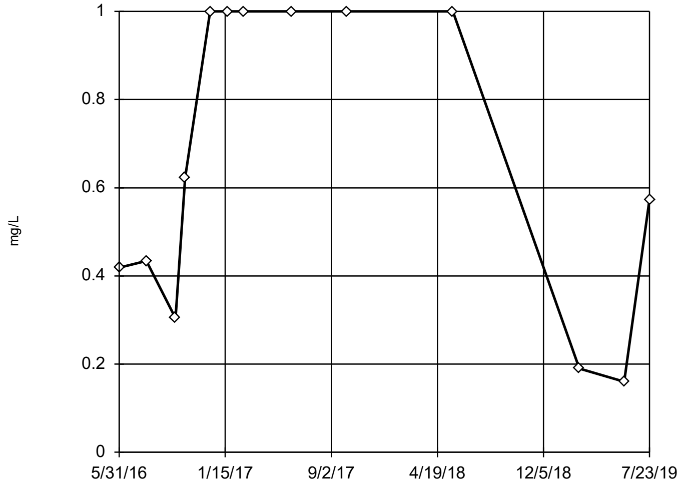
High cutoff = 2.504, low cutoff = 0.1589, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-9



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).

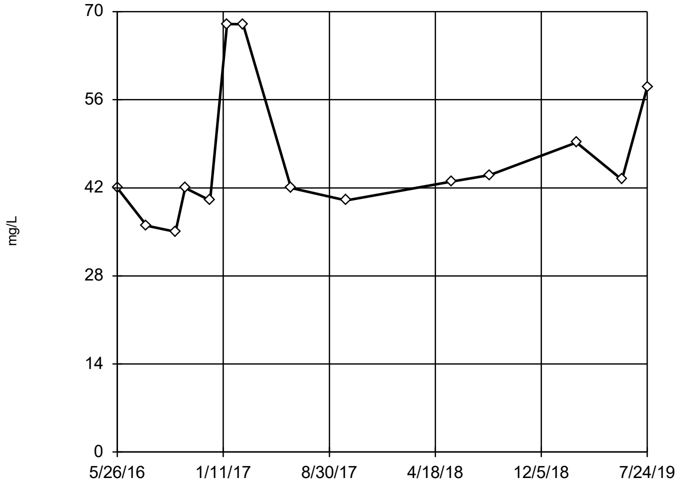
High cutoff = 6.527, low cutoff = -0.003982, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-1 (bg)



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).

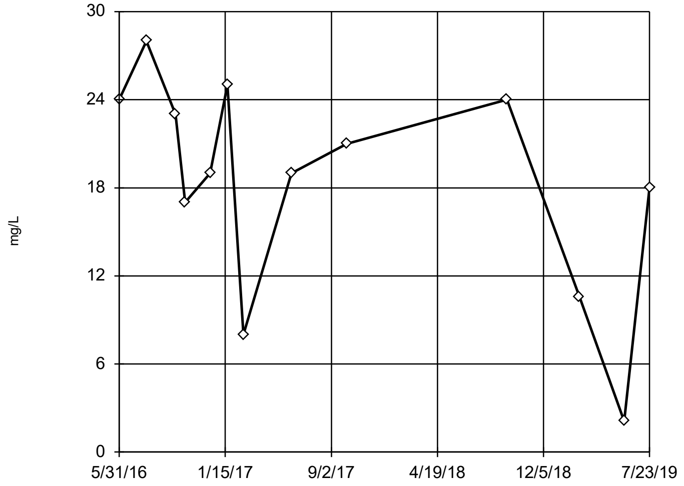
High cutoff = 127.2, low cutoff = 16.79, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



n = 13

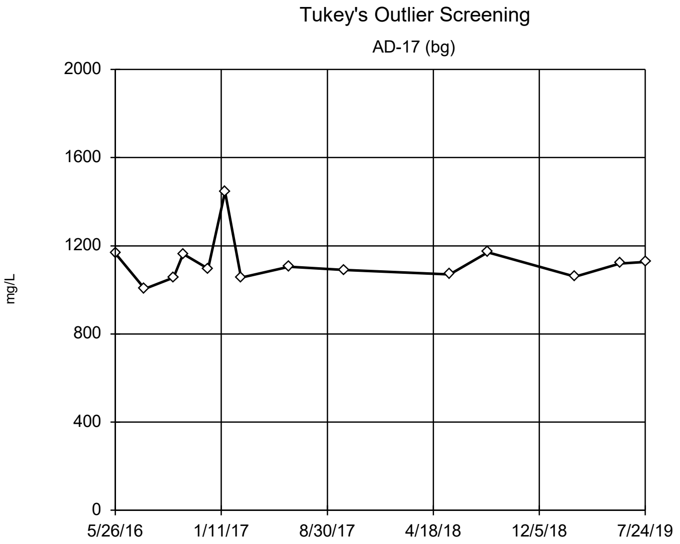
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 41.25, low cutoff = -30.42, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:04 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 14

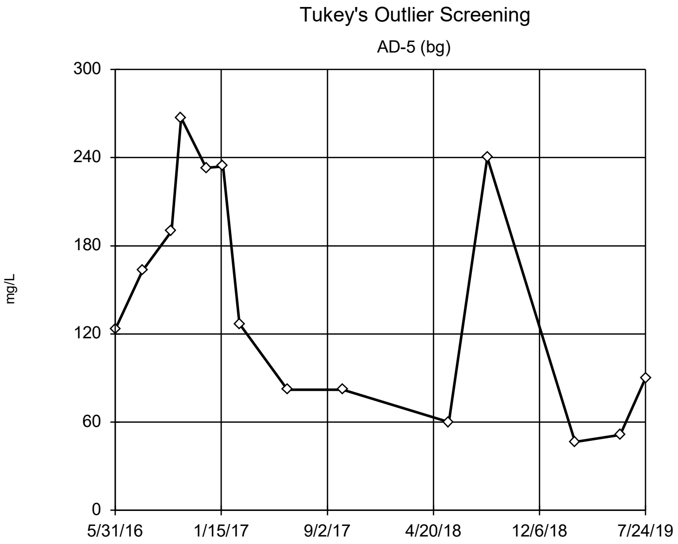
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1555, low cutoff = 792, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 14

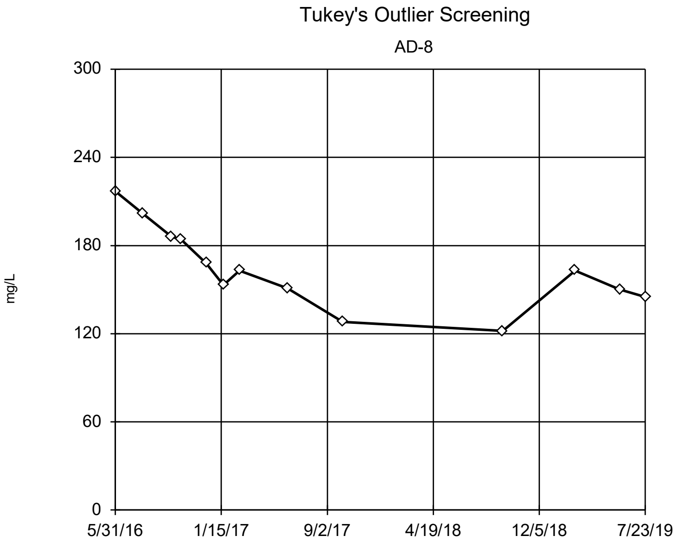
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 8614, low cutoff = 1.901, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 13

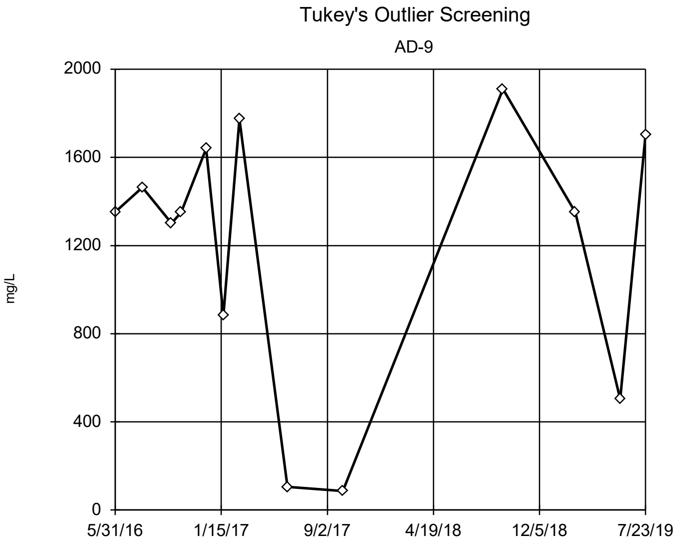
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 365.2, low cutoff = 74.72, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



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).

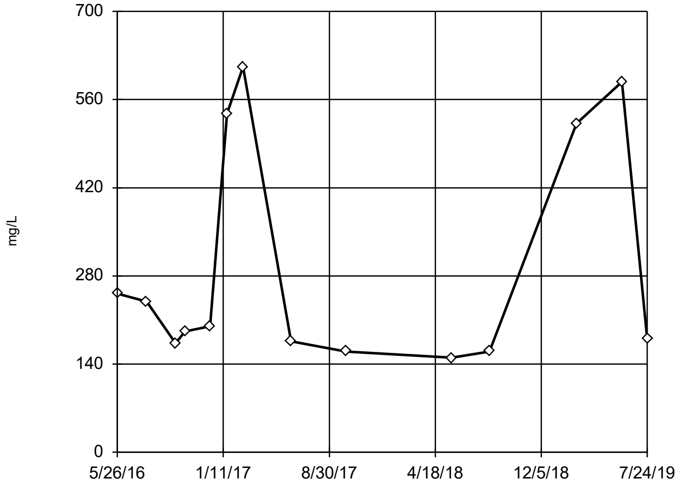
High cutoff = 3100, low cutoff = -2510, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-1 (bg)



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).

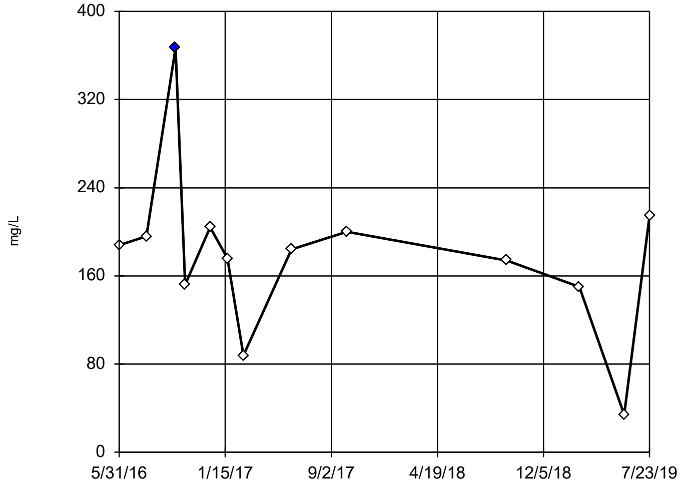
High cutoff = 17126, low cutoff = 5.148, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-15



n = 13

Outlier is drawn as solid. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

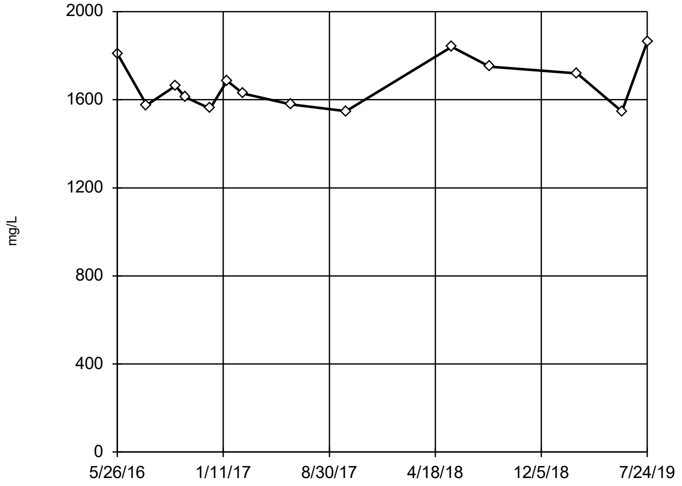
High cutoff = 355, low cutoff = -2, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-17 (bg)



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).

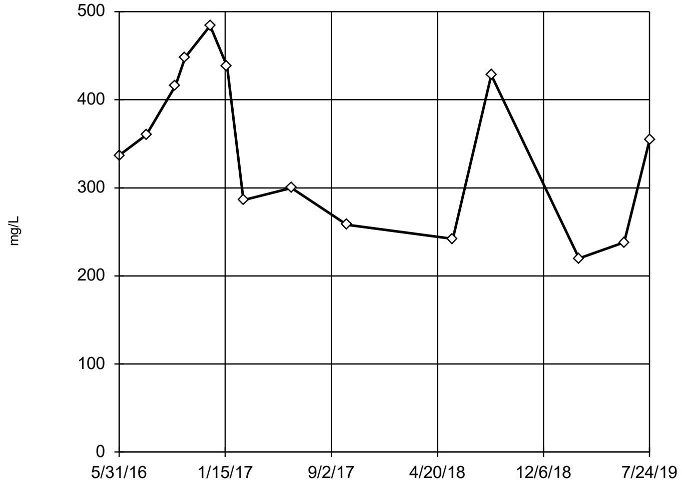
High cutoff = 2603, low cutoff = 1072, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-5 (bg)



n = 14

No outliers found. Tukey's method selected by user.

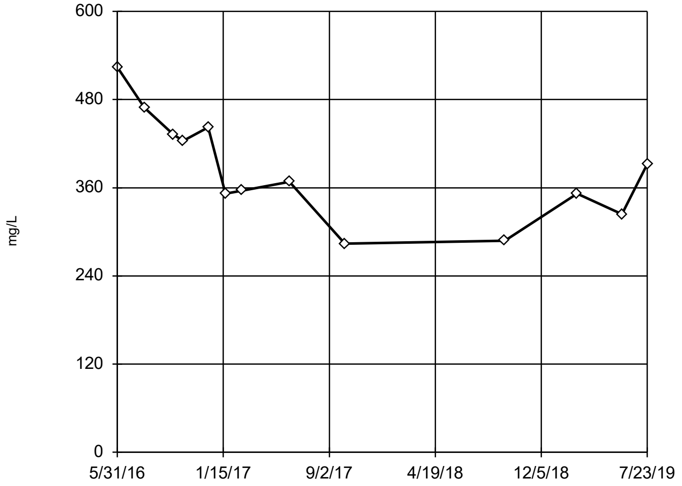
Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1282, low cutoff = 0.6602, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:05 PM View: Intrawell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Tukey's Outlier Screening

AD-8



n = 13

No outliers found. Tukey's method selected by user.

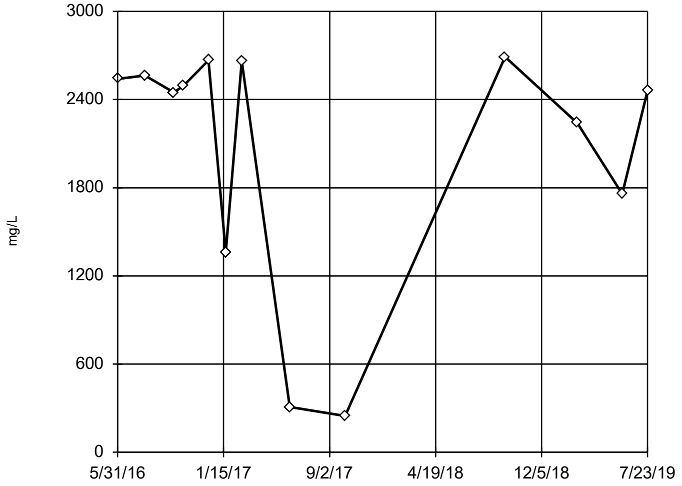
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 846.7, low cutoff = 132.1, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids   Analysis Run 11/20/2019 1:05 PM   View: Intrawell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Tukey's Outlier Screening

AD-9



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 = 3272, low cutoff = -3100, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids   Analysis Run 11/20/2019 1:05 PM   View: Intrawell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Mann-Whitney - Significant Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/8/2019, 4:18 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Chloride, total (mg/L)	**AD-5 (bg)**	**2.589**	**Yes**	**Yes**	**Mann-W**

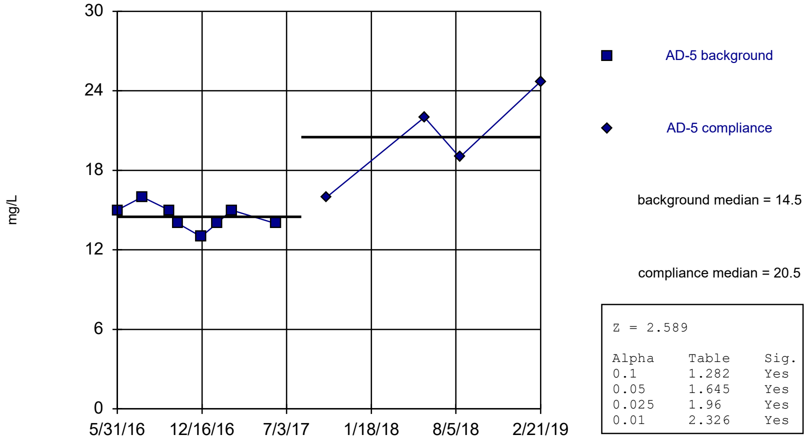
Mann-Whitney - All Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/8/2019, 4:18 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Calcium, total (mg/L)	AD-1 (bg)	-1.274	No	No	Mann-W
Calcium, total (mg/L)	AD-17 (bg)	-0.9358	No	No	Mann-W
Calcium, total (mg/L)	AD-5 (bg)	-2.123	No	No	Mann-W
Calcium, total (mg/L)	AD-15	-2.74	No	No	Mann-W
Calcium, total (mg/L)	AD-8	-2.127	No	No	Mann-W
Calcium, total (mg/L)	AD-9	-1.444	No	No	Mann-W
Chloride, total (mg/L)	AD-1 (bg)	-1.051	No	No	Mann-W
Chloride, total (mg/L)	AD-17 (bg)	1.366	No	No	Mann-W
Chloride, total (mg/L)	**AD-5 (bg)**	**2.589**	**Yes**	**Yes**	**Mann-W**
Chloride, total (mg/L)	AD-15	1.23	No	No	Mann-W
Chloride, total (mg/L)	AD-8	-1.64	No	No	Mann-W
Chloride, total (mg/L)	AD-9	0.5115	No	No	Mann-W
Fluoride, total (mg/L)	AD-1 (bg)	-1.591	No	No	Mann-W
Fluoride, total (mg/L)	AD-17 (bg)	0.5439	No	No	Mann-W
Fluoride, total (mg/L)	AD-5 (bg)	-0.3344	No	No	Mann-W
Fluoride, total (mg/L)	AD-15	-1.06	No	No	Mann-W
Fluoride, total (mg/L)	AD-8	0.6138	No	No	Mann-W
Fluoride, total (mg/L)	AD-9	-0.1113	No	No	Mann-W
Sulfate, total (mg/L)	AD-1 (bg)	0.6866	No	No	Mann-W
Sulfate, total (mg/L)	AD-17 (bg)	-0.08507	No	No	Mann-W
Sulfate, total (mg/L)	AD-5 (bg)	-1.531	No	No	Mann-W
Sulfate, total (mg/L)	AD-15	-0.4101	No	No	Mann-W
Sulfate, total (mg/L)	AD-8	-2.046	No	No	Mann-W
Sulfate, total (mg/L)	AD-9	-0.2046	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-1 (bg)	-1.786	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-17 (bg)	0.9341	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-5 (bg)	-1.953	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-15	-0.4558	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-8	-2.455	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-9	-0.5103	No	No	Mann-W

Mann-Whitney (Wilcoxon Rank Sum)

AD-5 (bg)



Z = 2.589

Alpha	Table	Sig.
0.1	1.282	Yes
0.05	1.645	Yes
0.025	1.96	Yes
0.01	2.326	Yes

Constituent: Chloride, total   Analysis Run 12/8/2019 4:15 PM   View: Mann Whitney

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Intrawell Prediction Limit Summary

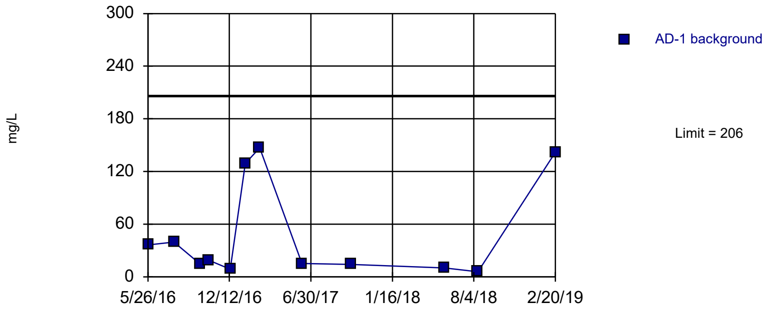
Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/8/2019, 4:24 PM

Constituent	Well	Upper Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-1	206	n/a	12	3.196	1.283	0	None	x^(1/3)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	206.7	n/a	12	193.3	6.384	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-5	58.47	n/a	12	41.36	8.1	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-15	5.395	n/a	11	3.563	0.8426	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-8	32.4	n/a	12	21.24	5.284	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-9	298.7	n/a	12	42241	22241	0	None	x^2	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-1	9	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Chloride, total (mg/L)	AD-17	45.62	n/a	12	35.02	5.02	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-5	24.25	n/a	12	4.039	0.4191	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-15	38.76	n/a	11	28.93	4.523	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-8	35.47	n/a	11	25.65	4.511	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-9	138.2	n/a	11	73.73	29.65	0	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-1	1	n/a	12	n/a	n/a	91.67	n/a	n/a	0.01077	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-17	0.7482	n/a	12	0.6254	0.1134	50	Kaplan-Meier	sqrt(x)	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-5	1	n/a	12	n/a	n/a	75	n/a	n/a	0.01077	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-15	1	n/a	11	n/a	n/a	81.82	n/a	n/a	0.01276	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	0.7368	n/a	11	0.7562	0.04695	18.18	Kaplan-Meier	sqrt(x)	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-9	1	n/a	11	n/a	n/a	54.55	n/a	n/a	0.01276	NP Intra (NDs) 1 of 2
Sulfate, total (mg/L)	AD-1	70.37	n/a	12	3.801	0.2145	0	None	ln(x)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	1445	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Sulfate, total (mg/L)	AD-5	318.3	n/a	12	154	77.83	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-15	33.18	n/a	11	19.87	6.117	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-8	230.1	n/a	11	167	28.99	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-9	2527	n/a	11	1201	609.4	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-1	612	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1872	n/a	12	1664	98.5	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-5	542	n/a	12	351.4	90.26	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-15	248.5	n/a	10	171.2	34.54	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-8	552.8	n/a	11	390.1	74.83	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-9	3070	n/a	11	1.2e10	7.7e9	0	None	x^3	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



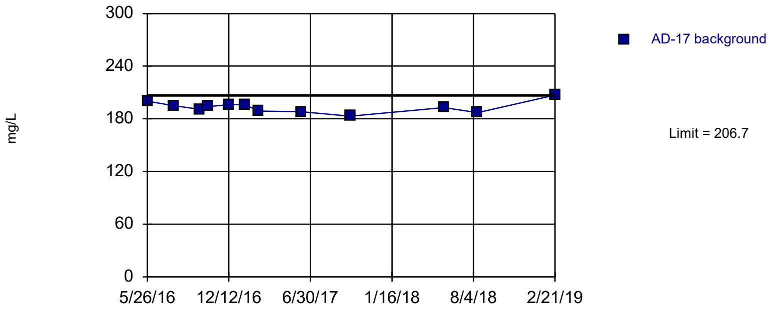
Background Data Summary (based on cube root transformation): Mean=3.196, Std. Dev.=1.283, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8246, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



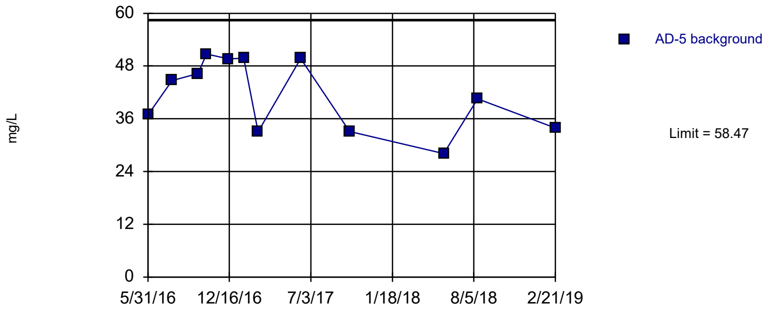
Background Data Summary: Mean=193.3, Std. Dev.=6.384, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9698, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



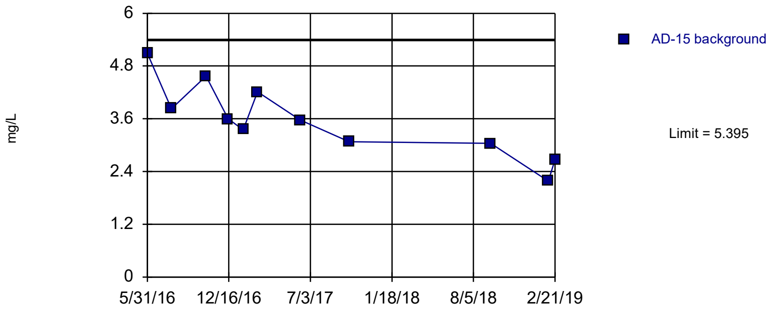
Background Data Summary: Mean=41.36, Std. Dev.=8.1, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8897, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-15



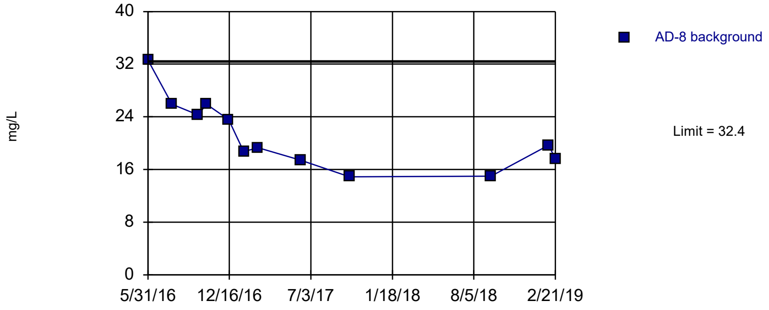
Background Data Summary: Mean=3.563, Std. Dev.=0.8426, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9882, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8



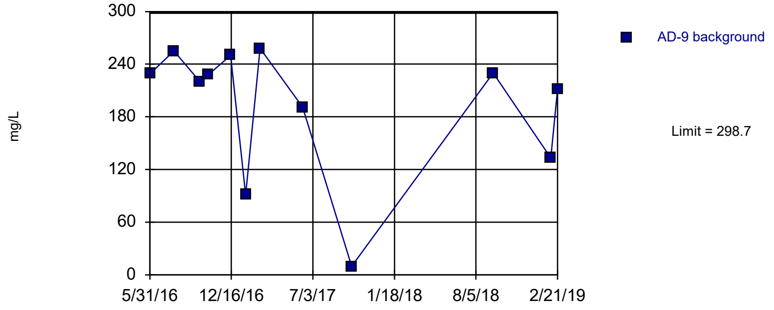
Background Data Summary: Mean=21.24, Std. Dev.=5.284, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.923, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-9



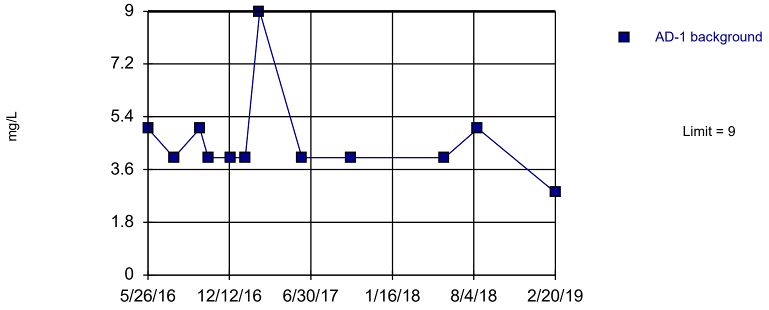
Background Data Summary (based on square transformation): Mean=42241, Std. Dev.=22241, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8804, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



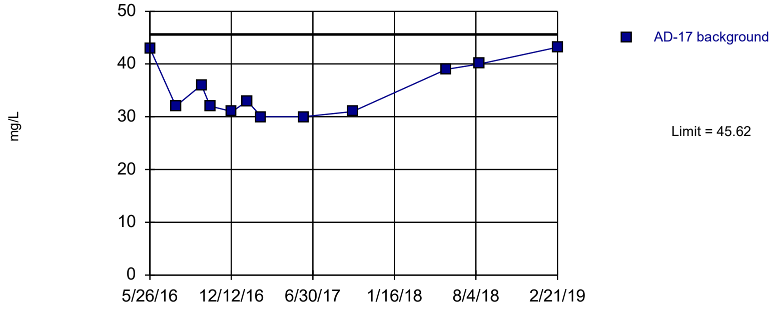
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



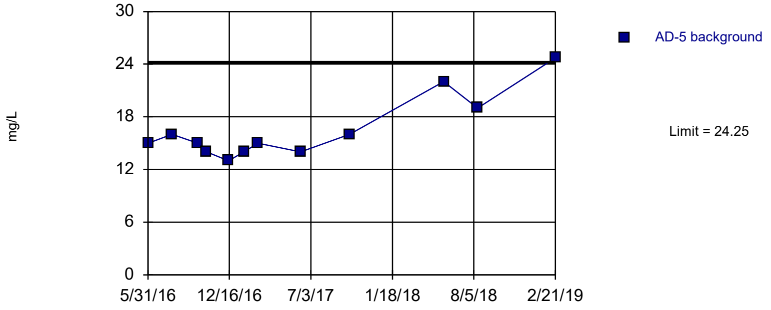
Background Data Summary: Mean=35.02, Std. Dev.=5.02, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8477, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



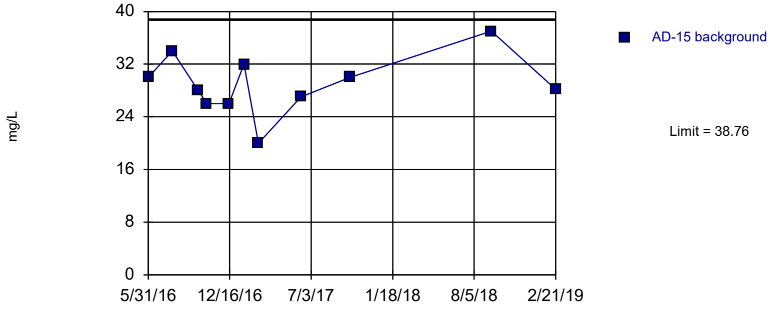
Background Data Summary (based on square root transformation): Mean=4.039, Std. Dev.=0.4191, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8217, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-15



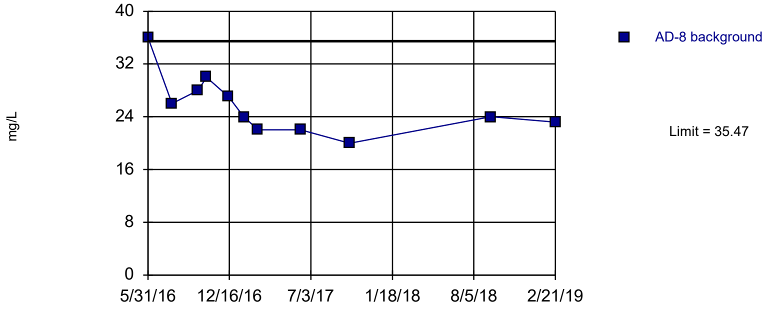
Background Data Summary: Mean=28.93, Std. Dev.=4.523, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9714, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8



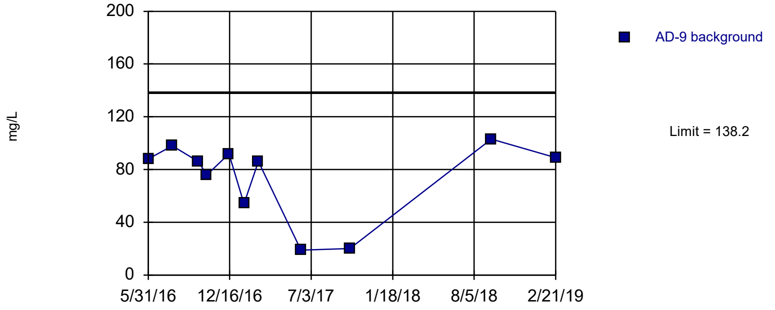
Background Data Summary: Mean=25.65, Std. Dev.=4.511, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9157, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

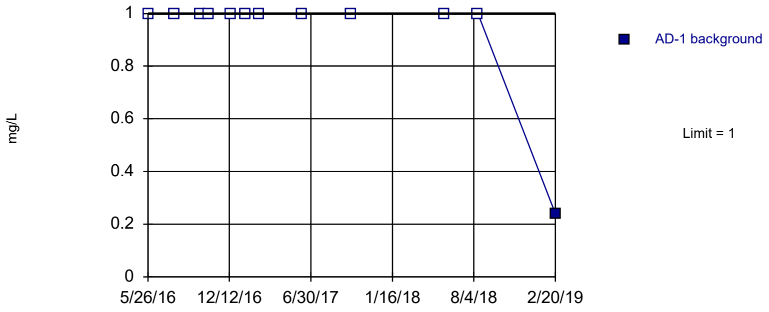
Intrawell Parametric, AD-9



Background Data Summary: Mean=73.73, Std. Dev.=29.65, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7926, 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: Chloride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



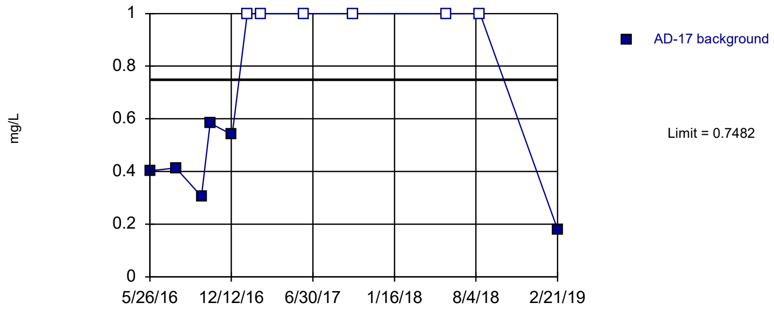
Prediction Limit

Intrawell Non-parametric, AD-1 (bg)

Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 12 background values. 91.67% NDs. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



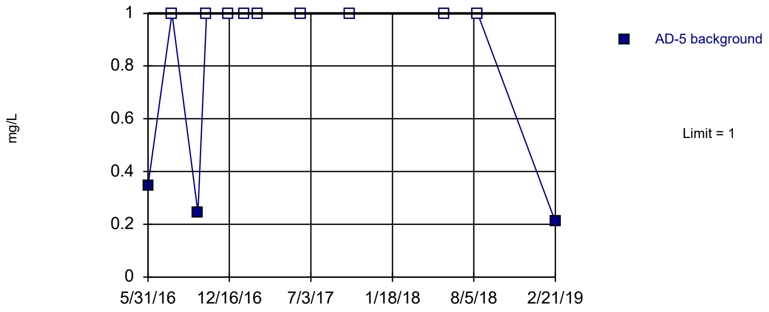
Prediction Limit

Intrawell Parametric, AD-17 (bg)

Background Data Summary (based on square root transformation) (after Kaplan-Meier Adjustment): Mean=0.6254, Std. Dev.=0.1134, n=12, 50% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8173, 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: Fluoride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



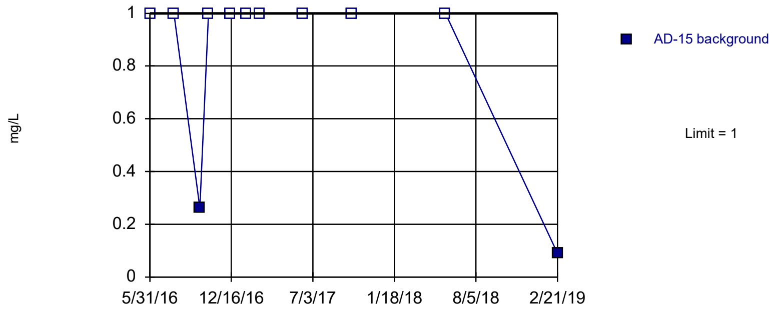
Prediction Limit

Intrawell Non-parametric, AD-5 (bg)

Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 12 background values. 75% NDs. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Prediction Limit

Intrawell Non-parametric, AD-15

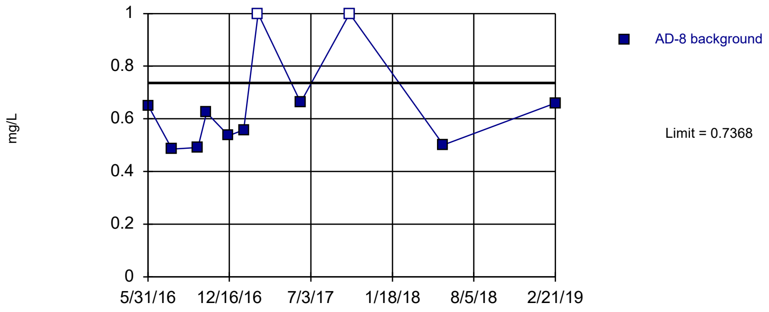
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 11 background values. 81.82% NDs. Well-constituent pair annual alpha = 0.02537. Individual comparison alpha = 0.01276 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-8



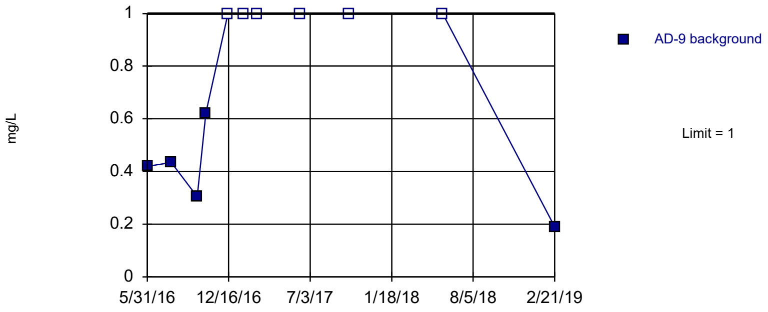
Background Data Summary (based on square root transformation) (after Kaplan-Meier Adjustment): Mean=0.7562, Std. Dev.=0.04695, n=11, 18.18% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8152, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-9



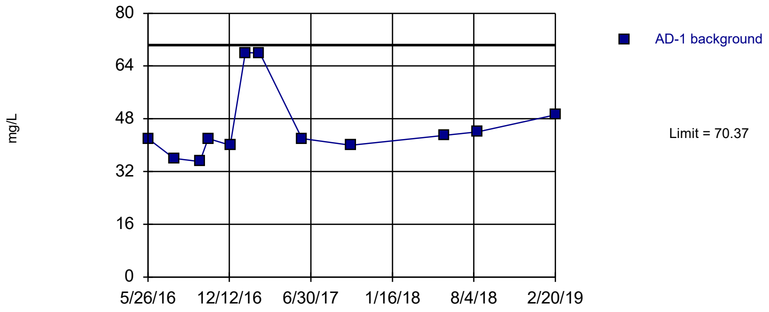
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 11 background values. 54.55% NDs. Well-constituent pair annual alpha = 0.02537. Individual comparison alpha = 0.01276 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/8/2019 4:22 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



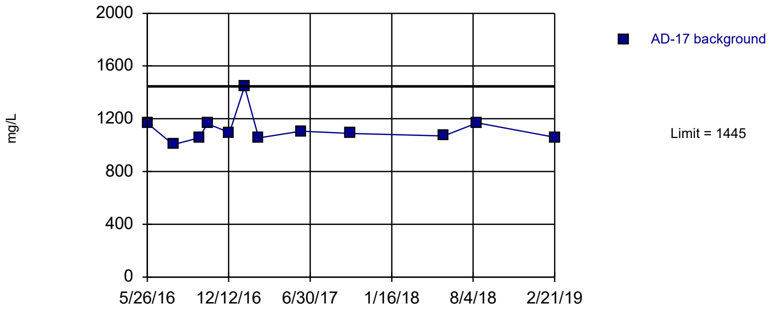
Background Data Summary (based on natural log transformation): Mean=3.801, Std. Dev.=0.2145, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.812, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-17 (bg)



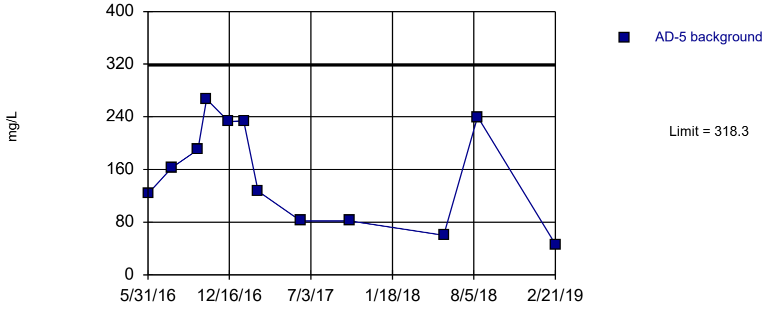
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



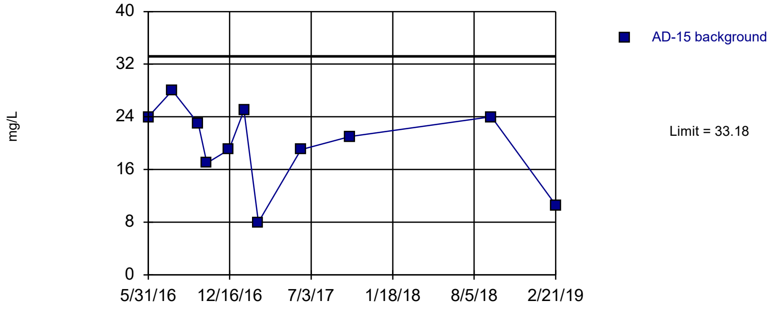
Background Data Summary: Mean=154, Std. Dev.=77.83, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.919, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-15



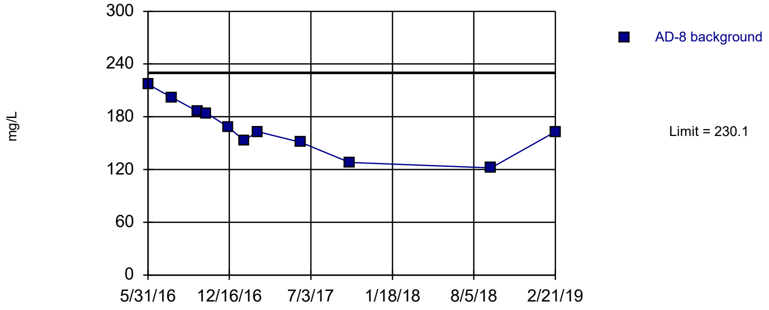
Background Data Summary: Mean=19.87, Std. Dev.=6.117, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9196, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8



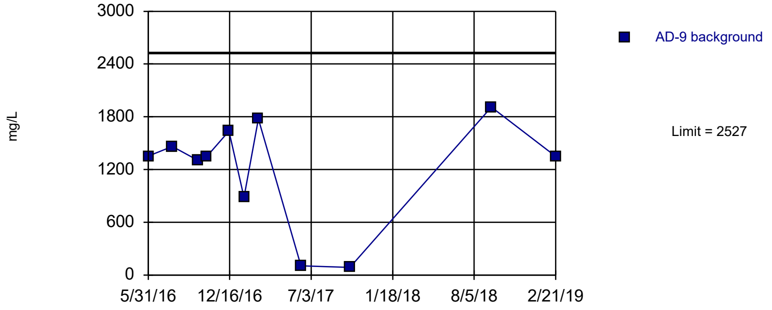
Background Data Summary: Mean=167, Std. Dev.=28.99, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9728, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-9



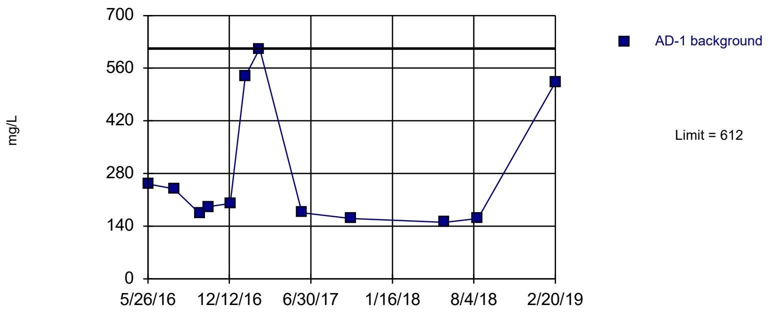
Background Data Summary: Mean=1201, Std. Dev.=609.4, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8425, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



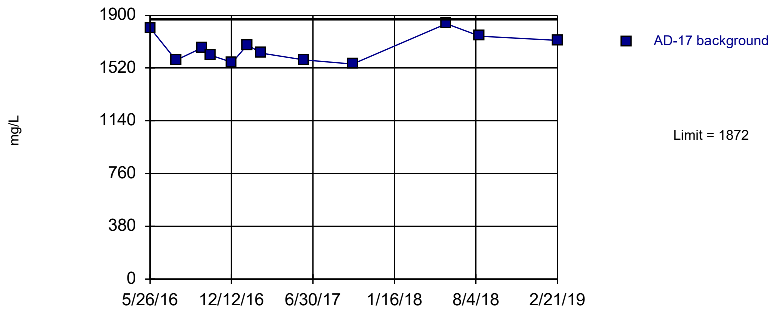
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



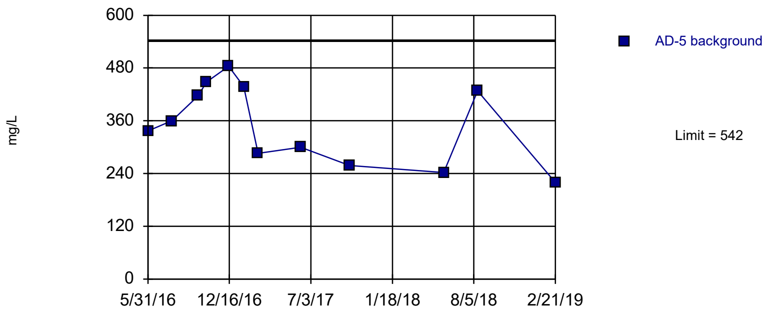
Background Data Summary: Mean=1664, Std. Dev.=98.5, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9253, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



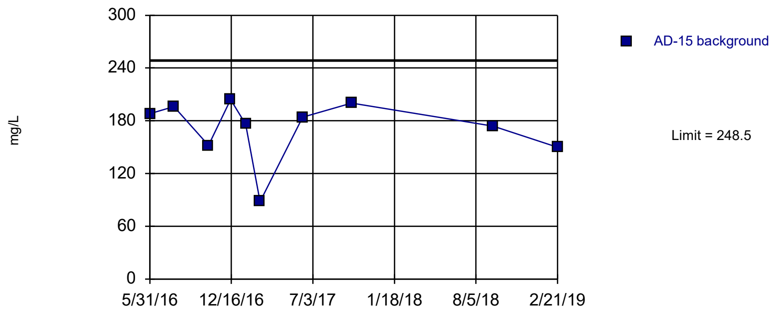
Background Data Summary: Mean=351.4, Std. Dev.=90.26, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9333, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-15

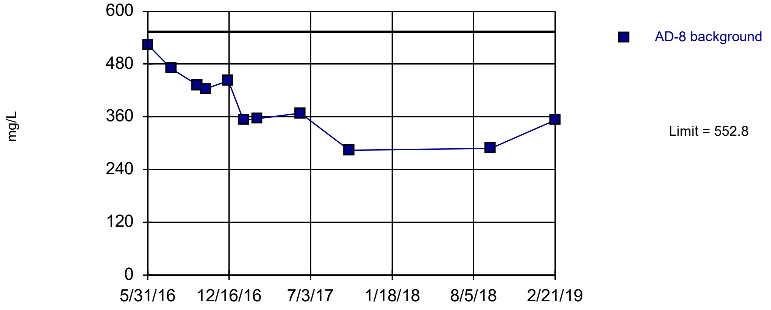


Background Data Summary: Mean=171.2, Std. Dev.=34.54, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8313, critical = 0.781. Kappa = 2.238 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Prediction Limit

Intrawell Parametric, AD-8

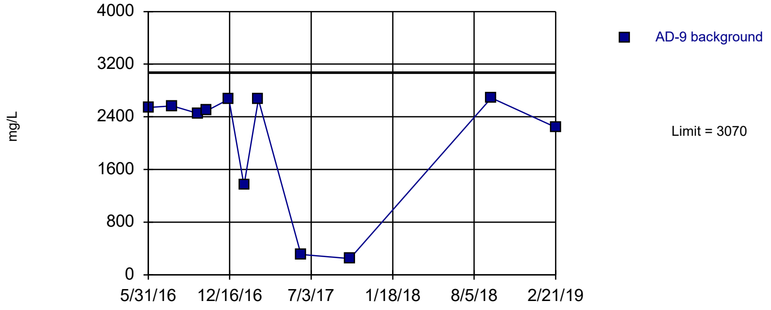


Background Data Summary: Mean=390.1, Std. Dev.=74.83, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9524, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Prediction Limit

Intrawell Parametric, AD-9



Background Data Summary (based on cube transformation): Mean=1.2e10, Std. Dev.=7.7e9, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8038, 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.

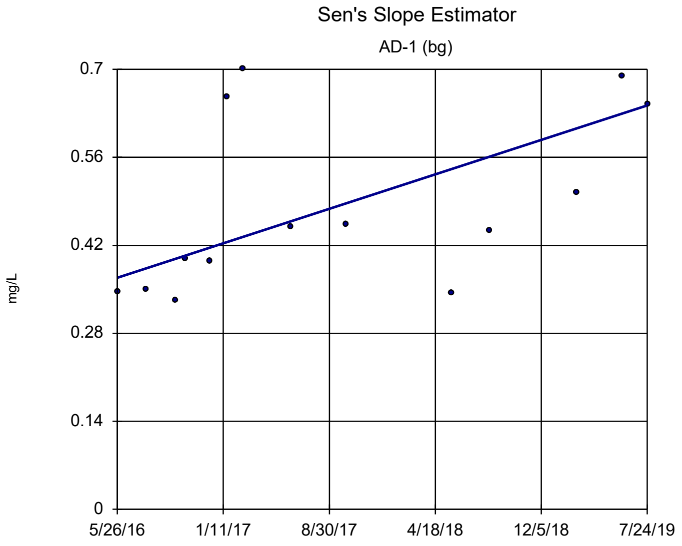
Constituent: Total Dissolved Solids Analysis Run 12/8/2019 4:23 PM View: PL's - Intrawell
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Trend Test Summary Table - All Results (No Significant)

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 11/22/2019, 8:13 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-1 (bg)	0.08662	41	48	No	14	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-17 (bg)	0.01085	21	48	No	14	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-5 (bg)	0	3	48	No	14	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-1 (bg)	0.02509	8	48	No	14	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-17 (bg)	-0.05848	-9	-48	No	14	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-5 (bg)	0.07449	23	48	No	14	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.23 . UG



n = 14

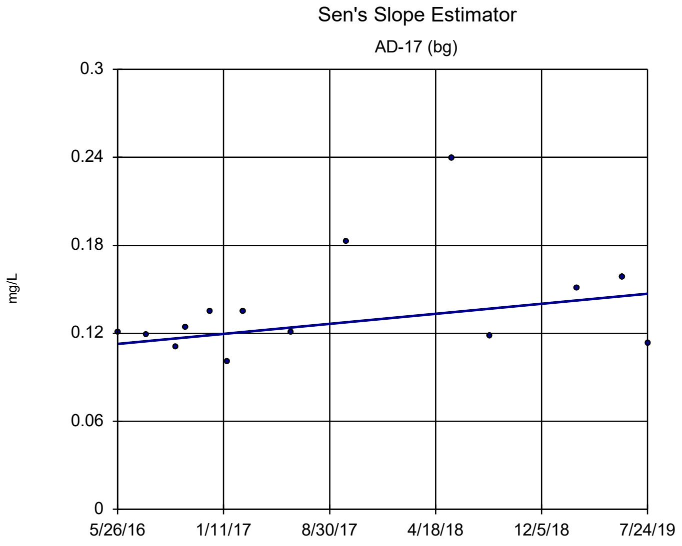
Slope = 0.08662
units per year.

Mann-Kendall
statistic = 41
critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 11/22/2019 8:12 PM View: Interwell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 14

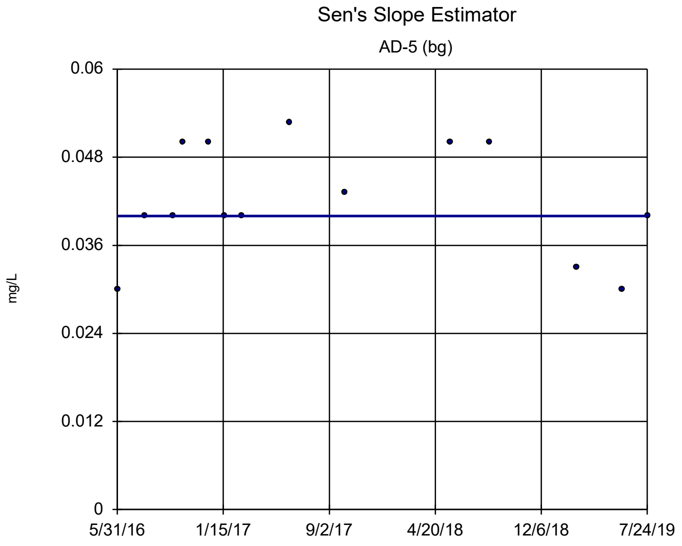
Slope = 0.01085
units per year.

Mann-Kendall
statistic = 21
critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 11/22/2019 8:12 PM View: Interwell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 14

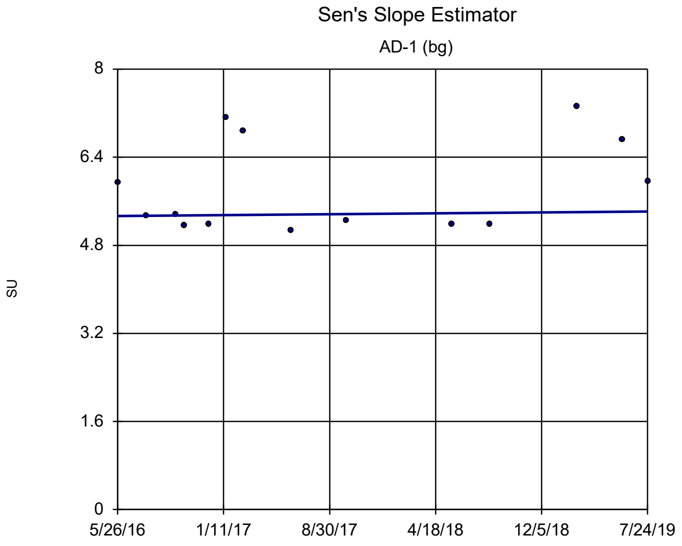
Slope = 0
units per year.

Mann-Kendall
statistic = 3
critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 11/22/2019 8:13 PM View: Interwell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



n = 14

Slope = 0.02509
units per year.

Mann-Kendall
statistic = 8
critical = 48

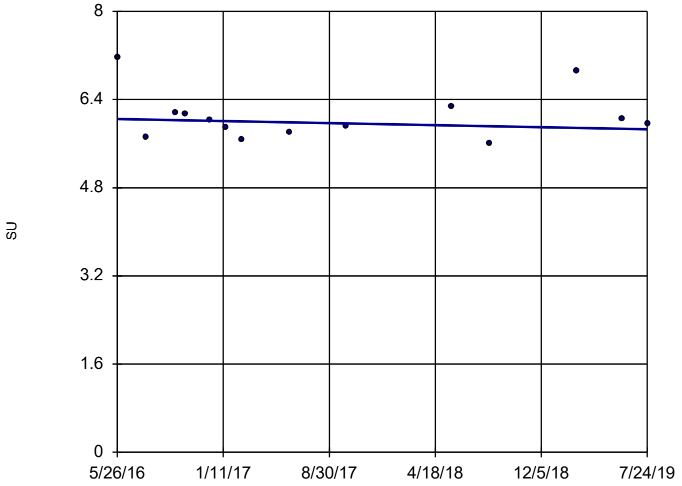
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 11/22/2019 8:13 PM View: Interwell AIII
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-17 (bg)



n = 14

Slope = -0.05848
units per year.

Mann-Kendall
statistic = -9
critical = -48

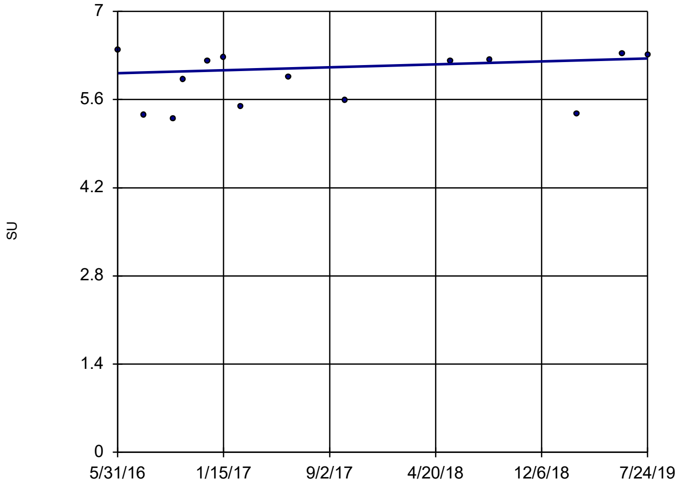
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: pH, field   Analysis Run 11/22/2019 8:13 PM   View: Interwell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-5 (bg)



n = 14

Slope = 0.07449
units per year.

Mann-Kendall
statistic = 23
critical = 48

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: pH, field   Analysis Run 11/22/2019 8:13 PM   View: Interwell AIII
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Interwell Prediction Limit Summary

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 12/8/2019, 4:25 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	0.7	n/a	n/a	36	n/a	n/a	0	n/a	n/a	0.001409	NP (normality) 1 of 2
pH, field (SU)	n/a	6.995	4.816	n/a	36	5.906	0.6169	0	None	No	0.001253	Param 1 of 2

Upper Tolerance Limits - Appendix IV

Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP   Printed 11/22/2019, 8:15 PM

Constituent	Well	Upper Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.005	n/a	n/a	n/a	39	71.79	n/a	0.1353	NP Inter(normal...
Arsenic, total (mg/L)	n/a	0.005	n/a	n/a	n/a	39	48.72	n/a	0.1353	NP Inter(normal...
Barium, total (mg/L)	n/a	0.6226	n/a	n/a	n/a	39	0	ln(x)	0.05	Inter
Beryllium, total (mg/L)	n/a	0.0007877	n/a	n/a	n/a	39	10.26	x^(1/3)	0.05	Inter
Cadmium, total (mg/L)	n/a	0.00367	n/a	n/a	n/a	39	30.77	x^(1/3)	0.05	Inter
Chromium, total (mg/L)	n/a	0.004	n/a	n/a	n/a	38	23.68	n/a	0.1424	NP Inter(normal...
Cobalt, total (mg/L)	n/a	0.0748	n/a	n/a	n/a	39	0	n/a	0.1353	NP Inter(normal...
Combined Radium 226 + 228 (pCi/L)	n/a	4.113	n/a	n/a	n/a	39	0	No	0.05	Inter
Fluoride, total (mg/L)	n/a	1	n/a	n/a	n/a	42	64.29	n/a	0.116	NP Inter(normal...
Lead, total (mg/L)	n/a	0.005	n/a	n/a	n/a	39	69.23	n/a	0.1353	NP Inter(normal...
Lithium, total (mg/L)	n/a	0.394	n/a	n/a	n/a	39	2.564	n/a	0.1353	NP Inter(normal...
Mercury, total (mg/L)	n/a	0.000033	n/a	n/a	n/a	39	53.85	n/a	0.1353	NP Inter(normal...
Molybdenum, total (mg/L)	n/a	0.005	n/a	n/a	n/a	39	69.23	n/a	0.1353	NP Inter(normal...
Selenium, total (mg/L)	n/a	0.005	n/a	n/a	n/a	39	41.03	n/a	0.1353	NP Inter(normal...
Thallium, total (mg/L)	n/a	0.002	n/a	n/a	n/a	39	89.74	n/a	0.1353	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/22/2019, 8:31 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Lithium, total (mg/L)	**AD-9**	**1.33**	**0.9164**	**0.39**	**Yes**	**13**	**0**	**x^2**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

Welsh PBAP Client: Geosyntec Data: Welsh PBAP Printed 11/22/2019, 8:31 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-15	0.005	0.00005	0.006	No	13	76.92	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-8	0.005	0.0001	0.006	No	13	76.92	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-9	0.005	0.0001	0.006	No	13	92.31	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-15	0.01211	0.002878	0.01	No	12	0	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-8	0.005	0.00037	0.01	No	13	61.54	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-9	0.005	0.00118	0.01	No	13	69.23	No	0.01	NP (normality)
Barium, total (mg/L)	AD-15	0.2524	0.1048	2	No	12	0	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-8	0.02819	0.02085	2	No	13	0	No	0.01	Param.
Barium, total (mg/L)	AD-9	0.04967	0.02686	2	No	13	0	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-15	0.001332	0.0002516	0.004	No	12	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-8	0.001	0.00002876	0.004	No	13	61.54	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-9	0.0009336	0.0003607	0.004	No	13	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-15	0.0004524	0.00005473	0.005	No	12	8.333	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-8	0.001	0.00002	0.005	No	13	69.23	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-9	0.001719	0.0002884	0.005	No	13	0	No	0.01	Param.
Chromium, total (mg/L)	AD-15	0.02417	0.002105	0.1	No	12	0	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-8	0.001525	0.0004025	0.1	No	13	38.46	No	0.01	Param.
Chromium, total (mg/L)	AD-9	0.001	0.0002622	0.1	No	13	61.54	No	0.01	NP (normality)
Cobalt, total (mg/L)	AD-15	0.01231	0.004507	0.075	No	12	0	sqrt(x)	0.01	Param.
Cobalt, total (mg/L)	AD-8	0.007254	0.004652	0.075	No	13	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-9	0.0273	0.0146	0.075	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-15	2.969	1.505	5	No	12	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-8	1.81	0.5087	5	No	13	0	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-9	2.656	1.672	5	No	13	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-15	1	0.086	4	No	13	69.23	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-8	0.89	0.4912	4	No	13	15.38	No	0.01	NP (Cohens/xfrm)
Fluoride, total (mg/L)	AD-9	1	0.19	4	No	13	46.15	No	0.01	NP (normality)
Lead, total (mg/L)	AD-15	0.019	0.000438	0.015	No	12	16.67	No	0.01	NP (Cohens/xfrm)
Lead, total (mg/L)	AD-8	0.005	0.00007	0.015	No	13	69.23	No	0.01	NP (normality)
Lead, total (mg/L)	AD-9	0.005	0.00008	0.015	No	13	69.23	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-15	0.02713	0.005433	0.39	No	13	0	ln(x)	0.01	Param.
Lithium, total (mg/L)	AD-8	0.1115	0.07781	0.39	No	13	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-9**	**1.33**	**0.9164**	**0.39**	**Yes**	**13**	**0**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-15	0.000081	0.00001932	0.002	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Mercury, total (mg/L)	AD-8	0.000025	0.00000859	0.002	No	12	66.67	No	0.01	NP (normality)
Mercury, total (mg/L)	AD-9	0.00003859	0.00001278	0.002	No	12	41.67	No	0.01	Param.
Molybdenum, total (mg/L)	AD-15	0.006706	0.001625	0.1	No	13	46.15	No	0.01	Param.
Molybdenum, total (mg/L)	AD-8	0.005	0.0008389	0.1	No	13	69.23	No	0.01	NP (normality)
Molybdenum, total (mg/L)	AD-9	0.005	0.002	0.1	No	13	92.31	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-15	0.005	0.0009	0.05	No	12	16.67	No	0.01	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-8	0.005	0.00007	0.05	No	13	46.15	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-9	0.006134	0.001092	0.05	No	13	30.77	No	0.01	Param.
Thallium, total (mg/L)	AD-15	0.002	0.0001	0.002	No	13	69.23	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-8	0.002	0.000129	0.002	No	13	61.54	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-9	0.002	0.0001	0.002	No	12	58.33	No	0.01	NP (normality)

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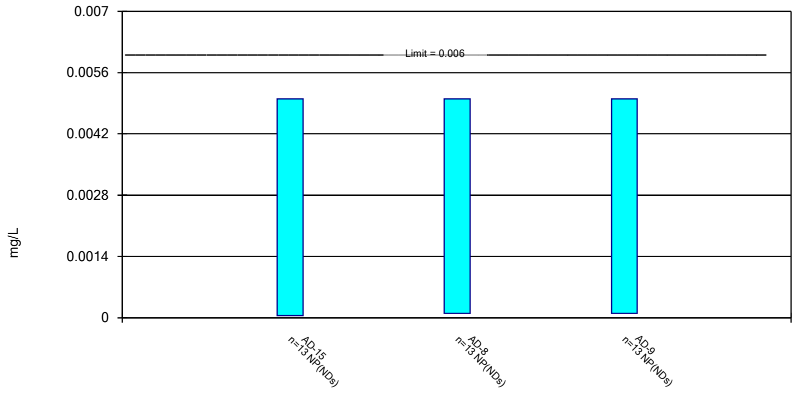
Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

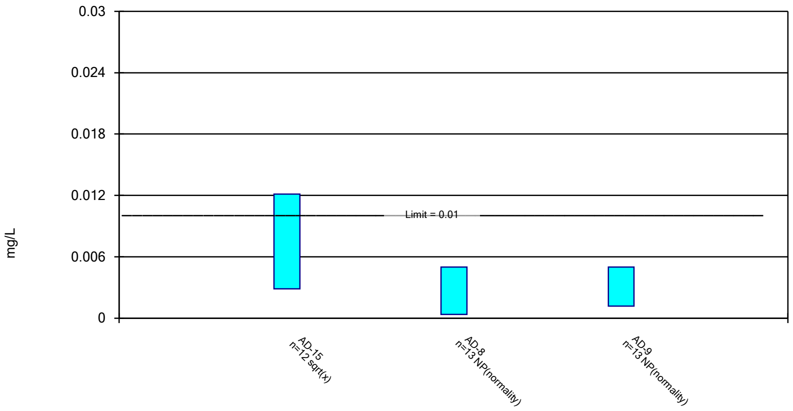


Constituent: Antimony, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . 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.

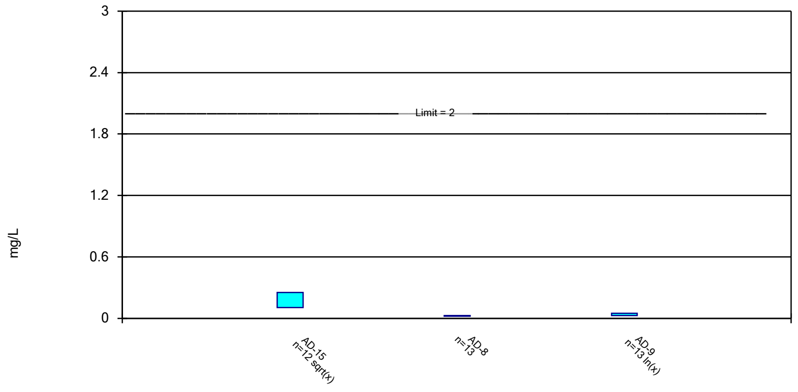


Constituent: Arsenic, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

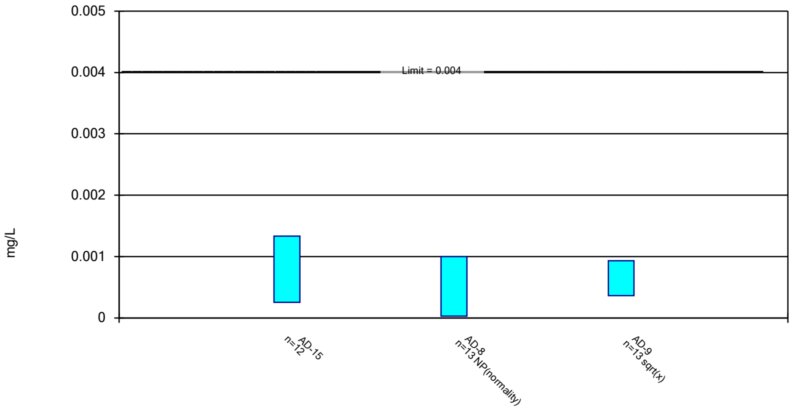


Constituent: Barium, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . 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.



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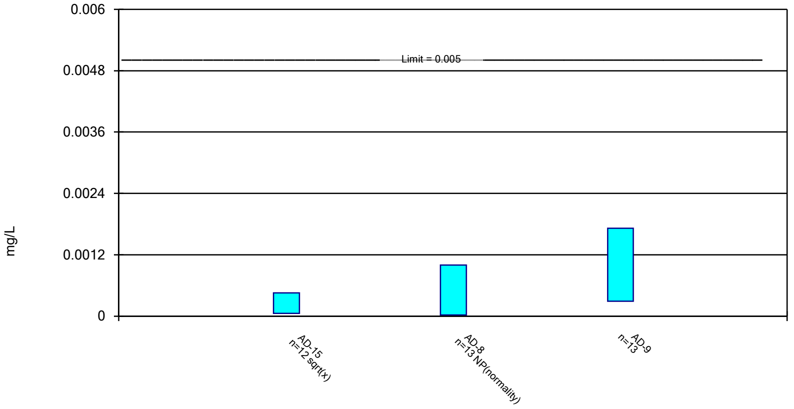
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Parametric and Non-Parametric (NP) Confidence Interval

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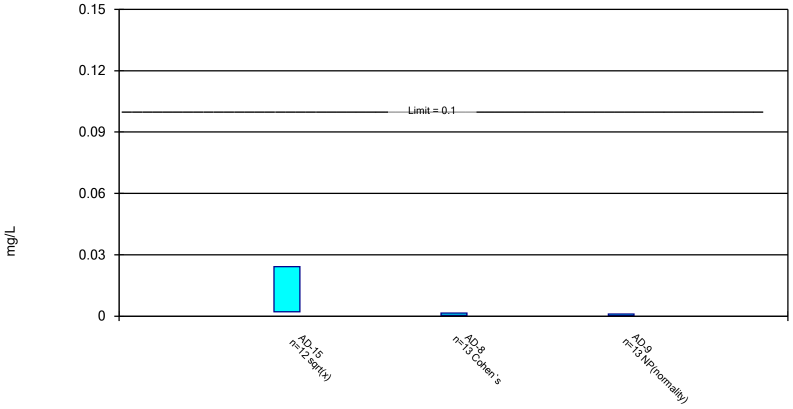
Constituent: Cadmium, total Analysis Run 11/22/2019 8:30 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

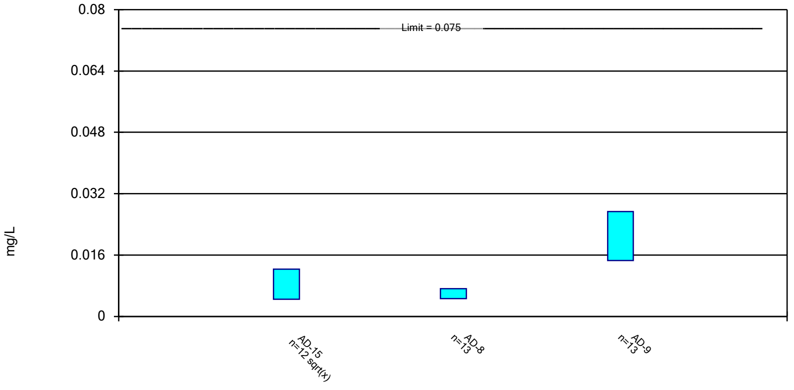


Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Chromium, total Analysis Run 11/22/2019 8:30 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

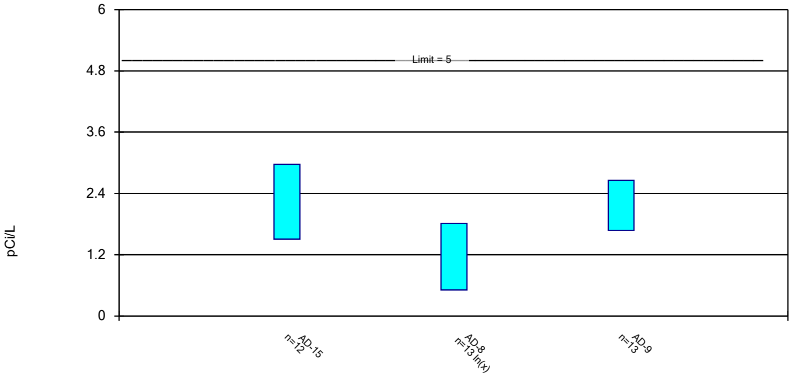


Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Cobalt, total Analysis Run 11/22/2019 8:30 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG



Parametric Confidence Interval

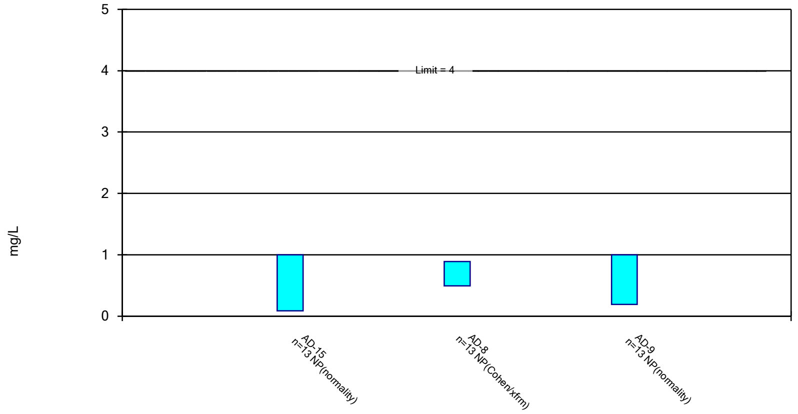
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Combined Radium 226 + 228 Analysis Run 11/22/2019 8:30 PM View: AIV
Welsh PBAP Client: Geosyntec Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

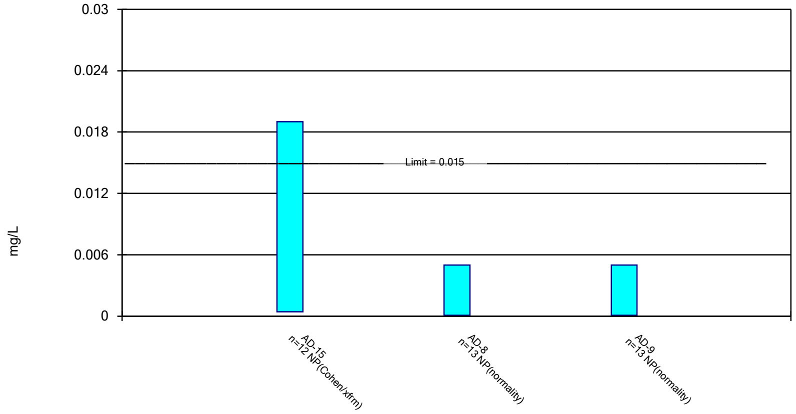


Constituent: Fluoride, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

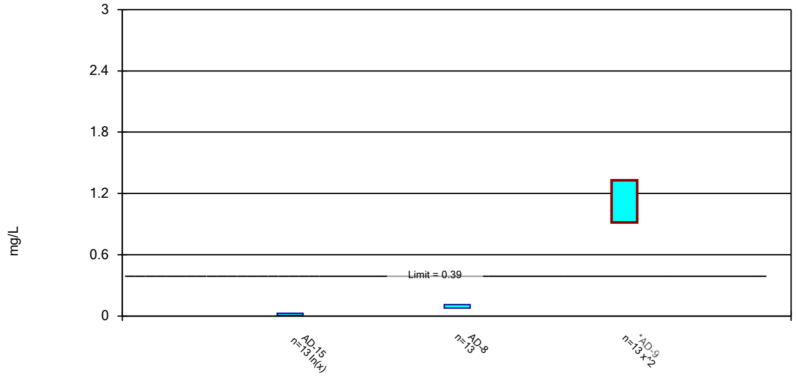


Constituent: Lead, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

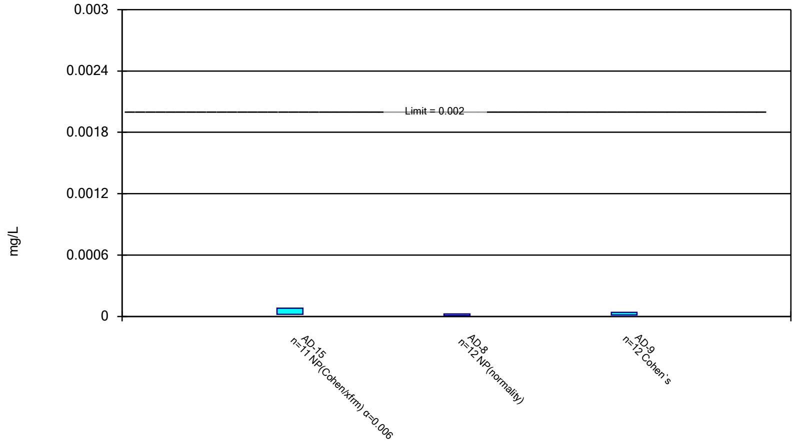


Constituent: Lithium, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . 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.

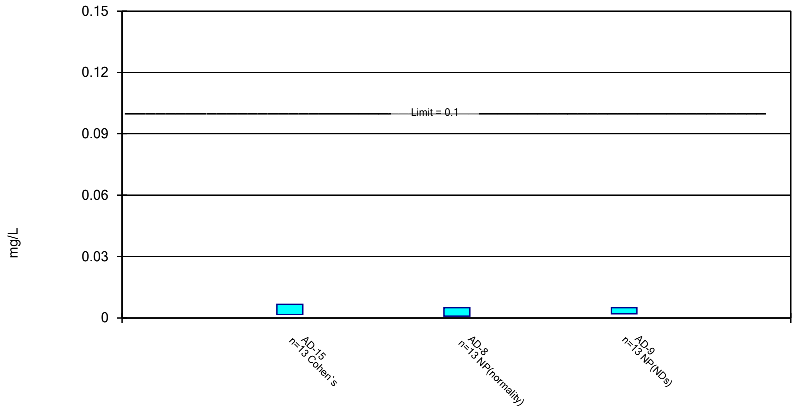


Constituent: Mercury, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . 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.

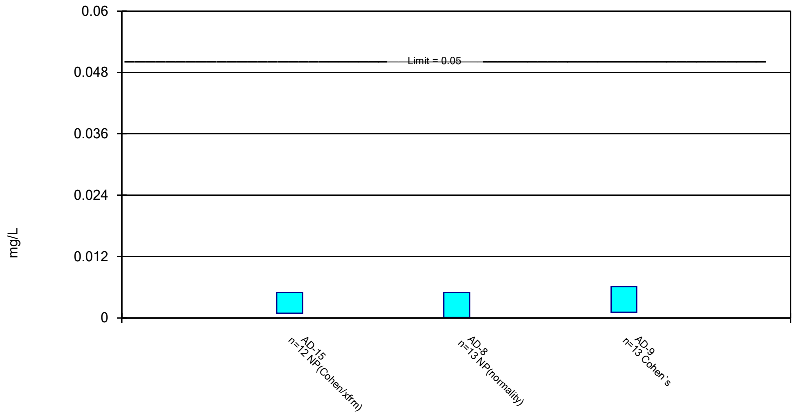


Constituent: Molybdenum, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . 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.

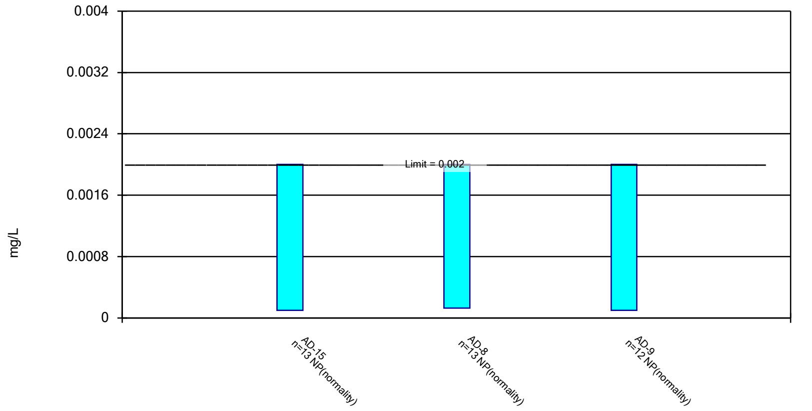


Constituent: Selenium, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total   Analysis Run 11/22/2019 8:30 PM   View: AIV
Welsh PBAP   Client: Geosyntec   Data: Welsh PBAP

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.

Welsh Power Plant
Primary Bottom Ash Pond
Alternate Source Demonstration

The Welsh Power Plant Primary Bottom Ash Pond initiated an assessment monitoring program in accordance with 40 CFR 257.95 on April 13, 2018. Groundwater protection standards (GWPS) were set in accordance with 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. The statistical evaluation revealed an exceedance of the lithium GWPS on January 8, 2019. A successful alternate source demonstration (ASD) was completed per 257.95(g)(3), therefore, the Welsh Primary Bottom Ash Pond will remain in assessment monitoring. An ASD is documentation that shows a source other than the CCR unit was responsible for causing the statistics to exceed the GWPS. The ASD document will explain the alternate cause of the GWPS exceedance. The successful ASD is attached.

ARCADIS Design & Consultancy for natural and built assets

AEP AMERICAN ELECTRIC POWER

ALTERNATIVE SOURCE DEMONSTRATION - LITHIUM PRIMARY BOTTOM ASH POND

J. Robert Welsh Power Plant
1187 County Road 4865
Pittsburg, Titus County, Texas

February 7, 2019

ALTERNATIVE SOURCE DEMONSTRATION - LITHIUM PRIMARY BOTTOM ASH POND

J. Robert Welsh Power Plant
1187 County Road 4865
Pittsburg, Titus County, Texas

Prepared for:

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ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power Service Corporation
amsl	above mean sea level
Arcadis	Arcadis U.S., Inc.
ASD	Alternate Source Demonstration
bgs	below ground surface
CCR	Coal Combustion Residual
CCR Unit	ash pond system
CFR	Code of Federal Regulations
cfs	cubic feet per second
GWPS	groundwater protection standards
ft	feet
ft/day	feet per day
ft^3/sec	cubic feet per second
MCL	maximum contaminant limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
NRCS	Natural Resources Conservation Services
PBAP	Primary Bottom Ash Pond
PCL	protective concentration level
SPLP	Synthetic Precipitation Leaching Procedure
SSI	statistically significant increase
SSL	statistically significant level
USDA	United States Department of Agriculture

1 INTRODUCTION

This Alternate Source Demonstration (ASD) report has been prepared on behalf of American Electric Power Service Company (AEP) for lithium detected in groundwater in the area of the Primary Bottom Ash Pond (PBAP) at the J. Robert Welsh Plant site located in Titus County, Texas. This ASD report was prepared in accordance with the Coal Combustion Residual (CCR) Rule (the Rule) specified in 40 Code of Federal Regulations (CFR) §257 and in consultation with the Electric Power Research Institute “Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites” (EPRI, 2017). As part of the Rule, CCR facility owners are required to conduct detection and assessment monitoring of “Appendix III” and “Appendix IV” constituents, respectively, to ensure compliance with applicable groundwater standards (described further below). Because the monitored constituents also have natural sources and can be influenced by sampling methodology implementation, the Rule allows owners or operators to evaluate and demonstrate whether a source other than the CCR unit caused a statistically significant increase (SSI) over background levels for an Appendix III or and Statistically significant levels (SSLs) over groundwater protection standards for Appendix IV constituent, such as natural variation in groundwater quality or sampling methodology error.

The owner or operator must complete the written ASD within 90 days of identifying the SSI or SSL and include the certification from a qualified professional engineer to verify the accuracy of the information in the report. This ASD report was prepared by Arcadis U.S., Inc. (Arcadis) on behalf of AEP within the 90-day period and has been certified by a qualified professional engineer.

1.1 Facility History

The J. Robert Welsh Plant is located within southern Titus County, approximately eight miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas (**Figure 1-1**). The Plant began operations in 1977 with three coal-fired generating units (Units 1, 2, and 3). Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash) have been generated. These byproducts were stored in the PBAP and in the adjacent Landfill that was constructed in the late 1970s. In 2000, the 22-acre Bottom Ash Storage Pond was installed south of the Landfill. The Bottom Ash Storage Pond was constructed with a 60-mil high-density polyethylene liner (**Figure 1-2**).

Presently bottom ash and economizer ash from the Plant are sluiced to the PBAP. Solids settle as the clear liquids flow through a drainage canal into the clear water pond (a non-CCR unit). Solids (bottom ash and economizer ash) in the PBAP are dredged and sluiced into the Bottom Ash Storage Pond. Marketable ash material from the PBAP is also temporarily stored in the western two thirds of the Landfill for processing, then loaded into trucks and sold for beneficial reuse (highway road base, etc.).

2 PHYSICAL SETTING

2.1 Regional Topography

The elevation at the Site ranges from approximately 300 feet (ft) above mean sea level (amsl) at Swauano Creek downstream of the Welsh Reservoir, to 360 ft amsl at a topographically high ridge at the west end of the Landfill. The PBAP is in a topographically low area that had been an un-named intermittent tributary of Swauano Creek prior to development of the Site. The Landfill is approximately 40 acres in size and is located in a topographically higher area directly south of the PBAP. The Bottom Ash Storage Pond is approximately 22 acres in size and in a topographically higher area directly south of the Landfill.

2.2 Geology and Soils

2.2.1 Regional and Local Geology

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 to the southeast. The Site, including all three CCR Units (PBAP, Landfill, Bottom Ash Storage Pond), is located along the outcrop of the Eocene-age Reklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966). The Reklaw Formation attains a thickness of approximately 110 ft in Titus County, and is underlain by the Eocene-age Carrizo Sand which consists of fine to coarse sand, silt, and clay (Broom et al. 1965). In the topographically low areas underlying the Welsh Reservoir to the east of the PBAP, Quaternary alluvial sediments associated with Swauano Creek are present (Flawn 1966). All the CCR monitoring wells at the Site are completed in the Reklaw Formation. Monitoring well locations are shown on **Figure 2-1.**

As shown on the regional geologic map and legend (**Figure 2-2A** and **Figure 2-2B**), the Reklaw Formation outcrop (Er) at the Site is relatively narrow (less than 1 mile in width). The Reklaw Formation is overlain by the Eocene-age Queen City Formation, which outcrops directly to the west of the Site. The Queen City Formation consists of fine to medium grained sand, shale, silt, and impure lignite, and attains a thickness of approximately 210 ft in Titus County (USGS., 1965). The Queen City Formation also contains ironstone concretions (Flawn, 1966).

2.2.2 Regional and Local Soil Composition

Information gathered from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) soil data provides a detailed inventory of the regional soils and their characteristics, including the widespread distribution of clay-bearing soils, that support data collected at the Site from soil borings and groundwater monitoring locations. Two main named soil layers are present in the Pittsburgh, TX, area in the vicinity of the Site:

- Norfolk sandy loam
- Susquehanna fine sandy loam

Both soils are similar in the uppermost 1.5 ft of material, generally grayish in color and containing fine sand, silt, and clay. However, the subsoils of both units have subtle differences from one another and are described herein. Observations from soil borings at the Site are consistent with the characteristics of one or both of these soil units, as described in the USDA NRCS document.

The Norfolk sandy loam is a widely distributed soil unit that is uniformly developed in the lowland areas and is derived from weathering Eocene-aged deposits. It is a generally porous soil, allowing infiltrating water to migrate downward toward the water table. The soil layer is generally yellowish-gray in color, however the subsoil at greater depths is characterized by increased clay content and a mottled red and yellow appearance. As noted in the USDA soil descriptions, the soil and subsoils of the Norfolk sandy loam may be broken down into the grain size distributions presented in **Table 2-1.**

The Susquehanna fine sandy loam is also widely distributed and generally resembles the Norfolk sandy loam at the surface. Subsoils of the Susquehanna contain a greater component of clay, and likely contain increased iron content, as evidenced by observed iron concretions and iron crust formation within the subsoil. This soil is often mottled in appearance, ranging from red and yellow to a reddish brown or gray. Despite the greater clay content, the soil and subsoil is not impervious to infiltrating water that migrates toward the water table. As noted in the USDA soil descriptions, the soil and subsoils of the Susquehanna fine sandy loam may be broken down into the grain size distributions presented in **Table 2-2.**

These soil descriptions are important for the understanding of contributing sources of key constituents, such as lithium to the groundwater system. Lithium can occur in soils through natural weathering processes and the development of clay minerals. In particular, lithium can be incorporated into the structure of clays in the smectite group through cation substitution, which is further influenced in the presence of iron within the clay structure (Drever, 2002; Stucki, 2005). The widespread distribution of clay deposits in the native soils in and near the Site and the propensity for clays to contain trace constituents of potential concern, supports the potential for natural sources of lithium.

Geologic cross-sections were generated to evaluate the stratigraphy in the localized area of the PBAP. The lines of geologic cross-section are shown on **Figure 2-3** and the cross-section details for cross-sections A-A' through E-E' are shown on **Figures 2-4** through **2-8**, respectively. As shown on **Figure 2-4**, an unsaturated brown to gray clay and sandy clay stratum is present in the area of the PBAP from the surface to a depth of approximately 20 ft below ground surface (bgs). The clay stratum is underlain by a saturated fine to medium grained clayey and silty sand stratum with an average thickness of approximately 10 ft and is consistent with the soils of the Susquehanna fine sandy loam deposits. As discussed below in Section 2.3.2, this saturated sand stratum is the uppermost water-bearing unit in the area of the PBAP. This sand stratum is underlain by an unsaturated gray to black silty clay stratum that locally serves as a lower confining layer (aquitard) for the uppermost water-bearing unit.

2.3 Hydrology

2.3.1 Regional Hydrology

The Reklaw Formation, which outcrops in the area of the Site, and the overlying Queen City Formation, which outcrops directly west of the Site, are part of the Cypress Aquifer, which also includes the underlying Carrizo Sand and Wilcox Formation (USGS, 1965). As shown on **Figure 2-9,** the Cypress Aquifer is approximately 900 ft thick in the Site area, and the approximate base of fresh water in the Cypress Aquifer is approximately 800 ft bgs.

Regional groundwater characteristics are presented in Texas Water Commission Bulletin "*Ground-Water Resources of Camp, Franklin, Morris, and Titus Counties, Texas, Texas*" (USGS, 1965). All of the regional aquifer units are combined in this document, and considered as one interconnected unit, referred to as the "Cypress aquifer". This singular aquifer unit, composed of all water bearing units of similar character, was divided into three zones based on water quality characteristics of each zone rather than lithology. The following three zones were identified, in order of increasing relative depth:

- Zone A: characterized by minimal iron content and low pH, ranging from 4.5 to 6.5.
- Zone B: characterized by increased dissolved iron content and pH ranging from 5.0 to 7.0
- Zone C: characterized by iron concentrations of less than 0.3 milligrams per liter (mg/L) and neutral to alkaline pH (7.0 to 8.0)

Groundwater at the Site is generally assumed to be influenced by groundwater from Zones A and B. As described in USGS, 1965, Zones A and B can be more simply described as:

- Zone A: zone of oxidation and acidic groundwater
- Zone B: intermediate zone

The dissolved iron content in the A and B zones (ranging from non-detect to greater than 10 mg/L; USGS 1965) is likely influenced by iron present in the soils and sediments, which are described in Section 2.2. Slow recharge rates and transmissive properties of these zones contributes to longer residence times whereby the infiltrating groundwater may react with soil and sediments, allowing for the oxidation of sulfides to generate sulfate and mobilizing ferrous iron into solution. In addition, groundwater from several wells completed in shallow (less than 60 ft in depth) sediments contained sulfate of up to 1,420 mg/L. Sulfate concentrations observed at the Site are consistent with the range of data for other similar depth wells in the four-county area (USGS, 1965).

Additional regional groundwater information is provided in the 107th Annual Meeting of the Texas Academy of Science abstract titled "Natural Sources of Poor Water Quality in Streams of East Texas" (Ledger et. al., 2004). This study characterized surface water streams associated with the regional groundwater in the Eocene-aged Reklaw Formation as acidic with high concentrations of sulfate and arsenic concentrations greater than 0.01 mg/L.

An observed decline in surface water quality was also noted if springs from the Reklaw Formation discharge to surface water bodies. Abundant sulfur is noted in the Reklaw formation and sediments undergo acid-sulfate weathering, as evidenced in the red-stained soils and sulfate concentrations of greater than 1,000 mg/L (Ledger et. al., 2004). In streams associated with the Reklaw Formation, sulfate levels may exceed 1,000 mg/L.

2.3.2 Local Hydrology

Groundwater flow direction at the Site is generally from west to east, following surface topography towards the Welsh Reservoir. Groundwater elevations and well construction information from monitoring wells completed in the uppermost water-bearing unit at the Site are summarized on **Table 2-3**. Depth to groundwater in the monitoring wells in the area of the PBAP ranges from approximately 10 to 15 ft bgs.

Figure 2-10 is a potentiometric surface map for the uppermost water-bearing unit at the Site based on October 29, 2018 water level data. As shown on **Figure 2-10**, shallow groundwater flow direction in the area of the CCR Units is in a general easterly direction toward the Welsh Reservoir at an average hydraulic gradient of approximately 0.01 foot per foot.

The hydraulic conductivity of the uppermost water-bearing unit at the Site was determined by conducting aquifer tests. A constant-rate pumping test was conducted at monitoring well AD-6 on September 21, 2017. Based on the AD-6 pumping test data, the hydraulic conductivity for the uppermost water-bearing unit was calculated at 0.05 ft per day (1.83 x 10-5 centimeters per second).

To provide a broader understanding of the hydraulic conductivity distribution across the Site, bail down slug tests were performed in October 2018 on a total of 5 wells; 1 up gradient well (AD-17) and 4 down gradient wells (AD-6, AD-9, AD-13 and AD-19) on October 30 and 31, 2018. These wells are all screened in the uppermost water-bearing unit and were chosen based on their distribution across the Site. The hydraulic conductivity estimates from the five monitoring wells tested ranged from 0.15 ft per day (AD-6) to 2.0 ft per day (AD-13). The overall mean hydraulic conductivity estimate was 0.84 ft per day, while the overall geometric mean was 0.60 ft per day.

2.4 Surface Water

The Site is located directly west of Swauano Creek, which was dammed near the southern end of the Site during plant development to form the Welsh Reservoir. The PBAP normal operating water level is near the weir box which has a bottom elevation of 325 ft amsl. The surface water elevation of the Welsh Reservoir, located east of the PBAP, is maintained at approximately 320 ft amsl. The Welsh Reservoir is likely a gaining surface water feature, and groundwater elevations at the Site are higher than the normal stage elevation of the Welsh Reservoir (approximately 320 ft amsl) as shown on **Figure 2-10**.

There are no current or historic gauging stations on Swauano Creek; however, there was a historic gauging station on adjacent Boggy Creek, which has a drainage basin area of 72 square miles versus 21.2 square miles for Swauano Creek. The average annual flow of the Boggy Creek gauging station during the driest year on record (1956) was 10.65 cubic feet per second (cfs), which corresponds to a flow of approximately 3 cfs for Swauano Creek.

3 DETECTION AND ASSESSMENT MONITORING STATISTICAL EVALUATION

3.1 General

The groundwater monitoring network for the uppermost water-bearing unit at the PBAP consists of three upgradient monitoring wells (AD-1, AD-5, AD-17) and three downgradient monitoring wells (AD-8, AD-9, AD-15). Additional details regarding the groundwater monitoring network are provided in the August 22, 2017 report entitled "*Primary Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation*" (Arcadis, 2017).

3.2 Detection Monitoring Results

Detection monitoring at the Site involves collection of groundwater samples from the groundwater monitoring network upgradient and downgradient monitoring wells for analyses of Appendix III CCR constituents, which includes boron, calcium, chloride, fluoride, sulfate, pH, and total dissolved solids. Following the baseline monitoring program, which included a minimum collection of eight independent samples from each of the background and downgradient wells that are part of the certified monitoring network, the first round of Detection Monitoring was conducted. Based on detection monitoring conducted at the PBAP in 2017 and 2018, an SSI over the background concentration was calculated for boron in AD-8. Because of the SSI noted for boron from the 2018 sample from AD-8, an Alternate Source Demonstration was completed which did not identify an alternate source for the boron SSI (Geosyntec, 2018).

3.3 Assessment Monitoring Results

Groundwater protection standards (GWPSs) were established for the Appendix IV parameters in accordance with 40 CFR Part 257.95(h). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or regional screening level for each Appendix IV parameter.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells (AD-8, AD-9, AD-15) to assess whether Appendix IV parameters were present at an SSL above the GWPS. An SSL was identified for lithium, which exceeded the GWPS of 0.390 mg/L at monitoring well AD-9 (0.935 mg/L), despite no observed SSIs in Appendix III parameters for this well (Geosyntec, 2019). Because the native soils have the potential to be a natural source of lithium in the regional and local groundwater and soil composition, this ASD report was prepared to provide additional information on the sources and distribution of lithium in groundwater at the Site. Further discussion of the Site-specific soil and groundwater data is provided in Section 4. Additional details regarding the statistical evaluation of the groundwater monitoring data is provided in the January 8, 2019 report entitled "*Statistical Analysis Summary, Primary Bottom Ash Pond*" (Geosyntec, 2019).

4 SOIL AND GROUNDWATER ANALYTICAL DATA EVALUATION

4.1 General

In addition to the detection and assessment monitoring groundwater sampling events conducted at the PBAP in 2017 and 2018 for statistical evaluation, a comprehensive site-wide groundwater sampling event was conducted by Arcadis during May 2018 to evaluate alternate potential sources of lithium detected in downgradient monitoring well AD-9. This May 2018 evaluation included the following tasks:

- Collection of groundwater samples from the PBAP upgradient monitoring wells (AD-1, AD-5, AD-17), the PBAP downgradient monitoring wells (AD-8, AD-9, AD-15), and other monitoring wells in the area completed in the uppermost water-bearing unit, including upgradient monitoring well AD-18; sidegradient monitoring wells MW-9, MW-10, and Temp-1; and downgradient monitoring wells AD-3, AD-4c, AD-10, AD-11, AD-13, AD-14, AD-16R, and AD-19.
- Collection of soil samples from eight soil borings (Temp-1, SB-2 through SB-8) around the perimeter of the CCR units at the site.
- Collection of three CCR material samples from the PBAP (Sample IDs: Ash-1, Ash-2, Ash-3) and one CCR material sample from the HDPE-lined Bottom Ash Storage Pond (Sample ID: Ash-4) for analysis of total metals, pore water concentrations, and leachate water using the Synthetic Precipitation Leaching Procedure (SPLP) (**Table 4-1**).

In addition, two sentinel downgradient monitoring wells (AD-20, AD-21) were installed in the uppermost water-bearing unit (Reklaw Formation) near the shoreline of the Welsh Reservoir east (hydraulically downgradient) of the CCR units during October 2018.

4.2 Soil and Groundwater Analytical Data Evaluation

4.2.1 Soil Evaluation

The soil evaluation results demonstrate a correlation between lithium in soil and lithium in groundwater in key locations, with a correlation in soil between lithium and iron. Boring logs from Site monitoring locations highlight similarities with observations provided in the county-wide soil survey reports. For example, boring locations SB-04 (AD-5) and SB-05 (AD-8) contain a greater content of the reddish-brown clay subsoils as noted in the Susquehanna fine sandy loam, which directly overlie the water table in these locations. The reddish brown color generally denotes the presence of iron in these locations, which can be either incorporated directly into the clay mineral structure (e.g. smectite), or as a secondary mineral (e.g. iron hydroxide) that is also present in the aquifer matrix (Stucki, 2005). The role of iron incorporated into the clay structure is important to localized geochemical processes, such as cation exchange, redox conditions, and hydrophilic properties, which can influence weathering characteristics and the mobility of trace constituents (i.e. lithium) in groundwater (Stucki, 2005). As shown on **Table 4-1** and **Figure 4-1**, the highest concentration of lithium (13.6 mg/kg) was detected in the soil sample from soil boring SB-4, which is located adjacent to monitoring well AD-5 hydraulically upgradient (northwest) of the PBAP. This data indicates lithium concentrations in soil in the area of the PBAP are naturally occurring and not the result of impacts from CCR materials. This is one line of evidence that the lithium detected in groundwater at monitoring well AD-9 is from a naturally occurring source, and not the CCR unit. Groundwater quality measured in the adjacent monitoring wells (AD-5 and AD-8) generally contained greater lithium concentrations (0.056 mg/L to 0.147 mg/L) than other monitoring locations on Site that did not contain such subsoils. Soil samples collected from monitoring locations SB-04 (AD-5) and SB-05 (AD-8, background) similarly contained greater concentrations of lithium (10.5 milligrams per kilogram [mg/kg] to 13.6 mg/kg) and iron (6,210 mg/kg to 10,400 mg/kg) than other locations on Site. While there is localized variation in the native soil sediments collected, these results demonstrate that the soils are a potential alternative source for lithium.

As shown on **Table 4-1** and **Figure 4-2**, the highest iron concentrations in soil are from soil boring SB-4 (AD-5; 10,400 mg/kg), located upgradient (northwest) of the PBAP, and soil boring SB-8 (AD-3; 11,000 mg/kg), located over 1,000 ft south (side gradient) of the PBAP. **Figure 4-3** shows an apparent correlation between the iron and lithium content in the coal ash, upgradient locations, and downgradient locations. However, SPLP and pore water results from the coal ash samples show that the iron and lithium present in the coal ash is not in a mobile form. Therefore, it is more likely that the regional groundwater interaction with naturally occurring lithium and iron is responsible for the observed lithium concentrations and variability across the Site. As detailed below in Section 4.2.2, iron and lithium concentrations in groundwater at the Site show a similar distribution to iron and lithium concentrations in soil, indicating naturally occurring sources for iron and lithium.

4.2.2 Groundwater Evaluation

Groundwater analytical results for the PBAP, the landfill, and the bottom ash storage pond are summarized on **Tables 4-2**, **4-3**, and **4-4**, respectively. As shown on **Figure 4-4**, the highest lithium concentration in groundwater is at monitoring well AD-18 (2.07 mg/L), which is west (upgradient) relative to the PBAP. This data indicates lithium concentrations in groundwater in the area of the PBAP are from a source other than the PBAP.

As shown on **Figure 4-5**, iron concentrations in groundwater are also elevated upgradient (west) relative to the PBAP. **Figure 4-6** shows the relationship of total and dissolved iron concentrations to lithium concentrations in upgradient, side-gradient, and downgradient monitoring wells. These results demonstrate a clear correlation between aqueous iron and lithium, with higher lithium concentrations associated with elevated iron. The greatest concentrations of both iron and lithium are observed in the upgradient monitoring wells AD-17 and AD-18. As identified in **Table 4-1** and noted on **Figure 4-6**, SPLP leachate and pore water analyzed from coal ash samples contain lithium in concentrations below detection, or at very low concentrations less than 0.02 mg/L. This data indicates lithium concentrations in groundwater in the area of the PBAP are from a source other than the PBAP. As discussed above in Section 2.2.1, the Queen City Formation, which overlies the Reklaw Formation, is located directly west of the Site. Therefore, groundwater from the Queen City Formation west (upgradient) of the CCR units may be the source of lithium and iron detected in soils and groundwater in the area of the CCR units. As discussed above in Section 2.3.1, elevated naturally occurring iron is documented in the Cypress Aquifer, and as discussed above in Section 2.2.1, the Queen City Formation contains naturally-occurring iron concretions.

Another line of evidence the lithium detected in groundwater in the area of the PBAP is from a naturally occurring source is provided in the 2002 Publication “Springs of Texas” (Gunnar Brune, 1981). The Springs of Texas publication states “*Hynoon Springs, also known as Marshall, Noonday Camp, and Iron Springs, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from the Queen City Formation*.” This spring, which contains naturally-occurring lithium, is located approximately 35 miles southeast of the Site. A copy of this reference is provided in **Appendix A**.

When reviewing historical and recent datasets, a broad relationship was noted between trace metal chemistry and turbidity. Where turbidity values were greatest, greater concentrations of selected CCR monitored constituents were also observed (e.g. arsenic and cadmium) and in some cases, in exceedance of Federal MCLs. As a result, low-flow sampling methodology was employed to reduce the amount of turbidity in the groundwater sample.

A comprehensive groundwater sampling event was conducted at the Site by Arcadis during May 2018 using low-flow methodology. A clean stainless steel low-flow sampling pump with new, well-dedicated polyethylene piping was slowly lowered into the mid-point of the water column at each monitoring well, and groundwater was then pumped at a low flow rate of less than 0.1 liters per minute until the produced water was visually clear. The turbidity of the produced water was measured using calibrated field instruments during well development, and groundwater samples were not collected until the turbidity measurements declined and stabilized. Once low-flow groundwater sampling techniques were properly followed by Arcadis during May 2018, water quality results indicated concentrations of selected constituents to be much less than previously reported and did not exceed criteria. Therefore, it was determined that the sediment disturbances generated during well purging and improper (turbid) groundwater sampling were causing most of the Federal MCL groundwater exceedances. Specifically, since CCR Rule monitoring requires analysis of unfiltered samples, the results suggest that the exceedances were associated with constituents present in undissolved suspended solid particulates rather than in a dissolved form, on a location by location basis. The May 2018 groundwater analytical results are most representative of groundwater quality at the Site because proper low-flow sampling protocols were adhered to and sediment contributions to the analytical results were minimized.

5 SUMMARY AND CONCLUSIONS

This ASD has been prepared in consultation with the Electric Power Research Institute “Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites”. The following lines of evidence indicate the SSL related to the lithium concentration in groundwater at AD-8 is from naturally occurring sources (ASD Type V), with some additional minor contributions from sampling methodology error (ASD Type I):

- An SSI was confirmed for boron within monitoring well AD-8 followed by a failed Alternate Source Demonstration for boron, triggering the assessment monitoring program for the PBAP. Under the assessment monitoring program, an SSL was identified for lithium which exceeded the GWPS of 0.390 mg/L at monitoring well AD-9 (0.935 mg/L), despite no observed SSIs in Appendix III parameters for this well. SSIs would be expected for Appendix III parameters if there was a CCR unit source for the lithium exceedance of the SSL, indicating that there may be an alternate source of lithium.
- As demonstrated in this ASD report, iron and lithium are associated in the sediments and in groundwater. The subsoils at the Site, particularly the Susquehanna fine sandy loam, contain naturally occurring high clay content. The role of iron incorporated into the clay structure is important to localized geochemical processes, such as cation exchange, redox conditions, and hydrophilic properties, which can influence weathering characteristics and the mobility of trace constituents (i.e. lithium) in groundwater (Stucki, 2005). This is a supporting line of evidence.
- The highest lithium concentration in the uppermost saturated zone soil samples collected during the Arcadis May 2018 investigation was from a background soil sample (SB-4, 27 ft depth) located upgradient (northwest) of the PBAP near AD-5. This is a key line of evidence that the PBAP is not the source of elevated lithium concentrations in soil at the Site.
- Leachate and pore water analyzed from coal ash samples contain lithium in concentrations below detection, or at very low concentrations less than 0.02 mg/L. This data indicates lithium concentrations in groundwater in the area of the PBAP are from a source other than the PBAP. This is a key line of evidence.
- The highest lithium concentration in groundwater samples collected during the Arcadis May 2018 investigation was from an upgradient (background) monitoring well (AD-18) located west of the PBAP. This is a key line of evidence that the PBAP is not the source of elevated lithium concentrations in groundwater at the Site.
- Iron and lithium concentrations in soil and groundwater at the Site show a similar distribution, indicating there is likely a common source for these metals. The 1965 USGS publication “*Ground-Water Resources of Camp, Franklin, Morris and Titus Counties, Texas”* documents naturally occurring high iron concentrations within zones of the Cypress Aquifer, in which the monitoring wells at the Site are completed. The University of Texas at Austin Bureau of Economic Geology 1966 publication “*Geologic Atlas of Texas, Texarkana Sheet*” documents naturally occurring iron concretions in the Queen City Formation, which outcrops directly west (upgradient) of the PBAP. This is a supporting line of evidence.

- The 1981 Gunnar Brune publication "*Springs of Texas"* documents naturally occurring elevated lithium in groundwater in the Queen City Formation at Hynoon Springs, which is approximately 35 miles from the Site. The publication states "*Hynoon Springs, also known as Marshall, Noonday Camp, and Iron Springs, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from Queen City sand".* This publication, along with soil and groundwater analytical data at the Site, supports the conclusion that the primary source of lithium in groundwater at the PBAP is from the Queen City Formation, which outcrops directly west (upgradient) of the PBAP. This is a key line of evidence.
- Effective well development and proper low flow sampling techniques minimize the potential for groundwater analyses to be unrepresentative of formation groundwater. This is a supporting line of evidence.
- This ASD report provides a strong demonstration of naturally occurring sources of lithium in groundwater (ASD Type V) as supported by five key lines of evidence and three supporting lines of evidence.

6 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 alternate source demonstration for lithium at the Primary Bottom Ash Pond meets the requirements of 40 CFR Part 257.95.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

KENNETH J. BRANDNER
69586

Kenneth J. Brandner

Signature

69586	Texas	2-7-19
Registration No.	Registration State	Date

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TABLES

Table 2-1
Grain Size Distribution in Soil and Subsoil of the Norfolk Sandy Loam
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Grain Size	Soil	Subsoil
Fine Gravel	0.0%	0.0%
Coarse Sand	0.2%	0.1%
Medium Sand	0.4%	0.3%
Fine Sand	29.4%	29.9%
Very Fine Sand	37.9%	24.0%
Silt	25.9%	25.1%
Clay	5.9%	20.2%

Table 2-2
Grain Size Distribution in Soil and Subsoil of the Susquehanna Fine Sandy Loam
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Grain Size	Soil	Subsoil
Fine Gravel	0.4%	0.0%
Coarse Sand	0.7%	0.2%
Medium Sand	0.9%	0.8%
Fine Sand	53.4%	36.6%
Very Fine Sand	16.0%	10.8%
Silt	21.2%	19.0%
Clay	7.2%	32.8%

Table 2-3
Well Construction and Water Level Data - CCR Units
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Top of Casing Elevation	Borehole Depth ft. bls	Date Installed	Screen Material	Well Diameter inches	Top of Screen		Bottom of Screen		6/7/2011	12/6/2011	5/2/2012	11/1/2012	5/14/2013	11/19/2013	5/12/2014	11/16/2014	5/12/2015	3/4/2016	5/26/2016	7/27/2016	10/19/2016	12/12/2016	1/17/2017	2/23/2017	10/6/2017	5/15/2018	10/29/2018
									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	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																															
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	357.57	25.0	1/11/01	Sch. 40 PVC	2	15.0	340.57	25.0	330.57	338.46	334.92	337.88	337.18	337.43	336.73	338.03	337.64	340.82	342.83	344.89	342.89	341.23	340.58	341.18	339.74	337.70	340.57	339.10
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	346.16	25.0	4/26/01	Sch. 40 PVC	2	15.0	329.16	25.0	319.16	330.16	329.07	330.00	329.26	329.83	329.70	330.09	329.69	332.56	332.32	---	---	---	---	---	---	---	331.50	331.25
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	333.10	17.0	4/26/01	Sch. 40 PVC	2	7.0	324.10	17.0	314.10	323.81	323.19	323.99	323.29	323.77	323.98	324.12	323.28	325.58	325.12	324.59	323.70	323.47	323.78	325.04	324.92	323.24	324.30	324.15
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	342.61	30.0	4/26/01	Sch. 40 PVC	2	19.0	321.61	29.0	311.61	324.81	324.84	324.62	324.40	324.74	325.52	325.44	325.13	327.00	326.90	---	---	---	---	---	---	---	---	---
AD-4a (a)	33.04527	94.84258	340.19	342.85	30.0	9/22/09	Sch. 40 PVC	2	20.0	320.19	30.0	310.19	325.01	324.19	325.24	322.90	324.86	324.68	325.64	325.34	327.19	327.12	---	---	---	---	---	---	---	---	---
AD-4b (a)	33.04531	94.84230	329.55	333.23	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.55	15.0	314.55	324.35	324.32	324.50	324.30	324.30	325.21	325.22	324.90	326.58	326.67	---	---	---	---	---	---	---	---	---
AD-4c (a)	33.04507	94.84244	329.15	333.28	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.15	15.0	314.15	324.18	324.50	324.64	324.37	324.11	325.06	325.01	324.71	326.50	326.19	325.89	324.01	323.76	325.07	326.39	324.89	324.20	324.95	325.62
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	351.00	30.0	1/11/01	Sch. 40 PVC	2	20.0	329.00	30.0	319.00	336.34	336.58	336.82	336.99	336.78	336.47	336.80	336.01	339.07	338.04	337.62	337.24	337.74	337.01	338.34	336.17	337.40	337.25	336.98
AD-6 (a)	33.05235	94.84757	343.31	346.33	33.0	9/23/09	Sch. 40 PVC	2	23.0	320.31	33.0	310.31	333.04	333.02	332.83	333.02	333.11	332.81	333.11	332.81	333.38	334.00	---	---	---	---	---	---	---	---	333.42
AD-7 (a)	33.05257	94.84219	347.86	350.82	38.0	9/24/09	Sch. 40 PVC	2	28.0	319.86	38.0	309.86	334.32	334.12	334.19	334.20	334.13	334.58	333.77	333.98	334.09	333.61	---	---	---	---	---	---	---	---	---
AD-8 (a)	33.05187	94.84026	337.53	340.01	29.0	9/21/09	Sch. 40 PVC	2	16.0	321.53	26.0	311.53	325.41	324.09	325.69	325.15	325.79	325.75	325.98	325.77	326.05	325.70	325.68	325.05	325.29	325.92	326.76	324.27	326.12	325.63	326.36
AD-9 (a)	33.04995	94.84196	340.32	343.09	35.0	9/21/09	Sch. 40 PVC	2	20.0	320.32	35.0	305.32	328.46	328.53	328.63	328.44	328.74	329.38	NM	330.18	329.98	329.74	329.28	329.53	328.92	329.31	330.50	328.05	329.47	329.40	329.98
AD-10 (a)	33.04881	94.84047	340.23	343.01	35.0	9/22/09	Sch. 40 PVC	2	20.0	320.23	35.0	305.23	323.44	322.55	323.27	323.35	323.51	323.76	323.57	323.88	323.95	323.55	---	---	---	---	---	---	---	323.53	324.19
AD-11 (a)	33.04824	94.84177	339.61	342.18	20.0	9/22/09	Sch. 40 PVC	2	10.0	329.61	20.0	319.61	327.99	328.37	327.82	327.93	327.94	328.13	328.20	327.97	328.96	328.13	328.39	328.14	327.87	328.20	328.90	328.25	327.85	327.61	327.83
AD-12 (a)	33.04901	94.84977	366.27	369.33	30.0	9/24/09	Sch. 40 PVC	2	20.0	346.27	30.0	336.27	348.30	348.29	349.86	349.56	349.99	349.65	349.89	350.01	350.65	350.39	---	---	---	---	---	---	---	349.52	348.28
AD-13 (a)	33.04918	94.84275	344.12	347.00	20.0	9/22/09	Sch. 40 PVC	2	6.0	338.12	16.0	328.12	332.36	332.24	333.09	332.26	332.68	333.25	333.35	332.01	337.58	334.76	334.54	332.93	332.39	332.84	334.54	331.83	331.42	331.83	331.52
AD-14 (a)	33.04715	94.84256	342.32	345.43	19.0	9/22/09	Sch. 40 PVC	2	8.0	334.32	18.0	324.32	330.40	329.80	331.67	330.34	330.94	331.69	332.12	330.17	336.63	334.83	334.51	331.71	330.94	330.79	332.63	330.87	329.91	330.76	330.52
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	343.29	46.0	12/12/15	Sch. 40 PVC	2	25.5	314.71	45.5	294.71	---	---	---	---	---	---	---	---	---	322.14	321.93	321.28	321.42	321.71	321.64	322.81	322.07	321.74	322.01
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	353.97	21.0	12/10/15	Sch. 40 PVC	2	11.0	339.86	21.0	329.86	---	---	---	---	---	---	---	---	---	337.09	335.84	332.14	331.52	331.43	330.96	330.71	---	---	---
AD-16R (e)	33° 02' 49"	94° 50' 28.9"	350.55	353.49	27.0	4/12/17	Sch. 40 PVC	2	12.0	338.55	27.0	323.55	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	327.12	328.68	326.71
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	357.10	40.0	12/10/15	Sch. 40 PVC	2	24.0	329.99	39.0	314.99	---	---	---	---	---	---	---	---	---	334.64	334.26	334.30	334.45	334.64	334.05	333.94	334.17	334.35	333.91
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	349.28	29.0	12/11/15	Sch. 40 PVC	2	14.0	332.17	29.0	317.17	---	---	---	---	---	---	---	---	---	343.66	343.26	340.81	339.92	339.38	338.97	340.38	339.43	342.75	340.97
AD-19	33.047201°	94.839694°	323.58	326.35	15.0	5/8/18	Sch. 40 PVC	2	5.0	318.58	15.0	308.58	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	321.24	321.54
AD-20	33° 02' 45.6"	94° 50' 22.8"	324.85	327.65	20.0	10/23/18	Sch. 40 PVC	2	4.0	320.85	19.0	305.85	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	323.28
AD-21	33° 02' 49.6"	94° 50' 20"	322.04	325.29	20.0	10/23/18	Sch. 40 PVC	2	3.5	318.54	18.5	303.54	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	320.26
Piezometers																															
B-2 (b)	33° 03.078'	94° 50.449'	339.7	339.7	50.0	10/28/09	Sch. 40 PVC	2	10.0	329.70	20.0	319.70	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-4 (b)	33° 03.011'	94° 50.462'	340.6	340.6	50.0	10/27/09	Sch. 40 PVC	2	8.0	332.60	18.0	322.60	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-5 (b)	33° 02.964'	94° 50.428'	340.0	340.0	50.0	10/27/09	Sch. 40 PVC	2	10.0	330.00	20.0	320.00	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-6 (b)	33° 02.912'	94° 50.462'	340.1	340.1	50.0	10/28/09	Sch. 40 PVC	2	12.0	328.10	22.0	318.10	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Temp-1	33.046864°	94.852059°	356.36	358.17	28.0	5/8/18	Sch. 40 PVC	2	8.0	348.36	28.0	328.36	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	345.55	342.79
MW-9	33° 03' 18"	94° 50' 19.4"	342.00	344.54	18.0	11/19/01	Sch. 40 PVC	2	3.0	339.00	18.0	324.00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	331.34	331.24
MW-10	33° 03' 13.6"	94° 50' 19.4"	341.96	344.80	19.0	11/19/01	Sch. 40 PVC	2	4.0	337.96	19.0	322.96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	332.29	332.75

NOTES:

NM = Not measured

(a) Source: Eagle Environmental Services Well Logs (2009).

(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).

(c) Source: Southwest Electric Power, State of Texas Well Report (2001).

(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.

(e) Monitoring well installed by ARCADIS on April 12, 2017 as a replacement for monitoring well AD-16.

Groundwater Elevation Source: AEP, Shallow Groundwater Data Summary through February 2017.

1983 State Plane Lambert Coordinate System

Datum: NAD 83

ft bls = feet below land surface

ft msl = feet above mean sea level

Elev. = Elevation

---- = No record

Table 4-1
Soil and Coal Ash Sample Analytical Results (mg/kg) - CCR Units
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

				Appendix III Parameters						Appendix IV Parameters															
Sample ID	**Date Sampled**	**Sample Depth (feet)**	**Units**	**Boron**	**Calcium**	**Chloride**	**Fluoride**	**pH**	**Sulfate**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Lead**	**Lithium**	**Mercury**	**Molybdenum**	**Selenium**	**Thallium**	**Radium 226 and 228 (pCi/L)**	**Iron**	**Manganese**
Soil Samples																									
Temp-1	5/8/18	15'	mg/kg	14.3	43.3	15	<1	5.0	93	<0.25	1.77	16.8	<0.05	<0.05	5.22	0.28	1.77	0.104	0.004	1.18	<0.25	1.26	0.273	<12.5	5.4
SB-2	5/10/18	22'	mg/kg	11.9	35.8	13	2	3.9	878	<0.25	<0.25	18.3	0.08	<0.05	3.53	0.551	3.98	0.08	0.005	0.287	0.684	<0.25	0.159	890	4.46
(AD-17)																									
SB-3	5/10/18	30'	mg/kg	3.05	90.2	94	1	3.8	1,194	<0.25	3.83	13.6	<0.05	0.132	9.21	0.649	4.22	0.322	0.009	1.64	<0.25	<0.25	0.593	3,960	6.87
(AD-18)																									
SB-4	5/9/18	5'	mg/kg	(FOC = 0.00723 g/g)			---	4.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
(AD-5)		27'	mg/kg	7.76	634	8	1	6.4	724	<0.25	1.81	20.4	0.115	0.417	6.73	4.76	3.2	13.6	0.006	0.561	0.536	<0.25	0.657	10,400	65.5
(Background)		27'	mg/kg	(FOC = 0.00688 g/g)																					
SB-5	5/9/18	19'	mg/kg	5.45	655	16	3	7.2	69	<0.25	1.11	8.53	0.109	0.241	3.75	3.58	2.96	10.5	0.044	0.313	0.297	<0.25	0.216	6,210	35.5
(AD-8)																									
SB-6	5/9/18	21'	mg/kg	5.33	397	20	2	7.8	116	<0.25	1.11	17.9	0.09	0.24	3.5	3.37	2.67	10.3	0.051	0.299	0.471	<0.25	2.502	5,970	38.4
(AD-9)																									
SB-7	5/9/18	13'	mg/kg	8.11	1,360	19	<1	5.0	198	<0.25	10.1	65	0.154	0.356	6.87	3.21	3.14	5.3	0.004	1.39	<0.25	<0.25	0.262	9,220	28.4
(AD-13)																									
SB-8	5/9/18	12'	mg/kg	16.6	6,150	13	1	5.2	24	<0.25	3.3	213	0.409	0.452	8.22	4.13	9.05	4.63	0.013	0.488	<0.25	<0.25	0.433	11,000	25.4
(AD-3)																									
AD-20	10/23/18	15-17	mg/kg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.567	---	---
AD-21	10/23/18	15-17	mg/kg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.424	---	---
Coal Ash Samples																									
Ash-1	5/10/18	1-2'	mg/kg	34.4	33,800	30.5	8.21	7.1	219	<0.877	14.6	607	1.02	0.464	31.8	5.55	16.9	11.6	0.0473	2.66	2.27	<0.54	*2.92*	37,500	139
		SPLP:	*mg/L*	*0.594*	*30.2*	---	---	---	---	*<0.00344*	*<0.00411*	*0.284*	*<0.000333*	*<0.000164*	*0.00273*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0176*	*<0.00363*	*<0.00287*	*0.0991*	*<0.0305*	*<0.00267*
		Pore Water:	*mg/L*	*0.643*	*113*	*20.1*	*1.86*	*7.4*	*6.6*	*<0.00344*	*0.0095*	*3.43*	*<0.000333*	*<0.000164*	*0.00396*	*<0.000553*	*<0.00285*	*0.0123*	*<0.0000653*	*0.00484*	*<0.00363*	*<0.00287*	0.755	---	*0.357*
Ash-2	5/10/18	1-2'	mg/kg	92.6	96,000	53.8	11.2	7.3	293	<1.56	19.4	2,760	1.64	1.56	41.2	9.63	24.5	15.5	0.0967	2.08	5.25	<0.957	*2.32*	18,300	365
		SPLP:	*mg/L*	*0.526*	*24.1*	---	---	---	---	*<0.00344*	*<0.00411*	*0.192*	*<0.000333*	*<0.000164*	*0.00222*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0165*	*<0.00363*	*<0.00287*	*0.112*	*<0.0305*	*<0.00267*
		Pore Water:	*mg/L*	*0.772*	*143*	*20.4*	*0.28*	*7.6*	*8.73*	*<0.00344*	*0.0106*	*3.99*	*<0.000333*	*<0.000164*	*0.00196*	*<0.000553*	*0.00346*	*0.0173*	*<0.0000653*	*0.00428*	*<0.00363*	*<0.00287*	0.508	---	*0.376*
Ash-3	5/10/18	1-2'	mg/kg	29	14,300	11.5	10.7	7.4	152	<0.687	11.8	766	0.845	0.394	19.2	5.77	12.2	6.87	0.0403	1.79	1.44	<0.423	*1.754*	21,100	110
		SPLP:	*mg/L*	*0.958*	*19.8*	---	---	---	---	*<0.00344*	*<0.00411*	*0.0315*	*<0.000333*	*<0.000164*	*0.00389*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0222*	*<0.00363*	*<0.00287*	*<0.256*	*0.471*	*<0.00267*
		Pore Water:	*mg/L*	*1.000*	*103*	*13.0*	*0.998*	*7.6*	*51.1*	*<0.00344*	*0.0108*	*1.54*	*<0.000333*	*<0.000164*	*0.00110*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0111*	*<0.00363*	*<0.00287*	0.594	---	*0.715*
Ash-4	5/10/18	1-2'	mg/kg	281	106,000	27.6	1.34	10.5	961	<0.757	9.72	3,390	2.23	1.06	35.1	16.2	16.3	20.4	0.0340	2.21	1.30	<0.466	*3.18*	24,200	177
		SPLP:	*mg/L*	*1.3*	*25.1*	---	---	---	---	*<0.00344*	*<0.00411*	*0.0216*	*<0.000333*	*<0.000164*	*0.00329*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*<0.00281*	*<0.00363*	*<0.00287*	*<0.407*	*<0.0305*	*<0.00267*
		Pore Water:	*mg/L*	*4.75*	*63.5*	*28.8*	*0.697*	*10.8*	*381*	*<0.00344*	*0.00745*	*0.217*	*<0.000333*	*<0.000164*	*0.00225*	*0.00093*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0798*	*<0.00363*	*<0.00287*	0.259	---	*0.00814*

NOTES:

mg/kg = Milligrams per kilogram

mg/L = Milligrams per liter

FOC = Fraction organic carbon (Walkley Black)

--- = Not analyzed

SPLP = Synthetic precipitation leaching procedure (concentrations shown in milligrams per liter)

Total concentrations (mg/kg) shown in normal font, SPLP and Pore Water concentrations (mg/L) shown in italics.

Radium concentrations for soil shown in picoCuries per gram. SPLP concentrations shown in picoCuries per liter.

Table 4-2
Groundwater Sampling Analytical Results (mg/L) - Primary Bottom Ash Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Background (Upgradient) Wells																									
AD-1	05/26/16	0.346	36.5	5	<1	5.93	--	42	252	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.010	0.000033	<0.005	<0.005	<0.002	1.18	--	--
	07/27/16	0.350	39.6	4	<1	5.93	--	36	239	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.019	<0.000025	<0.005	<0.005	<0.002	0.9952	--	--
	09/29/16	0.332	15	5	<1	5.37	--	35	173	<0.005	<0.005	0.141	<0.001	<0.001	0.005	<0.005	<0.005	0.014	<0.000025	<0.005	<0.005	<0.002	1.38	--	--
	10/19/16	0.398	19.1	4	<1	5.15	--	42	192	<0.005	<0.005	0.114	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	1.141	--	--
	12/12/16	0.394	8.74	4	<1	5.18	--	40	200	<0.005	<0.005	0.072	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	0.719	--	--
	01/17/17	0.656	129	4	<1	7.13	--	68	538	<0.005	<0.005	0.410	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.000025	<0.005	<0.005	<0.002	3.009	--	--
	02/23/17	0.700	147	9	<1	6.88	--	68	612	<0.005	<0.005	0.488	<0.001	<0.001	<0.001	<0.005	<0.005	0.001	<0.000025	<0.005	<0.005	<0.002	4.309	--	--
	06/07/17	0.449	15.1	4	<0.083	5.06	109	42	176	<0.00093	0.00114	0.09346	0.00037	<0.00007	0.00066	0.00077	<0.00068	0.00902	0.000007	<0.00029	0.0021	<0.00086	0.676	--	--
	10/06/17	--	--	--	--	5.25	97.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.352	12.1	3	<0.083	4.82	8.4	--	174	<0.00093	<0.00105	0.08823	0.00048	<0.00007	<0.00023	0.0008	<0.00068	0.00816	<0.000005	<0.00029	<0.00099	<0.00086	0.837	0.03	0.025
	Dissolved	*0.35*	*12*	--	--	4.82	8.4	--	--	*<0.00093*	*<0.00105*	*0.08582*	*0.00044*	*<0.00007*	*<0.00023*	*0.00083*	*<0.00068*	*0.00799*	*<0.000005*	*<0.00029*	*0.00197*	*<0.00086*	*0.531*	0.01	0.026
	05/24/18	0.345	10.2	4	<0.083	5.19	118	43	150	0.00317 J	<0.00105	0.0799	0.00039 J	<0.00007	<0.00023	0.00035 J	<0.00068	0.00814	0.000006 J	<0.00029	0.00138 J	<0.00086	1.983	--	--
	08/14/18	0.443	5.95	5	<0.083	5.18	102	44	160	0.00003 J	0.00021	0.063	0.000482	0.00002	0.00016	0.000797	0.000238	0.00708	0.000013 J	0.00021	0.0017	0.00003 J	1.10	--	--
AD-5	05/31/16	0.03	36.9	15	<1	6.38	--	123	337	<0.005	<0.005	0.057	<0.001	<0.001	<0.001	0.014	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	1.63	--	--
	07/28/16	0.04	44.7	16	<1	6.38	--	163	360	<0.005	<0.005	0.093	<0.001	<0.001	<0.001	0.015	<0.005	0.191	<0.000025	<0.005	<0.005	<0.002	4.75	--	--
	09/29/16	0.04	46.3	15	<1	5.29	--	190	416	<0.005	<0.005	0.087	<0.001	<0.001	<0.001	0.014	<0.005	0.186	<0.000025	<0.005	<0.005	<0.002	3.33	--	--
	10/20/16	0.05	50.7	14	<1	5.92	--	267	448	<0.005	<0.005	0.07	<0.001	<0.001	<0.001	0.009	<0.005	0.225	<0.000025	<0.005	<0.005	<0.002	2.319	--	--
	12/13/16	0.05	49.6	13	<1	6.29	--	233	484	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	0.013	<0.005	0.199	<0.000025	<0.005	<0.005	<0.002	2.182	--	--
	01/17/17	0.04	49.8	14	<1	6.27	--	234	438	<0.005	<0.005	0.047	<0.001	<0.001	<0.001	0.012	<0.005	0.239	<0.000025	<0.005	<0.005	<0.002	1.023	--	--
	02/23/17	0.04	33.0	15	<1	5.48	--	127	286	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	0.013	<0.005	0.166	<0.000025	<0.005	<0.005	<0.002	1.788	--	--
	06/07/17	0.05281	49.7	14	<0.083	5.96	867	82	300	<0.00093	0.00385	0.0877	0.00008	0.00039	0.00028	0.01193	<0.00068	0.124	<0.000005	<0.00029	<0.00099	<0.00086	2.32	--	--
	10/06/17	--	--	--	--	5.59	249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.05063	30.1	21	<0.083	5.79	<100	--	248	<0.00093	<0.00105	0.07627	0.00014	0.00037	<0.00023	0.01907	<0.00068	0.118	<0.000005	<0.00029	<0.00099	<0.00086	1.495	14.4	0.45
	Dissolved	*0.03752*	*29.1*	--	--	5.79	<100	--	--	*<0.00093*	*<0.00105*	*0.06865*	*<0.00002*	*<0.00007*	*<0.00023*	*0.01747*	*<0.00068*	*0.119*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.043*	*2.051*	8.38	0.43
	05/24/18	0.05007	28.1	22	<0.083	6.22	17.8	60	242	<0.00093	<0.00105	0.07116	<0.00002	0.00023 J	0.0008 J	0.01424	<0.00068	0.121	<0.000005	<0.00029	<0.00099	<0.00086	1.946	--	--
	08/15/18	0.05	40.5	19	<0.083	6.23	57.1	240	428	0.00001 J	0.00169	0.0637	0.000055	0.000008 J	0.000072	0.0114	0.000079	0.147	<0.000005	0.00013	0.00008 J	<0.01	0.316	--	--
AD-17	05/26/16	0.121	200	43	<1	7.17	--	1,166	1,810	<0.005	<0.005	0.021	<0.001	0.002	0.001	0.063	<0.005	0.370	0.000032	<0.005	<0.005	<0.002	1.53	--	--
	07/27/16	0.119	195	32	<1	7.17	--	1,005	1,576	<0.005	<0.005	0.020	<0.001	0.004	0.001	0.068	<0.005	0.374	<0.000025	<0.005	<0.005	<0.002	2.78	--	--
	09/29/16	0.111	191	36	<1	6.17	--	1,055	1,663	<0.005	<0.005	0.031	<0.001	<0.001	0.003	0.058	<0.005	0.354	<0.000025	<0.005	<0.005	<0.002	2.358	--	--
	10/20/16	0.124	194	32	1.0	6.14	--	1,163	1,612	<0.005	<0.005	0.034	<0.001	0.002	0.004	0.065	<0.005	0.394	<0.000025	<0.005	<0.005	<0.002	2.224	--	--
	12/13/16	0.135	196	31	<1	6.03	--	1,096	1,560	<0.005	<0.005	0.017	<0.001	0.003	<0.001	0.068	<0.005	0.323	<0.000025	<0.005	<0.005	<0.002	2.384	--	--
	01/17/17	0.101	196	33	<1	5.96	--	1,445	1,686	<0.005	<0.005	0.014	<0.001	0.003	0.068	0.068	<0.005	0.341	<0.000025	<0.005	<0.005	<0.002	2.436	--	--
	02/22/17	0.135	189	30	<1	5.67	--	1,055	1,628	<0.005	<0.005	0.020	<0.001	0.002	0.001	0.073	<0.005	0.331	<0.000025	<0.005	<0.005	<0.002	2.288	--	--
	06/06/17	0.121	188	30	<0.083	5.81	156	1,105	1,578	<0.00093	<0.00105	0.01033	<0.00002	0.00606	<0.00023	0.0748	<0.00068	0.329	0.000013	<0.00029	<0.00099	<0.00086	1.598	--	--
	10/05/17	--	--	--	--	5.92	598	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.247	213	45	<0.083	5.51	<100	--	1,846	<0.00093	<0.00105	0.00978	<0.00002	0.00915	<0.00023	0.07451	<0.00068	0.306	<0.000005	<0.00029	0.00414	<0.00086	1.514	260	3.72
	Dissolved	*0.231*	*205*	--	--	5.51	<100	--	--	*<0.00093*	*<0.00105*	*0.00737*	*<0.00002*	*0.00609*	*<0.00023*	*0.07938*	*<0.00068*	*0.301*	*<0.000005*	*<0.00029*	*0.00515*	*0.02*	*1.57*	241	3.56
	05/24/18	0.239	193	39	<0.083	6.28	7.8	1,067	1,836	<0.00093	<0.00105	0.00965	<0.00002	0.00646	<0.00023	0.07173	<0.00068	0.308	<0.000005	<0.00029	<0.00099	<0.00086	1.939	--	--
	08/15/18	0.118	187	40	<0.083	5.60	418	1,170	1,750	0.00002 J	0.00183	0.0128	0.000069	0.00025	0.000604	0.0435	0.0011	0.243	0.000011 J	0.00035	0.0003	0.000074	2.35	--	--
Background Statistical Evaluation Summary - Upper Prediction Limits:[a]										0.005	0.005	0.36	0.00077	0.0065	0.004	0.075	0.005	0.39	0.000033	0.005	0.005	0.0013	4.21	--	--

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters														
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Point of Compliance Wells																									
AD-8	05/31/16	1.46	32.6	36	1	6.91	--	217	524	<0.005	<0.005	0.034	<0.001	<0.001	0.002	0.007	<0.005	0.122	<0.000025	<0.005	<0.005	<0.002	1.046	--	--
	07/28/16	1.44	25.9	26	<1	6.91	--	202	469	<0.005	<0.005	0.026	<0.001	<0.001	<0.001	0.009	<0.005	0.098	<0.000025	<0.005	<0.005	<0.002	1.584	--	--
	09/29/16	1.51	24.3	28	<1	7.65	--	186	432	<0.005	<0.005	0.023	<0.001	<0.001	<0.001	0.007	<0.005	0.111	<0.000025	<0.005	<0.005	<0.002	6.3	--	--
	10/20/16	1.54	25.9	30	<1	6.07	--	184	424	<0.005	<0.005	0.024	<0.001	<0.001	<0.001	0.007	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	0.345	--	--
	12/12/16	1.53	23.6	27	<1	5.62	--	168	442	<0.005	<0.005	0.021	<0.001	<0.001	<0.001	0.007	<0.005	0.11	<0.000025	<0.005	<0.005	<0.002	1.083	--	--
	01/19/17	1.53	18.7	24	1	6.21	--	153	352	<0.005	<0.005	0.02	<0.001	<0.001	<0.001	0.006	<0.005	0.094	<0.000025	<0.005	<0.005	<0.002	0.823	--	--
	02/22/17	1.67	19.3	22	<1	6.78	--	163	356	<0.005	<0.005	0.019	<0.001	<0.001	<0.001	0.006	<0.005	0.092	<0.000025	<0.005	<0.005	<0.002	0.536	--	--
	06/06/17	1.39	17.4	22	0.6628	5.63	54	151	368	<0.00093	<0.00105	0.01908	<0.00002	<0.00007	<0.00023	0.00386	<0.00068	0.09491	0.000008	<0.00029	<0.00099	<0.00086	1.0735	--	--
	10/05/17	--	--	--	--	6.68	41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/30/18	1.29	17.2	22	0.716	6.07	3.0	--	368	<0.00093	<0.00105	0.02283	0.00004	<0.00007	<0.00023	0.00521	<0.00068	0.08418	0.000009	<0.00029	<0.00099	<0.00086	1.106	0.673	0.388
	Dissolved	*1.31*	*17.1*	--	--	6.07	3.0	--	--	*<0.00093*	*<0.00105*	*0.02046*	*<0.00002*	*<0.00007*	*<0.00023*	*0.00513*	*<0.00068*	*0.08356*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*0.5773*	< 0.01	0.363
	05/23/18	--	--	--	0.501 J	6.20	*48.2*	--	--	0.00319 J	<0.00105	0.02212	<0.00002	<0.00007	<0.00023	0.00319 J	<0.00068	0.0956	<0.000005	<0.00029	0.00175 J	<0.00086	0.3366	--	--
	8/15/18[b]	1.30	15.0	24	0.615 J	6.77	104	122	288	0.00001 J	0.00031	0.0212	0.000008 J	0.000002 J	0.00005	0.00536	0.000039	0.0555	0.000007 J	0.00016	0.00007 J	0.000129	3.44	--	--
AD-9	05/31/16	0.12	229	88	<1	6.32	--	1,352	2,541	<0.005	<0.005	0.051	<0.001	0.001	<0.001	0.027	<0.005	1.32	<0.000025	<0.005	<0.005	<0.002	2.95	--	--
	07/28/16	0.105	255	98	<1	6.32	--	1,464	2,564	<0.005	<0.005	0.031	<0.001	0.002	<0.001	0.022	<0.005	1.38	0.000045	<0.005	0.008	<0.002	1.447	--	--
	09/29/16	0.115	220	86	<1	4.72	--	1,301	2,448	<0.005	<0.005	0.033	<0.001	<0.001	<0.001	0.012	<0.005	1.17	<0.000025	<0.005	<0.005	<0.002	3.199	--	--
	10/19/16	0.109	228	76	1	5.22	--	1,350	2,494	<0.005	<0.005	0.026	<0.001	<0.001	<0.001	0.016	<0.005	1.44	<0.000025	<0.005	<0.005	<0.002	1.311	--	--
	12/12/16	0.108	250	92	<1	5.72	--	1,639	2,667	<0.005	<0.005	0.027	<0.001	0.002	<0.001	0.024	<0.005	1.33	<0.000025	<0.005	<0.005	<0.002	3.0	--	--
	01/19/17	0.312	91.1	54	<1	5.43	--	884	1,360	<0.005	<0.005	0.098	0.002	<0.001	<0.001	0.042	<0.005	0.634	<0.000025	<0.005	<0.005	<0.002	2.349	--	--
	02/22/17	0.1	258	86	<1	5.77	--	1,774	2,662	<0.005	<0.005	0.022	<0.001	<0.001	<0.001	0.024	<0.005	1.41	<0.000025	<0.005	<0.005	<0.002	2.32	--	--
	06/06/17	0.146	191	19	<0.083	4.61	100	105	308	<0.00093	<0.00105	0.04227	0.00077	0.00222	<0.00023	0.02416	<0.00068	1.00	0.000006	<0.00029	<0.00099	<0.00086	1.586	--	--
	10/05/17	--	--	--	--	5.78	102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	0.08607	10.5	85	<0.083	4.20	<100		1,972	<0.00093	<0.00105	0.04937	0.00134	0.00023	<0.00023	0.01628	<0.00068	0.217	<0.000005	<0.00029	<0.00099	<0.00086	1.582	0.446	0.378
	Dissolved	*0.07126*	*10.2*	--	--	4.20	<100	--	--	*<0.00093*	*<0.00105*	*0.04695*	*0.00122*	*0.00012*	*<0.00023*	*0.01592*	*<0.00068*	*0.204*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.549*	0.166	0.369
	05/23/18	--	--	--	<0.083	5.30	44.6	--	--	<0.00093	<0.00105	0.03045	0.00032 J	0.00288	<0.00023	0.0267	<0.00068	1.20	<0.000005	<0.00029	<0.00099	0.00846	2.556	--	--
	8/15/18[b]	0.198	230	103	<0.083	4.96	237	1,910	2,694	<0.01	0.00168	0.0242	0.000268	0.00006	0.00042	0.0111	0.000262	0.851	0.000013 J	0.00011	0.0003	0.000062	1.864	--	--
AD-15	05/31/16	0.329	5.09	30	<1	5.58	--	24	188	<0.005	0.012	0.215	<0.001	<0.001	0.017	0.011	0.007	0.017	0.000054	<0.005	<0.005	<0.002	2.28	--	--
	07/28/16	0.407	3.83	34	<1	5.58	--	28	196	<0.005	0.006	0.124	<0.001	<0.001	0.004	0.006	<0.005	0.021	<0.000025	<0.005	<0.005	<0.002	1.322	--	--
	09/29/16	0.360	13.7	28	<1	4.57	--	23	367	<0.005	0.131	1.93	0.015	0.007	0.28	0.134	0.161	0.149	0.000707	<0.005	0.014	<0.002	9.92	--	--
	10/19/16	0.152	4.57	26	<1	4.35	--	17	152	<0.005	0.023	0.415	0.002	<0.001	0.054	0.019	0.022	0.036	0.0001	<0.005	<0.005	<0.002	3.567	--	--
	12/12/16	0.334	3.60	26	<1	4.67	--	19	204	<0.005	0.006	0.184	<0.001	<0.001	0.015	0.010	<0.005	0.013	0.000026	<0.005	<0.005	<0.002	3.36	--	--
	01/19/17	0.413	3.35	32	<1	5.77	--	25	176	<0.005	0.006	0.153	<0.001	<0.001	0.009	0.007	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	2.386	--	--
	02/22/17	0.100	4.21	20	<1	4.95	--	8	88	<0.005	0.020	0.353	0.002	<0.001	0.049	0.020	0.019	0.025	0.000058	<0.005	<0.005	<0.002	2.261	--	--
	06/06/17	0.321	3.57	27	<0.083	4.83	246	19	184	<0.00093	0.00854	0.166	0.00061	0.00048	0.01235	0.00844	0.00298	0.0108	0.000022	<0.00029	0.00271	<0.00086	2.491	--	--
	10/05/17	--	--	--	--	5.94	208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/30/18	0.08009	2.49	22	<0.083	4.60	7.32		94	<0.00093	0.00222	0.08419	0.00024	<0.00007	<0.00023	0.00403	<0.00068	0.00395	<0.000005	<0.00029	<0.00099	<0.00086	1.749	6.64	0.036
	Dissolved	*0.05773*	*2.49*	--	--	4.60	7.32	--	--	*<0.00093*	*<0.00105*	*0.08405*	*0.00019*	*<0.00007*	*<0.00023*	*0.00346*	*<0.00068*	*0.00378*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*0.748*	< 0.01	0.034
	Field Filtered[c]	*0.301*	*3.03*	*35*	*<0.083*	4.60	7.32	--	*8*	*<0.00093*	*0.00216*	*0.08611*	*0.00012*	*<0.00007*	*<0.00023*	*0.00421*	*<0.00068*	*0.00498*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.630*	7.09	0.061
	FF Dissolved[c]	*0.309*	*3*	--	--	4.60	7.32	--	--	*<0.00093*	*<0.00105*	*0.08373*	*0.00024*	*<0.00007*	*<0.00023*	*0.0038*	*<0.00068*	*0.00516*	*<0.000005*	*0.00048*	*<0.00099*	*<0.00086*	*5.743*	<0.01	0.062
	05/23/18	--	--	--	<0.083	4.76	147	--	--	<0.00093	0.00256 J	0.102	0.00003 J	0.0001 J	0.00263	0.00474 J	<0.00068	0.00562	<0.000005	<0.00029	0.00154 J	0.00137 J	1.46	--	--
	8/15/18[b]	0.341	3.04	37	<0.083	4.59	249	24	174	0.00003 J	0.00326	0.0852	0.000116	0.00001 J	0.000481	0.00371	0.000438	0.00338	0.000008 J	0.00005 J	0.0009	0.00009	1.076	--	--

Table 4-2
Groundwater Sampling Analytical Results (mg/L) - Primary Bottom Ash Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters																
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Supplemental Downgradient Monitoring Wells																									
AD-10	5/16/2018	0.08311	15.5	40	<0.083	3.72	<100	--	280	<0.00093	0.0022	0.03855	0.00166	0.00033	<0.00023	0.02432	<0.00068	0.316	<0.000005	<0.00029	<0.00099	0.00098	1.704	0.338	0.25
	Dissolved	*0.07733*	*15.3*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.03712*	*0.00149*	*0.00009*	*<0.00023*	*0.02412*	*<0.00068*	*0.296*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.505*	0.282	0.251
Supplemental Sidegradient Monitoring Wells																									
MW-9	5/15/2018	0.578	44.8	93	<0.083	4.74	57.4	--	780	0.00097	<0.00105	0.01661	0.00021	0.00019	<0.00023	0.03083	<0.00068	0.03225	0.000127	<0.00029	<0.00099	<0.00086	0.779	0.142	0.306
	Dissolved	*0.556*	*44.7*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.01588*	*0.00015*	*0.00036*	*<0.00023*	*0.03189*	*0.00813*	*0.03151*	*0.00015*	*<0.00029*	*<0.00099*	*<0.00086*	*0.2578*	< 0.01	0.308
MW-10	5/15/2018	0.707	59.3	5	<0.083	6.68	1.7	--	346	<0.00093	0.00128	0.08634	0.00006	<0.00007	<0.00023	0.00385	<0.00068	0.01001	<0.000005	0.00079	0.01898	<0.00086	0.969	0.101	0.054
	Dissolved	*0.689*	*59.8*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.08253*	*<0.00002*	*<0.00007*	*<0.00023*	*0.00064*	*<0.00068*	*0.00924*	*<0.000005*	*0.00082*	*0.01651*	*<0.00086*	*1.026*	< 0.01	0.002
Reference Values:																									
MCL					4					0.006	0.01	2	0.004	0.005	0.1				0.002		0.05	0.002	5[e]		
Rule Specified																0.006	0.015	0.04		0.1					
Background Limit					1					0.005	0.005	0.36	0.00077	0.0065[d]	0.004	0.075[d]	0.005	0.39[d]	0.000033	0.005	0.005	0.0013	4.21[e]		
Interwell Background Value(s) (UPL, LPL where applicable) AD-8, AD-9, AD-15		0.652				4.81-6.99																			
Intrawell Background Value (UPL) AD-8			35.68	38.3	1.034			236	569																
Intrawell Background Value (UPL) AD-9			350	139.3	0.7259			2527	3147																
Intrawell Background Value (UPL) AD-15			5.71	38.42	1			35.6	388																

NOTES:
All concentration data are provided in milligrams per liter (mg/L) unless otherwise noted.
J = Analyte was positively identified, though the quantitation was below Reporting Limit.
MCL = Maximum contaminant level
LPL = Lower prediction limit
UPL = Upper prediction limit
pCi/L = PicoCuries per liter
-- = Not analyzed
a = Data taken from Geosyntec "Statistical Analysis Summary, Primary Bottom Ash Pond" dated January 8, 2019.
b = Some inorganic analyte groundwater samples collected 9/17/18.
c = Sample ID "AD-15 DUP" was field filtered (FF) using a 5 micron filter.
d = Calculated Upper Tolerance Limit is higher than MCL.
e = Data is "Combined Radium, Total".
▨ Denotes groundwater sample collected by ARCADIS using low-flow methods.
Unless otherwise noted, values shown are total (unfiltered) analyses.
Dissolved (0.45-micron lab filtered) parameter concentrations shown in italics.

Table 4-3
Groundwater Sampling Analytical Results (mg/L) - Landfill
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters																
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Background (Upgradient) Wells																										
AD-5	05/31/16	0.03	36.9	15	<1	6.38	--	123	337	<0.005	<0.005	0.057	<0.001	<0.001	<0.001	0.014	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	1.63	--	--
	07/28/16	0.04	44.7	16	<1	6.38	--	163	360	<0.005	<0.005	0.093	<0.001	<0.001	<0.001	0.015	<0.005	0.191	<0.000025	<0.005	<0.005	<0.002	4.75	--	--
	09/29/16	0.04	46.3	15	<1	5.29	--	190	416	<0.005	<0.005	0.087	<0.001	<0.001	<0.001	0.014	<0.005	0.186	<0.000025	<0.005	<0.005	<0.002	3.33	--	--
	10/20/16	0.05	50.7	14	<1	5.92	--	267	448	<0.005	<0.005	0.07	<0.001	<0.001	<0.001	0.009	<0.005	0.225	<0.000025	<0.005	<0.005	<0.002	2.319	--	--
	12/13/16	0.05	49.6	13	<1	6.29	--	233	484	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	0.013	<0.005	0.199	<0.000025	<0.005	<0.005	<0.002	2.182	--	--
	01/17/17	0.04	49.8	14	<1	6.27	--	234	438	<0.005	<0.005	0.047	<0.001	<0.001	<0.001	0.012	<0.005	0.239	<0.000025	<0.005	<0.005	<0.002	1.023	--	--
	02/23/17	0.04	33.0	15	<1	5.48	--	127	286	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	0.013	<0.005	0.166	<0.000025	<0.005	<0.005	<0.002	1.788	--	--
	06/07/17	0.05281	49.7	14	<0.083	5.96	867	82	300	<0.00093	0.00385	0.0877	0.00008	0.00039	0.00028	0.01193	<0.00068	0.124	<0.000005	<0.00029	<0.00099	<0.00086	2.32	--	--
	10/06/17	--	--	--	--	5.59	249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.05063	30.1	21	<0.083	5.79	<100	--	248	<0.00093	<0.00105	0.07627	0.00014	0.00037	<0.00023	0.01907	<0.00068	0.118	<0.000005	<0.00029	<0.00099	<0.00086	1.495	14.4	0.45
	Dissolved	*0.03752*	*29.1*	--	--	5.79	<100	--	--	*<0.00093*	*<0.00105*	*0.06865*	*<0.00002*	*<0.00007*	*<0.00023*	*0.01747*	*<0.00068*	*0.119*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.043*	*2.051*	8.38	0.43
	05/24/18	0.05007	28.1	22	<0.083	6.22	17.8	60	242	<0.00093	<0.00105	0.07116	<0.00002	0.00023 J	0.0008 J	0.01424	<0.00068	0.121	<0.000005	<0.00029	<0.00099	<0.00086	1.946	--	--
	08/15/18	0.05	40.5	19	<0.083	6.23	57.1	240	428	0.00001 J	0.00169	0.0637	0.000055	0.000008 J	0.000072	0.0114	0.000079	0.147	<0.000005	0.00013	0.00008 J	<0.01	0.316	--	--
AD-18	05/26/16	0.146	409	422	<1	5.1	--	5,135	10,000	<0.005	<0.005	0.012	0.014	0.003	<0.001	0.922	<0.005	2.07	0.000168	<0.005	0.006	0.003	12.6	--	--
	07/27/16	0.148	457	432	2	5.1	--	4,930	9,476	<0.005	<0.005	0.019	0.005	0.002	<0.001	0.734	<0.005	1.94	0.000091	<0.005	0.007	0.003	10.62	--	--
	09/29/16	0.156	469	637	4	5.59	--	4,632	9,569	<0.005	<0.005	0.02	0.004	<0.001	<0.001	0.666	<0.005	1.86	0.000117	<0.005	0.007	<0.002	7.05	--	--
	10/20/16	0.188	498	876	0.8664	5.7	--	5,537	9,540	<0.005	<0.005	0.021	0.002	0.001	<0.001	0.569	<0.005	2.06	0.000053	<0.005	<0.005	<0.002	5.82	--	--
	12/13/16	0.178	510	695	5	5.75	--	4,382	8,912	<0.005	<0.005	0.021	0.007	0.001	<0.001	0.641	<0.005	1.74	0.00005	<0.005	<0.005	<0.002	9.6	--	--
	01/17/17	0.050	412	159	5	4.49	--	5,414	8,562	<0.005	0.01	0.014	0.022	0.001	<0.001	0.929	<0.005	1.95	0.000224	<0.005	<0.005	0.002	22.51	--	--
	02/22/17	0.090	401	151	6	4.37	--	5,169	8,412	<0.005	<0.005	0.014	0.026	0.002	<0.001	0.961	<0.005	1.82	0.000107	<0.005	<0.005	0.00228	19.11	--	--
	06/06/17	0.125	428	304	6.53	4.27	121	5,920	9,394	<0.00093	0.00331	0.01038	0.01883	0.00303	<0.00023	0.940	<0.00068	2.15	0.000113	<0.00029	0.00212	<0.00086	16.12	--	--
	10/05/17	--	--	--	--	5.87	165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.163	433	362	9.4	3.61	104.1	--	9,952	0.00224	0.00276	0.00813	0.01733	0.0036	0.00098	0.928	<0.00068	2.07	0.000043	<0.00029	0.00194	0.00144	19.95	19.7	14.1
	Dissolved	*0.153*	*423*	--	--	--	--	--	--	*0.00467*	*0.00189*	*0.00748*	*0.01676*	*0.00316*	*<0.00023*	*0.898*	*<0.00068*	*2.06*	*0.000012*	*<0.00029*	*0.00135*	*0.01466*	*18.09*	19.1	13.7
Background Statistical Evaluation Summary - Upper Prediction Limits:[a]										0.005	0.005	0.36	0.00077	0.0065	0.004	0.075	0.005	0.39	0.000033	0.005	0.005	0.002	4.21	---	---
Point of Compliance Wells																										
AD-11	05/31/16	2.47	8.47	9	2	5.21	--	518	388	<0.005	<0.005	0.014	0.004	<0.001	0.003	0.026	<0.005	0.032	<0.000025	<0.005	<0.005	<0.002	1.77	--	--
	07/28/16	2.83	8.88	10	2	5.21	--	596	1,000	<0.005	<0.005	0.012	0.004	<0.001	<0.001	0.026	<0.005	0.047	<0.000025	<0.005	<0.005	<0.002	2.23	--	--
	09/29/16	3.4	10.7	12	2	4.08	--	683	1,065	<0.005	<0.005	0.052	0.005	<0.001	0.007	0.03	<0.005	0.047	<0.000025	<0.005	<0.005	<0.002	3.92	--	--
	10/19/16	3.77	8.78	11	<1	3.68	--	706	1,024	<0.005	<0.005	0.02	0.005	<0.001	0.002	0.027	<0.005	0.047	<0.000025	<0.005	<0.005	<0.002	2.56	--	--
	12/12/16	3.36	8.98	10	2	3.75	--	548	1,044	<0.005	<0.005	0.013	0.004	<0.001	<0.001	0.025	<0.005	0.041	<0.000025	<0.005	<0.005	<0.002	1.569	--	--
	01/17/17	2.81	10.3	11	2	4.41	--	760	1,048	<0.005	<0.005	0.013	0.004	<0.001	<0.001	0.025	<0.005	0.046	<0.000025	<0.005	<0.005	<0.002	1.082	--	--
	02/22/17	2.88	9.31	10	2	4.34	--	558	876	<0.005	<0.005	0.019	0.004	<0.001	0.002	0.024	<0.005	0.035	<0.000025	<0.005	<0.005	<0.002	1.45	--	--
	06/06/17	2.79	9.93	10	1.366	3.86	219	556	960	<0.00093	0.00123	0.01012	0.00279	0.00041	0.00032	0.02216	<0.00068	0.03654	<0.000005	<0.00029	<0.00099	<0.00086	1.902	--	--
	10/05/17	--	--	--	--	4.43	162	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	1.48	4.37	10	<0.083	3.77	75.3		558	0.00417	0.00127	0.01281	0.00148	0.00053	0.00041	0.00935	<0.00068	0.01978	<0.000005	0.00094	0.00103	<0.00086	1.264	1.35	0.063
	Dissolved	*1.45*	*4.28*	--	--	3.77	75.3	--	--	*<0.00093*	*0.00278*	*0.01202*	*0.00098*	*<0.00007*	*<0.00023*	*0.00877*	*<0.00068*	*0.01836*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.656*	1.25	0.062
	05/23/18	--	--	--	<0.083	*4.05*	*49.8*	--	--	<0.00093	0.0026 J	0.01627	0.00089 J	0.00018 J	0.0008 J	0.00863	<0.00068	0.01875	0.000007 J	<0.00029	0.00134 J	0.046	1.912	--	--
	08/15/18	1.84	6.61	15	<0.083	4.73	112	410	720	--	0.00105	0.0119	0.00118	0.00037	0.000257	0.0153	--	0.0175	<0.000005	--	0.0024	0.0002	2.6	--	--

Table 4-3
Groundwater Sampling Analytical Results (mg/L) - Landfill
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
AD-13	05/31/16	1.19	8.02	12	<1	6.05		177	900	<0.005	<0.005	0.062	<0.001	<0.001	<0.001	<0.005	<0.005	0.011	<0.000025	<0.005	<0.005	<0.002	1.22	--	--
	07/27/16	1.23	3.7	15	1	6.05		187	--	<0.005	<0.005	0.036	<0.001	<0.001	<0.001	<0.005	<0.005	0.026	<0.000025	<0.005	<0.005	<0.002	1.601	--	--
	09/29/16	1.37	2.7	17	1	4.56		207	431	<0.005	<0.005	0.04	<0.001	<0.001	<0.001	<0.005	<0.005	0.02	<0.000025	<0.005	<0.005	<0.002	2.213	--	--
	10/19/16	1.67	3.66	19	1	4.34		226	482	<0.005	<0.005	0.03	<0.001	<0.001	<0.001	<0.005	<0.005	0.022	<0.000025	<0.005	<0.005	<0.002	3.662	--	--
	12/05/16	--	--	--	--	--		--	532	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	12/13/16	1.96	3.77	18	1	4.79		287	596	<0.005	<0.005	0.051	0.001	<0.001	0.007	0.007	<0.005	0.025	<0.000025	<0.005	<0.005	<0.002	2.27	--	--
	01/19/17	0.402	33.5	7	<1	5.38		90	222	<0.005	0.006	0.112	<0.001	<0.001	0.004	<0.005	<0.005	0.004	<0.000025	<0.005	<0.005	<0.002	2.228	--	--
	02/23/17	1.27	10.3	13	<1	5.06		183	392	<0.005	<0.005	0.041	<0.001	<0.001	<0.001	<0.005	<0.005	0.015	<0.000025	<0.005	<0.005	<0.002	1.556	--	--
	06/06/17	1.68	3.03	15	0.6679	4.22	171	244	494	0.00153	<0.00105	0.01712	0.00089	0.00014	<0.00023	0.00624	<0.00068	0.02082	<0.000005	<0.00029	0.00103	<0.00086	1.565	--	--
	10/06/17	--	--	--	--	4.61	173	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	1.42	7.48	10	0.5362	4.20	1.4		532	<0.00093	<0.00105	0.0216	0.00088	0.00011	<0.00023	0.00809	<0.00068	0.02603	<0.000005	<0.00029	<0.00099	<0.00086	2.064	0.858	0.046
	Dissolved	*1.41*	*7.31*	--	--	4.20	1.4	--	--	*<0.00093*	*<0.00105*	*0.02097*	*0.0008*	*<0.00007*	*<0.00023*	*0.00784*	*<0.00068*	*0.02439*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.407*	0.712	0.045
	05/23/18	--	--	--	0.6534 J	*4.52*	*52.7*	--	--	<0.00093	<0.00105	0.02653	0.00087 J	<0.00007	0.00073 J	0.00937	<0.00068	0.0291	0.000008 J	<0.00029	<0.00099	<0.043	2.16	--	--
	08/14/18	1.49	10.1	18	0.7442	4.82	131	316	620	--	0.00137	0.0169	0.000971	0.00031	0.000503	0.0131	--	0.0321	<0.000005	--	0.0017	0.000277	4.0	--	--
AD-14	05/31/16	1.28	2.88	4	<1	4.75	--	115	285	<0.005	<0.005	0.031	<0.001	<0.001	<0.001	0.010	<0.005	0.012	0.00003	<0.005	<0.005	<0.002	0.87	--	--
	07/27/16	1.14	2.51	5	<1	4.75	--	111	267	<0.005	<0.005	0.084	<0.001	<0.001	0.001	0.009	<0.005	0.024	<0.000025	<0.005	<0.005	<0.002	1.487	--	--
	09/29/16	1.14	1.19	5	<1	4.17	--	111	252	<0.005	<0.005	0.03	<0.001	<0.001	<0.001	0.009	<0.005	0.015	<0.000025	<0.005	<0.005	<0.002	4.817	--	--
	10/19/16	1.25	2.48	4	<1	3.88	--	118	276	<0.005	<0.005	0.039	<0.001	0.001	<0.001	0.009	<0.005	0.014	<0.000025	<0.005	<0.005	<0.002	1.972	--	--
	12/12/16	1.25	2.41	5	<1	4.11	--	101	296	<0.005	<0.005	0.047	<0.001	0.001	0.001	0.009	<0.005	0.013	0.000037	<0.005	<0.005	<0.002	1.271	--	--
	01/17/17	0.915	10.3	4	<1	6.07	--	92	254	<0.005	<0.005	0.038	<0.001	<0.001	<0.001	<0.005	<0.005	0.013	<0.000025	<0.005	<0.005	<0.002	1.825	--	--
	02/22/17	1.06	9.48	4	<1	5.39	--	90	212	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	<0.005	<0.005	0.012	<0.000025	<0.005	<0.005	<0.002	0.512	--	--
	06/06/17	1.26	7.69	6	<0.083	4.77	167	108	256	<0.00093	<0.00105	0.04483	0.00038	0.00067	0.00127	0.00678	<0.00068	0.0127	0.000021	<0.00029	0.00261	<0.00086	1.138	--	--
	10/06/17	--	--	--	--	4.57	150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	1.61	4.67	11	<0.083	4.11	5.1	--	332	<0.00093	<0.00105	0.03161	0.00094	0.00204	<0.00023	0.01501	<0.00068	0.01638	0.000137	<0.00029	0.00221	<0.00086	1.097	0.09	0.008
	Dissolved	*1.56*	*4.55*	--	--	4.11	5.1	--	--	*<0.00093*	*<0.00105*	*0.02938*	*0.00094*	*0.00193*	*<0.00023*	*0.01476*	*<0.00068*	*0.01523*	*0.000149*	*<0.00029*	*0.00387*	*<0.00086*	*0.5903*	0.06	0.007
	05/23/18	--	--	--	<0.083	4.17	43.2	--	--	<0.00093	<0.00105	0.02817	0.00078 J	0.00161	<0.00023	0.01434	<0.00068	0.0152	0.000145	<0.00029	0.00362	<0.043	1.601	--	--
	08/14/18	1.51	4.51	12	<0.083	4.27	198	204	384	--	0.00039	0.024	0.000854	0.00199	0.000276	0.0176	--	0.011	0.000181	--	0.0037	0.000242	1.5	--	--
Supplemental Downgradient Monitoring Well																									
AD-10	5/16/2018	0.08311	15.5	40	<0.083	3.72	<100	--	280	<0.00093	0.0022	0.03855	0.00166	0.00033	<0.00023	0.02432	<0.00068	0.316	<0.000005	<0.00029	<0.00099	0.00098	1.704	0.338	0.25
	Dissolved	*0.07733*	*15.3*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.03712*	*0.00149*	*0.00009*	*<0.00023*	*0.02412*	*<0.00068*	*0.296*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.505*	0.282	0.251
Supplemental Sidegradient Monitoring Well																									
Temp-1	5/17/2018	0.662	26.2	34	<0.083	4.90	23.8	--	556	<0.00093	<0.00105	0.07752	0.00058	<0.00007	0.00102	0.01058	<0.00068	0.01075	<0.000005	<0.00029	<0.00099	<0.00086	1.277	1.94	0.203
	Dissolved	*0.621*	*24.6*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.06778*	*0.00042*	*<0.00007*	*<0.00023*	*0.00946*	*<0.00068*	*0.00986*	*<0.000005*	*<0.00029*	*<0.00099*	*0.00191*	*2.278*	0.813	0.192
Reference Values:																									
MCL					4					0.006	0.01	2	0.004	0.005	0.1				0.002		0.05	0.002	5^c		
Rule Specified																0.006	0.015	0.04		0.1					
Background Limit					1					0.005	0.005	0.36	0.00077	0.0065^b	0.004	0.075^b	0.005	0.39^b	0.000033	0.005	0.005	0.0013	4.21^c		
Interwell Background Value(s) (UPL, LPL where applicable) AD-8, AD-9, AD-15		0.652				4.81-6.99																			
Intrawell Background Value (UPL) AD-8			35.68	38.3	1.034			236	569																
Intrawell Background Value (UPL) AD-9			350	139.3	0.7259			2527	3147																
Intrawell Background Value (UPL) AD-15			5.71	38.42	1			35.6	388																

NOTES:
All concentration data are provided in milligrams per liter (mg/L) unless otherwise noted.
J = Analyte was positively identified, though the quantitation was below Reporting Limit.
MCL = Maximum contaminant level
LPL = Lower prediction limit
UPL = Upper prediction limit
pCi/L = PicoCuries per liter
-- - Not analyzed
a = Data taken from Geosyntec "Statistical Analysis Summary, Primary Bottom Ash Pond" dated January 8, 2019.
b = Calculated Upper Tolerance Limit is higher than MCL.
c = Data is "Combined Radium, Total".
▨ Denotes groundwater sample collected by ARCADIS using low-flow methods.
Unless otherwise noted, values shown are total (unfiltered) analyses.
Dissolved (0.45-micron lab filtered) parameter concentrations shown in italics.

Table 4-4
Groundwater Sampling Analytical Results (mg/L) - Bottom Ash Storage Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters																
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Background (Upgradient) Wells																										
AD-1	05/26/16	0.346	36.5	5	<1	5.93	--	42	252	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.010	0.000033	<0.005	<0.005	<0.002	1.18	--	--
	07/27/16	0.350	39.6	4	<1	5.93	--	36	239	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.019	<0.000025	<0.005	<0.005	<0.002	0.9952	--	--
	09/29/16	0.332	15	5	<1	5.37	--	35	173	<0.005	<0.005	0.141	<0.001	<0.001	0.005	<0.005	<0.005	0.014	<0.000025	<0.005	<0.005	<0.002	1.38	--	--
	10/19/16	0.398	19.1	4	<1	5.15	--	42	192	<0.005	<0.005	0.114	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	1.141	--	--
	12/12/16	0.394	8.74	4	<1	5.18	--	40	200	<0.005	<0.005	0.072	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	0.719	--	--
	01/17/17	0.656	129	4	<1	7.13	--	68	538	<0.005	<0.005	0.410	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.000025	<0.005	<0.005	<0.002	3.009	--	--
	02/23/17	0.700	147	9	<1	6.88	--	68	612	<0.005	<0.005	0.488	<0.001	<0.001	<0.001	<0.005	<0.005	0.001	<0.000025	<0.005	<0.005	<0.002	4.309	--	--
	06/07/17	0.449	15.1	4	<0.083	5.06	109	42	176	<0.00093	0.00114	0.09346	0.00037	<0.00007	0.00066	0.00077	<0.00068	0.00902	0.000007	<0.00029	0.0021	<0.00086	0.676	--	--
	10/06/17	--	--	--	--	5.25	97.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.352	12.1	3	<0.083	4.82	8.4	--	174	<0.00093	<0.00105	0.08823	0.00048	<0.00007	<0.00023	0.0008	<0.00068	0.00816	<0.000005	<0.00029	<0.00099	<0.00086	0.837	0.03	0.025
	Dissolved	*0.35*	*12*	--	--	4.82	8.4	--	--	*<0.00093*	*<0.00105*	*0.08582*	*0.00044*	*<0.00007*	*<0.00023*	*0.00083*	*<0.00068*	*0.00799*	*<0.000005*	*<0.00029*	*0.00197*	*<0.00086*	*0.531*	0.01	0.026
	05/24/18	0.345	10.2	4	<0.083	5.19	118	43	150	0.00317 J	<0.00105	0.0799	0.00039 J	<0.00007	<0.00023	0.00035 J	<0.00068	0.00814	0.000006 J	<0.00029	0.00138 J	<0.00086	1.983	--	--
	08/14/18	0.443	5.95	5	<0.083	5.18	102	44	160	0.00003 J	0.00021	0.063	0.000482	0.00002	0.00016	0.000797	0.000238	0.00708	0.000013 J	0.00021	0.0017	0.00003 J	1.10	--	--
AD-5	05/31/16	0.03	36.9	15	<1	6.38	--	123	337	<0.005	<0.005	0.057	<0.001	<0.001	<0.001	0.014	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	1.63	--	--
	07/28/16	0.04	44.7	16	<1	6.38	--	163	360	<0.005	<0.005	0.093	<0.001	<0.001	<0.001	0.015	<0.005	0.191	<0.000025	<0.005	<0.005	<0.002	4.75	--	--
	09/29/16	0.04	46.3	15	<1	5.29	--	190	416	<0.005	<0.005	0.087	<0.001	<0.001	<0.001	0.014	<0.005	0.186	<0.000025	<0.005	<0.005	<0.002	3.33	--	--
	10/20/16	0.05	50.7	14	<1	5.92	--	267	448	<0.005	<0.005	0.07	<0.001	<0.001	<0.001	0.009	<0.005	0.225	<0.000025	<0.005	<0.005	<0.002	2.319	--	--
	12/13/16	0.05	49.6	13	<1	6.29	--	233	484	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	0.013	<0.005	0.199	<0.000025	<0.005	<0.005	<0.002	2.182	--	--
	01/17/17	0.04	49.8	14	<1	6.27	--	234	438	<0.005	<0.005	0.047	<0.001	<0.001	<0.001	0.012	<0.005	0.239	<0.000025	<0.005	<0.005	<0.002	1.023	--	--
	02/23/17	0.04	33.0	15	<1	5.48	--	127	286	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	0.013	<0.005	0.166	<0.000025	<0.005	<0.005	<0.002	1.788	--	--
	06/07/17	0.05281	49.7	14	<0.083	5.96	867	82	300	<0.00093	0.00385	0.0877	0.00008	0.00039	0.00028	0.01193	<0.00068	0.124	<0.000005	<0.00029	<0.00099	<0.00086	2.32	--	--
	10/06/17	--	--	--	--	5.59	249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.05063	30.1	21	<0.083	5.79	<100	--	248	<0.00093	<0.00105	0.07627	0.00014	0.00037	<0.00023	0.01907	<0.00068	0.118	<0.000005	<0.00029	<0.00099	<0.00086	1.495	14.4	0.45
	Dissolved	*0.03752*	*29.1*	--	--	5.79	<100	--	--	*<0.00093*	*<0.00105*	*0.06865*	*<0.00002*	*<0.00007*	*<0.00023*	*0.01747*	*<0.00068*	*0.119*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.043*	*2.051*	8.38	0.43
	05/24/18	0.05007	28.1	22	<0.083	6.22	17.8	60	242	<0.00093	<0.00105	0.07116	<0.00002	0.00023 J	0.0008 J	0.01424	<0.00068	0.121	<0.000005	<0.00029	<0.00099	<0.00086	1.946	--	--
	08/15/18	0.05	40.5	19	<0.083	6.23	57.1	240	428	0.00001 J	0.00169	0.0637	0.000055	0.000008 J	0.000072	0.0114	0.000079	0.147	<0.000005	0.00013	0.00008 J	<0.01	0.316	--	--
AD-17	05/26/16	0.121	200	43	<1	7.17	--	1,166	1,810	<0.005	<0.005	0.021	<0.001	0.002	0.001	0.063	<0.005	0.370	0.000032	<0.005	<0.005	<0.002	1.53	--	--
	07/27/16	0.119	195	32	<1	7.17	--	1,005	1,576	<0.005	<0.005	0.020	<0.001	0.004	0.001	0.068	<0.005	0.374	<0.000025	<0.005	<0.005	<0.002	2.78	--	--
	09/29/16	0.111	191	36	<1	6.17	--	1,055	1,663	<0.005	<0.005	0.031	<0.001	<0.001	0.003	0.058	<0.005	0.354	<0.000025	<0.005	<0.005	<0.002	2.358	--	--
	10/20/16	0.124	194	32	1.0	6.14	--	1,163	1,612	<0.005	<0.005	0.034	<0.001	0.002	0.004	0.065	<0.005	0.394	<0.000025	<0.005	<0.005	<0.002	2.224	--	--
	12/13/16	0.135	196	31	<1	6.03	--	1,096	1,560	<0.005	<0.005	0.017	<0.001	0.003	<0.001	0.068	<0.005	0.323	<0.000025	<0.005	<0.005	<0.002	2.384	--	--
	01/17/17	0.101	196	33	<1	5.96	--	1,445	1,686	<0.005	<0.005	0.014	<0.001	0.003	0.068	0.068	<0.005	0.341	<0.000025	<0.005	<0.005	<0.002	2.436	--	--
	02/22/17	0.135	189	30	<1	5.67	--	1,055	1,628	<0.005	<0.005	0.020	<0.001	0.002	0.001	0.073	<0.005	0.331	<0.000025	<0.005	<0.005	<0.002	2.288	--	--
	06/06/17	0.121	188	30	<0.083	5.81	156	1,105	1,578	<0.00093	<0.00105	0.01033	<0.00002	0.00606	<0.00023	0.0748	<0.00068	0.329	0.000013	<0.00029	<0.00099	<0.00086	1.598	--	--
	10/05/17	--	--	--	--	5.92	598	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.247	213	45	<0.083	5.51	<100	--	1,846	<0.00093	<0.00105	0.00978	<0.00002	0.00915	<0.00023	0.07451	<0.00068	0.306	<0.000005	<0.00029	0.00414	<0.00086	1.514	260	3.72
	Dissolved	*0.231*	*205*	--	--	5.51	<100	--	--	*<0.00093*	*<0.00105*	*0.00737*	*<0.00002*	*0.00609*	*<0.00023*	*0.07938*	*<0.00068*	*0.301*	*<0.000005*	*<0.00029*	*0.00515*	*0.02*	*1.57*	241	3.56
	05/24/18	0.239	193	39	<0.083	6.28	7.8	1,067	1,836	<0.00093	<0.00105	0.00965	<0.00002	0.00646	<0.00023	0.07173	<0.00068	0.308	<0.000005	<0.00029	<0.00099	<0.00086	1.939	--	--
	08/15/18	0.118	187	40	<0.083	5.6	418	1,170	1,750	0.00002 J	0.00183	0.0128	0.000069	0.00025	0.000604	0.0435	0.0011	0.243	0.000011 J	0.00035	0.0003	0.000074	2.35	--	--
AD-18	05/26/16	0.146	409	422	<1	5.1	--	5,135	10,000	<0.005	<0.005	0.012	0.014	0.003	<0.001	0.922	<0.005	2.07	0.000168	<0.005	0.006	0.003	12.58	--	--
	07/27/16	0.148	457	432	2	5.1	--	4,930	9,476	<0.005	<0.005	0.019	0.005	0.002	<0.001	0.734	<0.005	1.94	0.000091	<0.005	0.007	0.003	10.62	--	--
	09/29/16	0.156	469	637	4	5.59	--	4,632	9,569	<0.005	<0.005	0.02	0.004	<0.001	<0.001	0.666	<0.005	1.86	0.000117	<0.005	0.007	<0.002	7.05	--	--
	10/20/16	0.188	498	876	0.8664	5.7	--	5,537	9,540	<0.005	<0.005	0.021	0.002	0.001	<0.001	0.569	<0.005	2.06	0.000053	<0.005	<0.005	<0.002	5.82	--	--
	12/13/16	0.178	510	695	5	5.75	--	4,382	8,912	<0.005	<0.005	0.021	0.007	0.001	<0.001	0.641	<0.005	1.74	0.00005	<0.005	<0.005	<0.002	9.60	--	--
	01/17/17	0.050	412	159	5	4.49	--	5,414	8,562	<0.005	0.01	0.014	0.022	0.001	<0.001	0.929	<0.005	1.95	0.000224	<0.005	<0.005	0.002	22.51	--	--
	02/22/17	0.090	401	151	6	4.37	--	5,169	8,412	<0.005	<0.005	0.014	0.026	0.002	<0.001	0.961	<0.005	1.82	0.000107	<0.005	<0.005	0.00228	19.11	--	--
	06/06/17	0.125	428	304	6.53	4.27	121	5,920	9,394	<0.00093	0.00331	0.01038	0.01883	0.00303	<0.00023	0.940	<0.00068	2.15	0.000113	<0.00029	0.00212	<0.00086	16.12	--	--
	10/05/17	--	--	--	--	5.87	165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.163	433	362	9.4	3.61	104.1	--	9,952	0.00224	0.00276	0.00813	0.01733	0.0036	0.00098	0.928	<0.00068	2.07	0.000043	<0.00029	0.00194	0.00144	19.95	19.7	14.1
	Dissolved	*0.153*	*423*	--	--	--	--	--	--	*0.00467*	*0.00189*	*0.00748*	*0.01676*	*0.00316*	*<0.00023*	*0.898*	*<0.00068*	*2.06*	*0.000012*	*<0.00029*	*0.00135*	*0.01466*	*18.09*	19.1	13.7

Table 4-4
Groundwater Sampling Analytical Results (mg/L) - Bottom Ash Storage Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

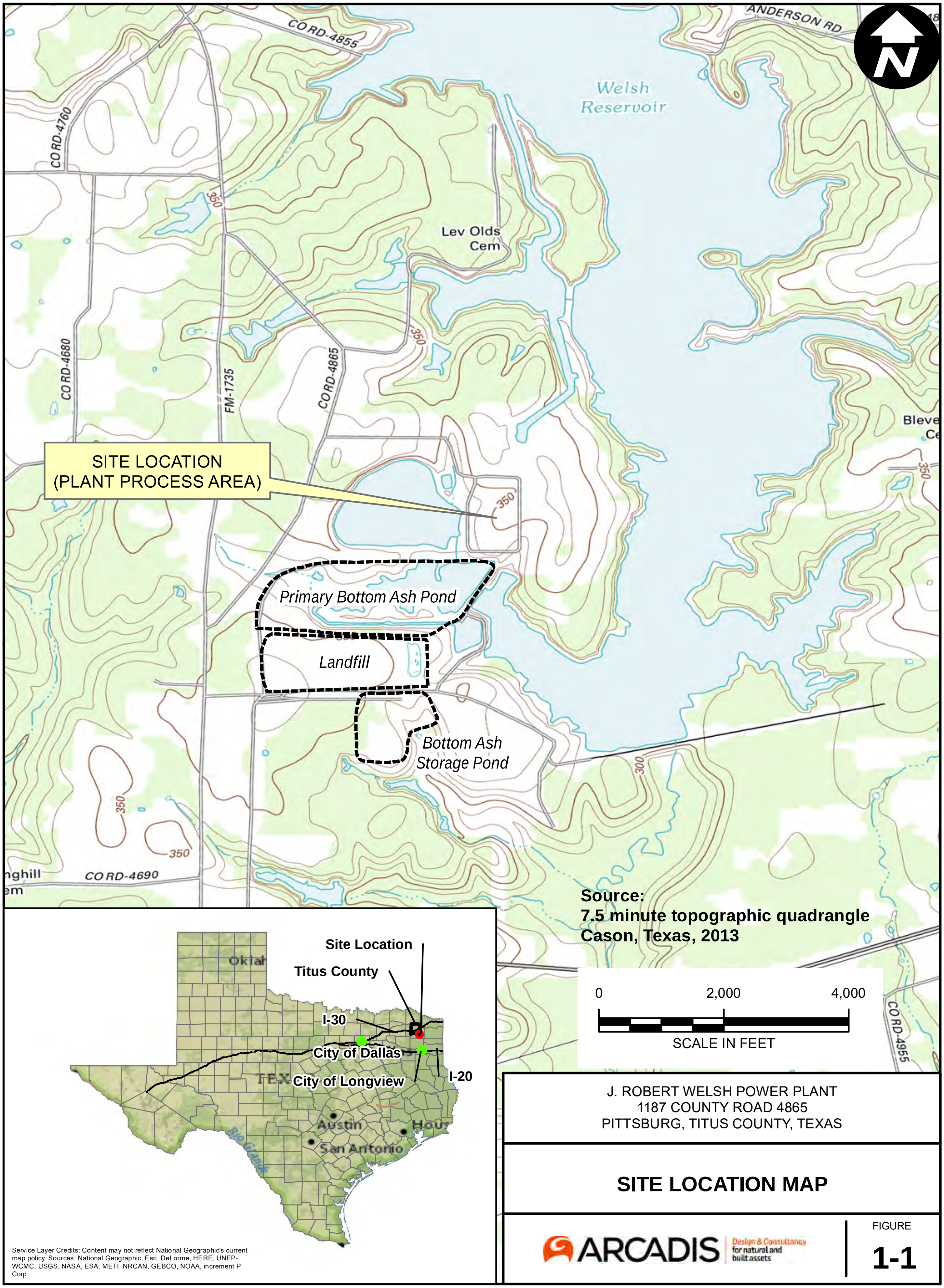
Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Point of Compliance Wells																									
AD-3	05/31/16	0.02	1.41	9	<1	6.58	--	4	106	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	<0.005	<0.005	0.010	0.00085	<0.005	<0.005	<0.002	1.02	--	--
	07/27/16	0.02	0.706	8	<1	6.58	--	5	118	<0.005	<0.005	0.036	<0.001	<0.001	<0.001	<0.005	<0.005	0.024	0.000589	<0.005	<0.005	<0.002	0.1786	--	--
	09/30/16	0.02	<0.5	9	<1	4.75	--	6	127	<0.005	<0.005	0.043	<0.001	<0.001	<0.001	<0.005	<0.005	0.019	0.00039	<0.005	<0.005	<0.002	0.552	--	--
	10/19/16	0.06	0.794	8	<1	3.71	--	9	112	<0.005	<0.005	0.041	<0.001	<0.001	<0.001	<0.005	<0.005	0.018	0.000351	0.006	<0.005	<0.002	1.589	--	--
	12/12/16	0.02	1.05	8	<1	4.67	--	11	138	<0.005	<0.005	0.045	<0.001	<0.001	<0.001	<0.005	<0.005	0.017	0.000321	<0.005	<0.005	<0.002	0.546	--	--
	01/19/17	0.02	0.746	9	<1	4.60	--	4	76	<0.005	<0.005	0.041	<0.001	<0.001	<0.001	<0.005	<0.005	0.014	0.000504	<0.005	<0.005	<0.002	0.229	--	--
	02/23/17	0.02	0.573	9	<1	4.69	--	5	104	<0.005	<0.005	0.037	<0.001	<0.001	<0.001	<0.005	<0.005	0.014	0.000501	<0.005	<0.005	<0.002	0.4592	--	--
	06/07/17	0.03326	0.543	9	0.2625	4.49	56.6	5	104	<0.00093	0.00191	0.038	0.00024	0.00008	0.00075	0.00128	<0.00068	0.01503	0.000365	<0.00029	<0.00099	<0.00086	0.459	--	--
	10/06/17	--	--	--	--	5.15	65.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/15/18	0.01869	0.56	9	<0.083	4.31	11.1		132	0.00166	0.0016	0.0365	0.00034	0.00008	<0.00023	0.00136	<0.00068	0.01459	0.00037	<0.00029	0.00323	0.00127	0.016	0.188	0.004
	Dissolved	*0.01132*	*0.595*	--	--	4.31	11.1	--	--	*<0.00093*	*<0.00105*	*0.0361*	*0.00023*	*<0.00007*	*<0.00023*	*0.00133*	*<0.00068*	*0.01445*	*0.000379*	*<0.00029*	*<0.00099*	*<0.00086*	*0.242*	< 0.01	0.004
	05/24/18	0.0069 J	0.545	8	<0.083	4.58	8.50	3	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AD-4c	05/31/16	0.05	0.798	10	<1	5.41	--	32	204	<0.005	<0.005	0.088	<0.001	<0.001	0.009	<0.005	<0.005	0.004	0.000191	<0.005	<0.005	<0.002	1.29	--	--
	07/27/16	0.03	0.666	12	<1	5.41	--	35	208	<0.005	<0.005	0.059	<0.001	<0.001	0.004	<0.005	<0.005	0.015	0.000185	<0.005	<0.005	<0.002	0.5075	--	--
	09/29/16	0.02	<0.5	11	<1	4.96	--	45	212	<0.005	<0.005	0.074	<0.001	<0.001	0.008	<0.005	<0.005	0.006	0.00016	<0.005	<0.005	<0.002	2.572	--	--
	10/19/16	0.04	0.578	10	<1	4.30	--	35	212	<0.005	<0.005	0.069	<0.001	<0.001	0.009	<0.005	<0.005	0.006	0.000141	<0.005	<0.005	<0.002	1.657	--	--
	12/12/16	0.02	0.341	11	<1	4.62	--	36	252	<0.005	<0.005	0.021	<0.001	<0.001	<0.001	<0.005	<0.005	0.004	0.000143	<0.005	<0.005	<0.002	0.685	--	--
	01/19/17	0.02	0.761	10	<1	4.67	--	43	184	<0.005	<0.005	0.075	<0.001	<0.001	0.004	<0.005	<0.005	0.005	0.000125	<0.005	<0.005	<0.002	2.045	--	--
	02/23/17	0.02	0.467	9	<1	5.10	--	40	196	<0.005	<0.005	0.030	<0.001	<0.001	<0.001	<0.005	<0.005	0.004	0.000098	<0.005	<0.005	<0.002	0.517	--	--
	06/07/17	0.03331	0.573	10	<0.083	4.88	351	39	228	<0.00093	0.00119	0.05142	0.00019	0.00008	0.00403	0.00075	<0.00068	0.00482	0.000147	<0.00029	<0.00099	<0.00086	0.953	--	--
	10/06/17	--	--	--	--	5.38	308	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	0.0186	0.498	14	<0.083	4.67	6.40		232	<0.00093	<0.00105	0.02572	0.0001	<0.00007	0.00044	0.00049	<0.00068	0.00394	0.000228	<0.00029	<0.00099	<0.00086	0.435	0.592	< 0.001
	Dissolved	*0.02017*	*0.468*	--	--	4.67	6.40	--	--	*<0.00093*	*<0.00105*	*0.02223*	*0.00006*	*<0.00007*	*<0.00023*	*0.00043*	*<0.00068*	*0.0039*	*0.000031*	*<0.00029*	*<0.00099*	*<0.00086*	*0.354*	0.394	0.002
	05/24/18	0.02505	0.434	14	<0.083	*5.17*	*48.1*	42	224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	08/14/18	--	--	15	--	--	125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AD-16	01/26/16	0.05	2.81	6	<1	3.84	--	49	180	<0.005	0.02	0.198	0.002	<0.001	0.054	0.013	0.016	0.015	0.000259	<0.005	<0.005	<0.002	4.478	--	--
	03/21/16	0.04	2.04	6	<1	4.20	--	47	104	<0.005	<0.005	0.119	<0.001	<0.001	0.009	<0.005	<0.005	0.007	0.000114	<0.005	<0.005	<0.002	4.44	--	--
	05/31/16	0.03	1.55	6	<1	4.44	--	40	96	<0.005	<0.005	0.127	<0.001	<0.001	0.001	<0.005	<0.005	0.002	0.000037	<0.005	<0.005	<0.002	5.99	--	--
	07/27/16	0.04	3.42	7	<1	4.44	--	70	184	<0.005	0.01	0.123	0.002	<0.001	0.011	0.022	<0.005	0.035	0.000212	<0.005	<0.005	<0.002	7.21	--	--
AD-16R	06/06/17	0.04198	2.75	7	0.3438	3.68	46.9	54	204	<0.00093	0.00707	0.0464	0.00221	0.00103	0.00176	0.04174	<0.00068	0.0293	<0.000005	<0.00029	0.00198	<0.00086	6.66	--	--
	06/28/17	0.06398	1.24	6	0.2512	3.91	--	55	200	<0.00093	0.00528	0.04143	0.00216	0.00092	0.00095	0.04087	<0.00068	0.02932	<0.000005	<0.00029	<0.00099	<0.00086	12.11	--	--
	07/28/17	0.02841	1.92	7	<0.083	2.77	--	48	162	<0.00093	0.0037	0.04851	0.00217	0.00128	0.00107	0.04533	<0.00068	0.02617	0.000006	<0.00029	0.00127	0.00143	8.52	--	--
	08/02/17	0.03177	1.86	7	<0.083	3.00	--	49	174	<0.00093	0.00446	0.04961	0.00206	0.00122	0.00095	0.04311	<0.00068	0.02498	<0.000005	<0.00029	0.00174	0.00202	5.45	--	--
	10/06/17	--	--	--	--	3.29	31.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/15/18	0.04030	2.73	6	<0.083	3.18	0.0		212	0.00269	0.0074	0.04301	0.00278	0.00129	0.0007	0.04123	<0.00068	0.02977	<0.000005	0.00103	<0.00099	<0.00086	5.89	1.47	0.053
	Dissolved	*0.02614*	*2.59*	--	--	3.18	0.0	--	--	*<0.00093*	*0.00294*	*0.04155*	*0.0022*	*0.00071*	*0.00025*	*0.03996*	*<0.00068*	*0.0278*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*5.90*	0.599	0.05
	05/23/18	0.03202	2.53	6	<0.083	*3.79*	*36.9*	67	204	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	08/14/18	--	--	--	--	--	142	44	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Supplemental Downgradient Monitoring Wells																									
AD-19	5/17/2018	0.07234	9.4	34	<0.083	5.72	42.1	--	372	<0.00093	<0.00105	0.05026	0.00073	<0.00007	0.00117	0.0111	<0.00068	0.02924	<0.000005	0.00078	0.00194	<0.00086	1.421	3.04	0.089
	Dissolved	*0.06293*	*8.76*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.04*	*0.00025*	*<0.00007*	*<0.00023*	*0.00965*	*<0.00068*	*0.02842*	*<0.000005*	*0.00041*	*<0.00099*	*0.012*	*2.577*	2.13	0.08
AD-20	10/31/18	0.029	3.14	18.4	0.09	4.88	13	12.5	140	0.00004	0.00185	0.205	0.000651	0.00114	0.000514	0.0161	0.000425	0.0126	<0.00005	<0.0004	0.0008	0.0003	4.16	1.11	0.0742
AD-21	10/30/18	0.025	5.0	17	0.23	5.04	0.0	27.4	180	0.00006	0.00124	0.0868	0.00181	0.00065	0.000263	0.0337	0.000148	0.034	<0.00005	<0.0004	0.0011	0.0002	3.76	3.13	0.154

Table 4-4
Groundwater Sampling Analytical Results (mg/L) - Bottom Ash Storage Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Reference Values:																									
MCL					4					0.006	0.01	2	0.004	0.005	0.1				0.002	N/A	0.05	0.002	5[b]		
Rule Specified																0.006	0.015	0.04		0.1					
Background Limit					1					0.005	0.005	0.36	0.00077	0.0065[a]	0.004	0.075[a]	0.005	0.39[a]	0.000033	0.005	0.005	0.0013	4.21[b]		
Interwell Background Value(s) (UPL, LPL where applicable) AD-8, AD-9, AD-15		0.652				4.81-6.99																			
Intrawell Background Value (UPL) AD-8			35.68	38.3	1.034			236	569																
Intrawell Background Value (UPL) AD-9			350	139.3	0.7259			2527	3147																
Intrawell Background Value (UPL) AD-15			5.71	38.42	1			35.6	388																

NOTES:
All concentration data are provided in milligrams per liter (mg/L) unless otherwise noted.
J = Analyte was positively identified, though the quantitation was below Reporting Limit.
MCL = Maximum contaminant level
LPL = Lower prediction limit
UPL = Upper prediction limit
pCi/L = PicoCuries per liter.
-- = Not analyzed.
a = Calculated Upper Tolerance Limit is higher than MCL.
b = Data is "Combined Radium, Total".
▨ Denotes groundwater sample collected by ARCADIS using low-flow sampling methods.
Unless otherwise noted, values shown are total (unfiltered) analyses.
Dissolved (0.45-micron lab filtered) parameter concentrations shown in italics.

FIGURES



Source:
7.5 minute topographic quadrangle
Cason, Texas, 2013

Service Layer Credits: Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

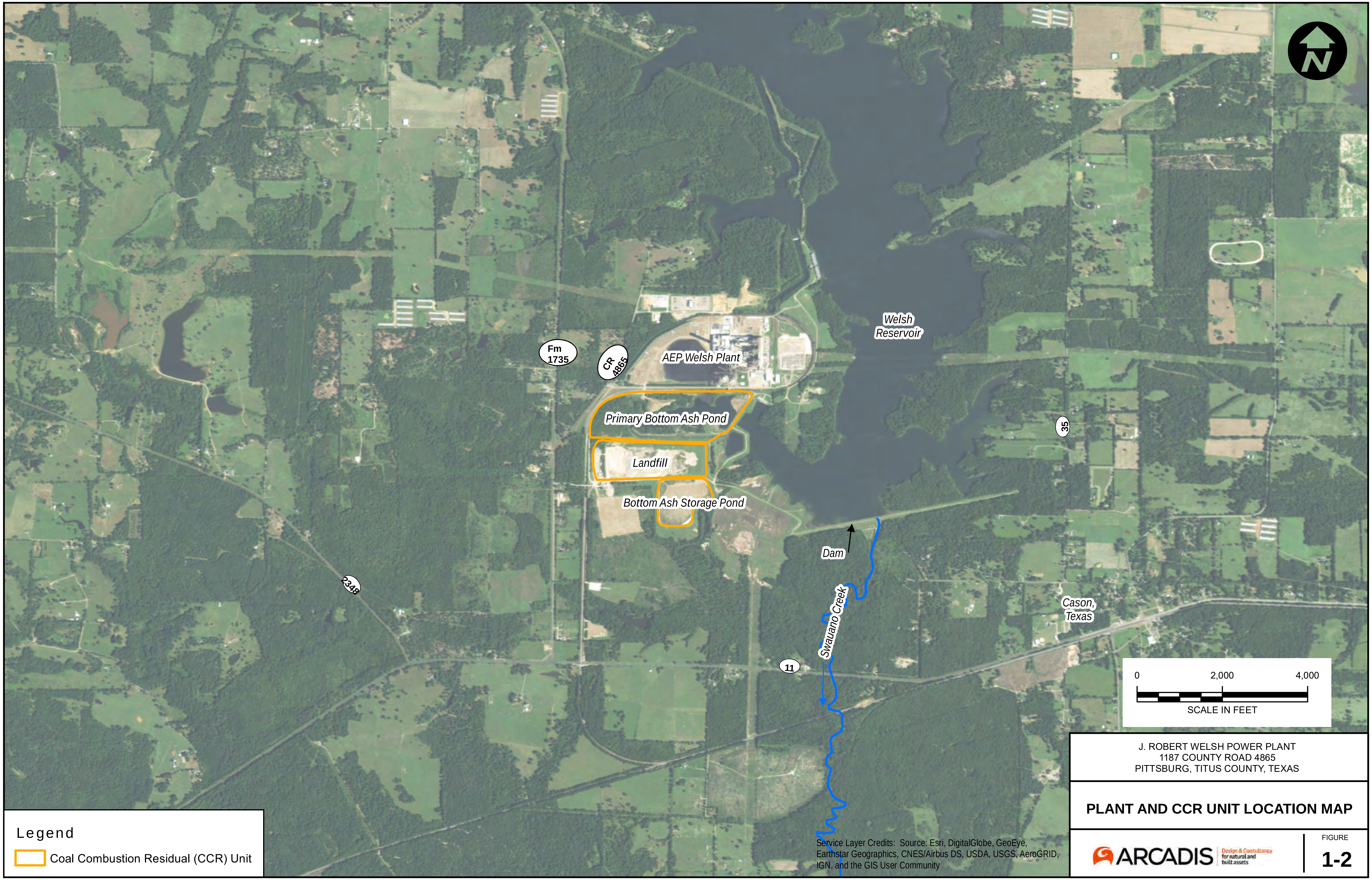
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-1

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\Dec2017Update\fig 1 - site map.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

▭ Coal Combustion Residual (CCR) Unit

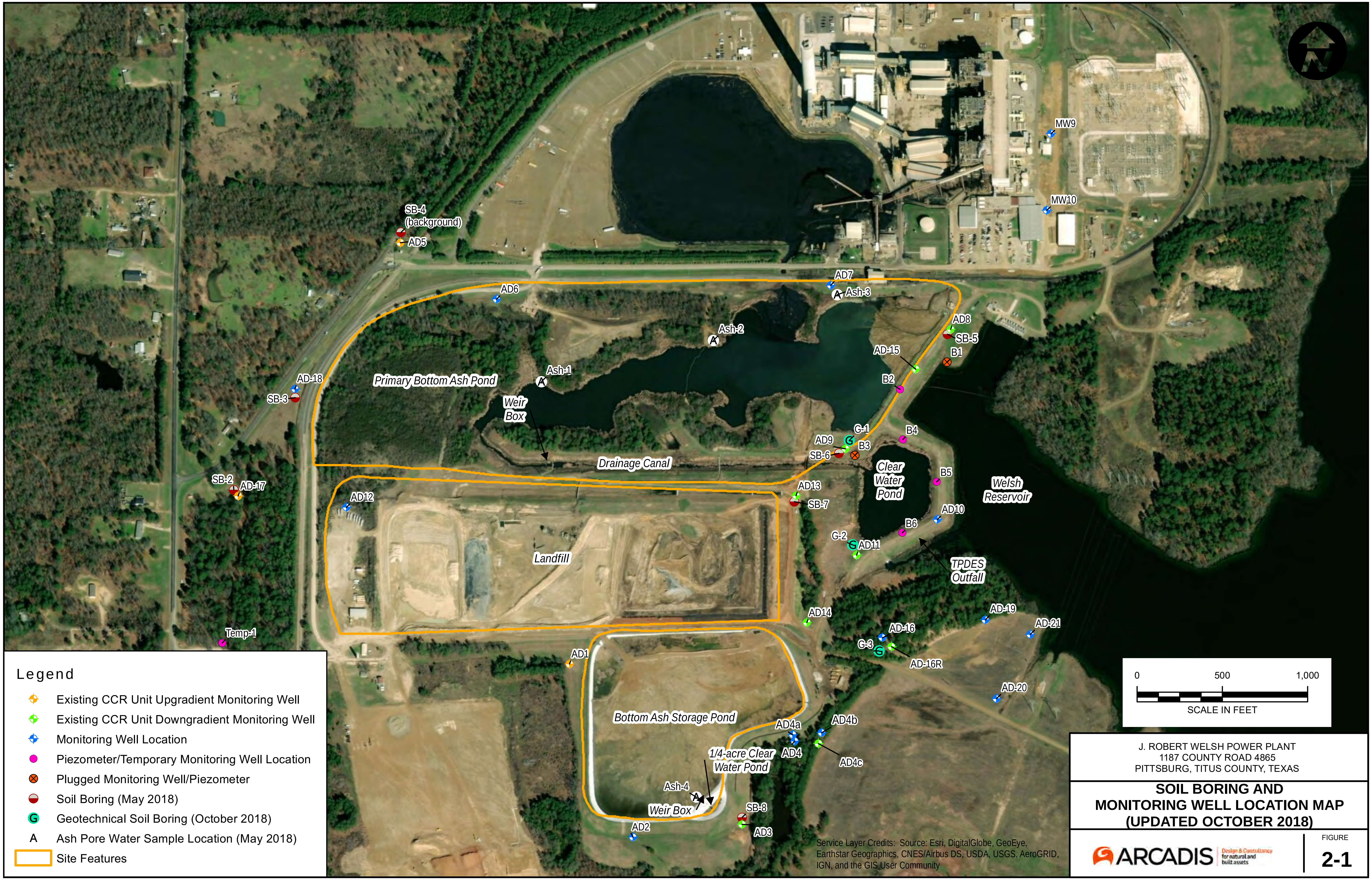
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-2

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\Dec2017Update\fig 1-2 - CCR location.mxd



Legend

- 🔶 Existing CCR Unit Upgradient Monitoring Well
- 🟢 Existing CCR Unit Downgradient Monitoring Well
- 🔷 Monitoring Well Location
- ● Piezometer/Temporary Monitoring Well Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◒ Soil Boring (May 2018)
- G Geotechnical Soil Boring (October 2018)
- A Ash Pore Water Sample Location (May 2018)
- ▭ Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

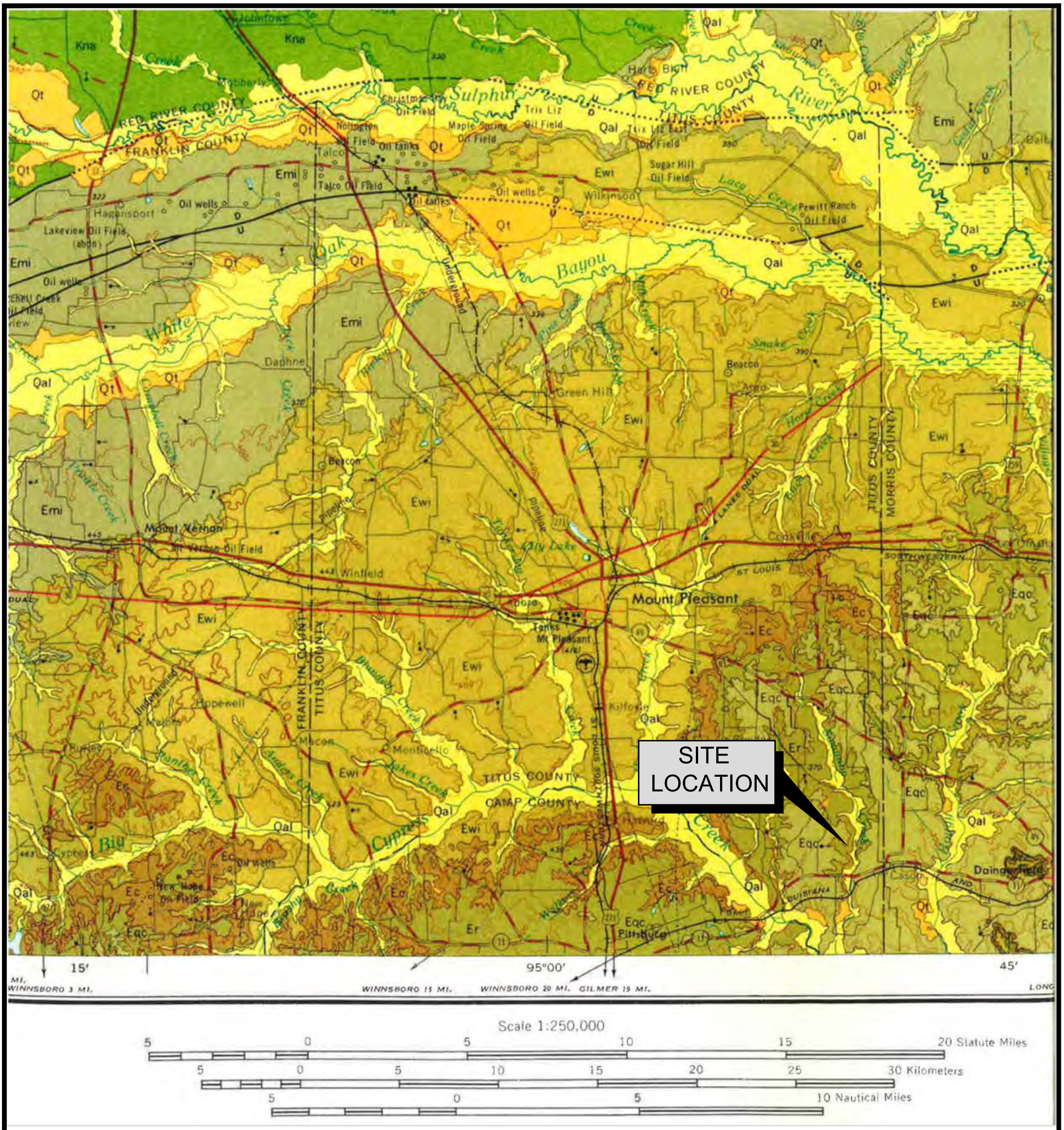
SOIL BORING AND MONITORING WELL LOCATION MAP (UPDATED OCTOBER 2018)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-1

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\November2018\Fig2-1-SoilBoring_MonitoringWellLocations.mxd

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0005 - Welsh Lithium ASD\Figures-Maps\Figure 2-1 Regional Geo Map.dwg LAYOUT: MODEL SAVED: 11/7/2018 1:36 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/28/2019 4:04 PM BY: LEASE, DIANA



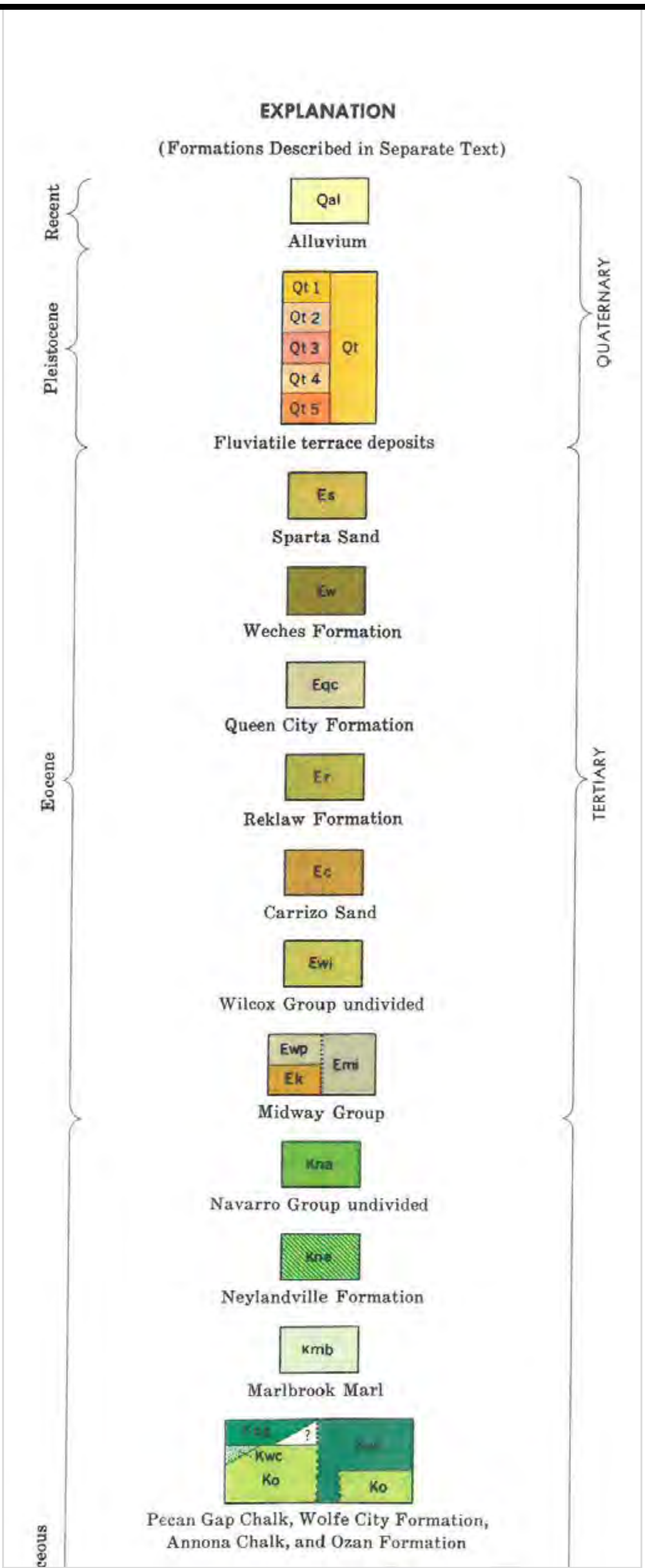
N

J. ROBERT WELSH POWER PLANT
PITTSBURG, TITUS COUNTY, TEXAS

REGIONAL GEOLOGIC MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-2A

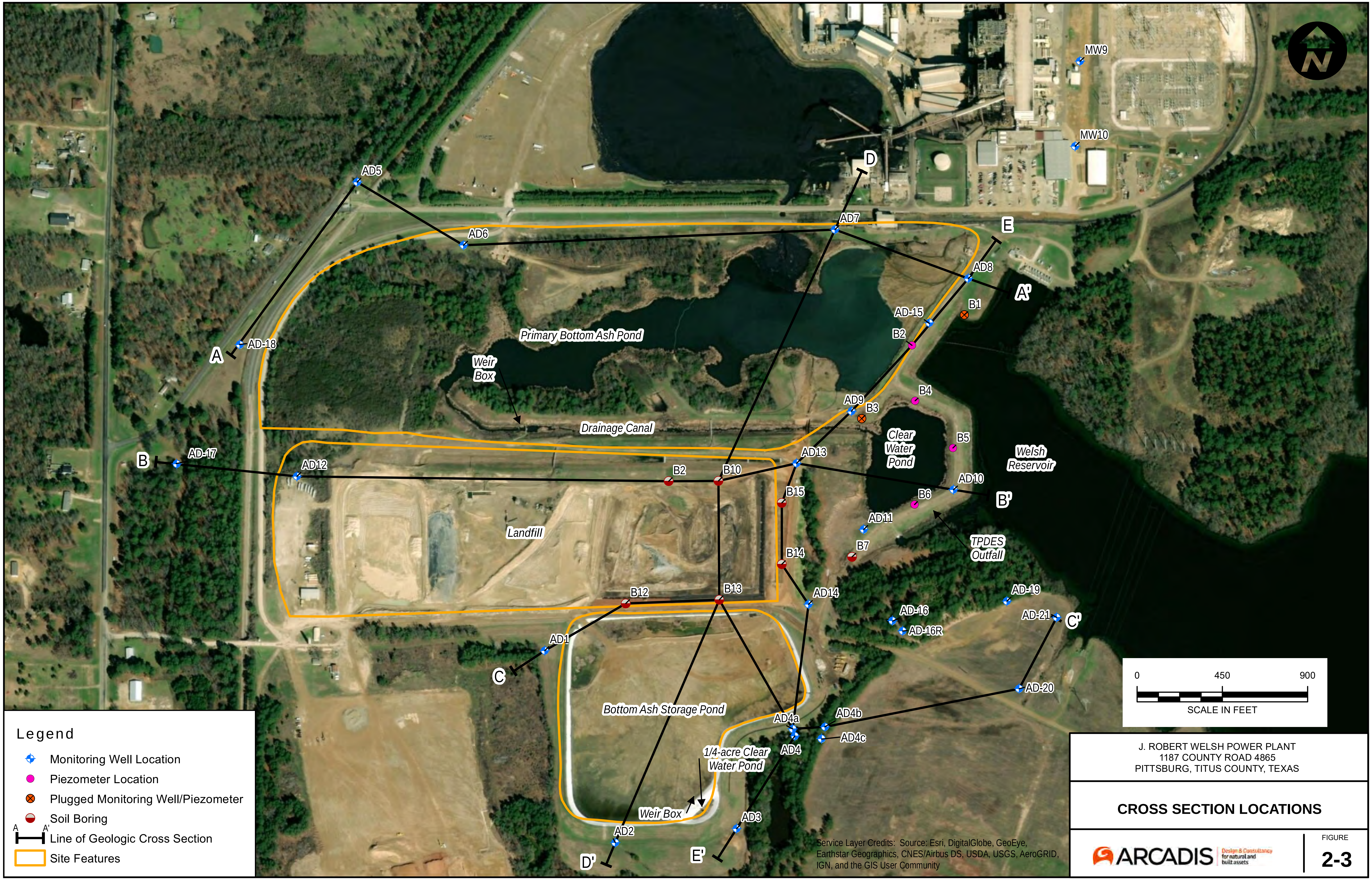


J. ROBERT WELSH POWER PLANT
PITTSBURG, TITUS COUNTY, TEXAS

REGIONAL
GEOLOGIC LEGEND

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-2B



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- ✦ Monitoring Well Location
- ● Piezometer Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- A ├─┤ A' Line of Geologic Cross Section
- ▭ Site Features

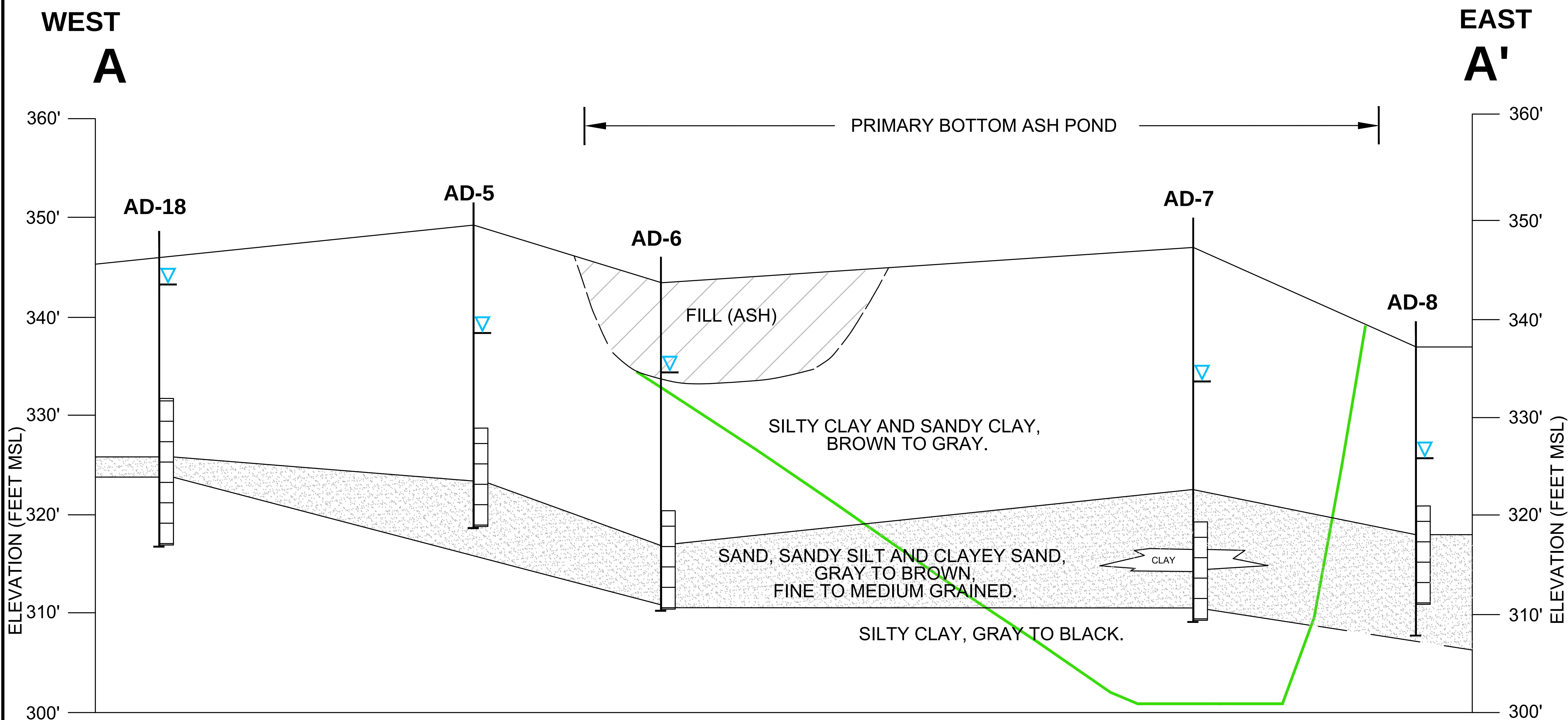
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-3

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Lithium_ASD_Report\Fig2-3-Cross Section LocationsREV.mxd



0 300'
HORIZONTAL SCALE

NOTE: BASE OF ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

▯ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (3/4/16)

— PROJECTED BASE OF ASH POND (SEE NOTE)

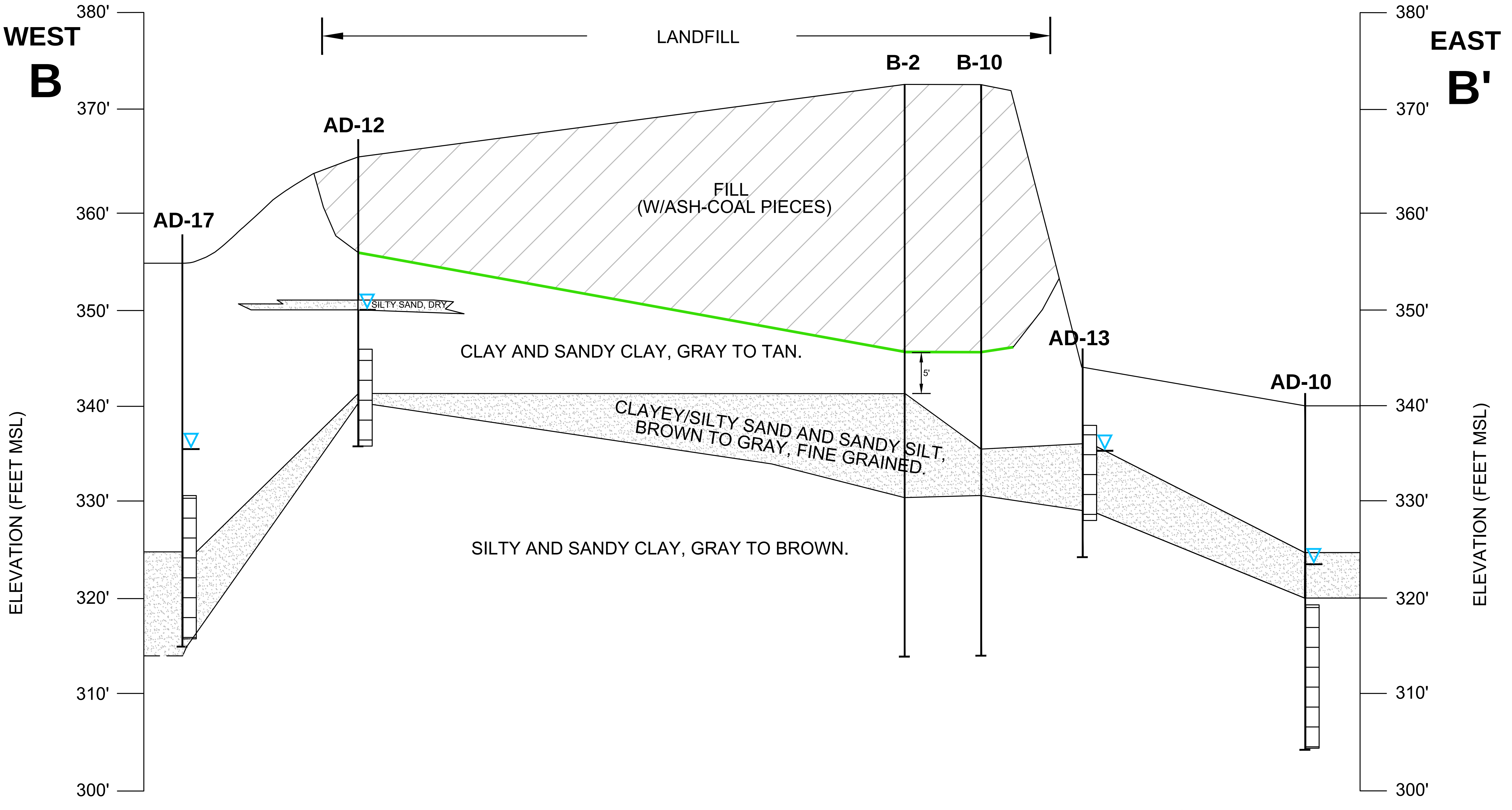
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0005 - Welsh Lithium ASD\Figures-Maps\Figure 2-2 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 1/28/2019 1:30 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/28/2019 3:24 PM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

NOTE: BASE OF LANDFILL ELEVATION TAKEN FROM "WELSH POWER PLANT- UNIT 1 FLY ASH STORAGE AREA PHASE I" DRAWING ID WEPX-88, DATED 12/3/76.

LEGEND

☷	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
🟩	BASE OF LANDFILL (SEE NOTE)

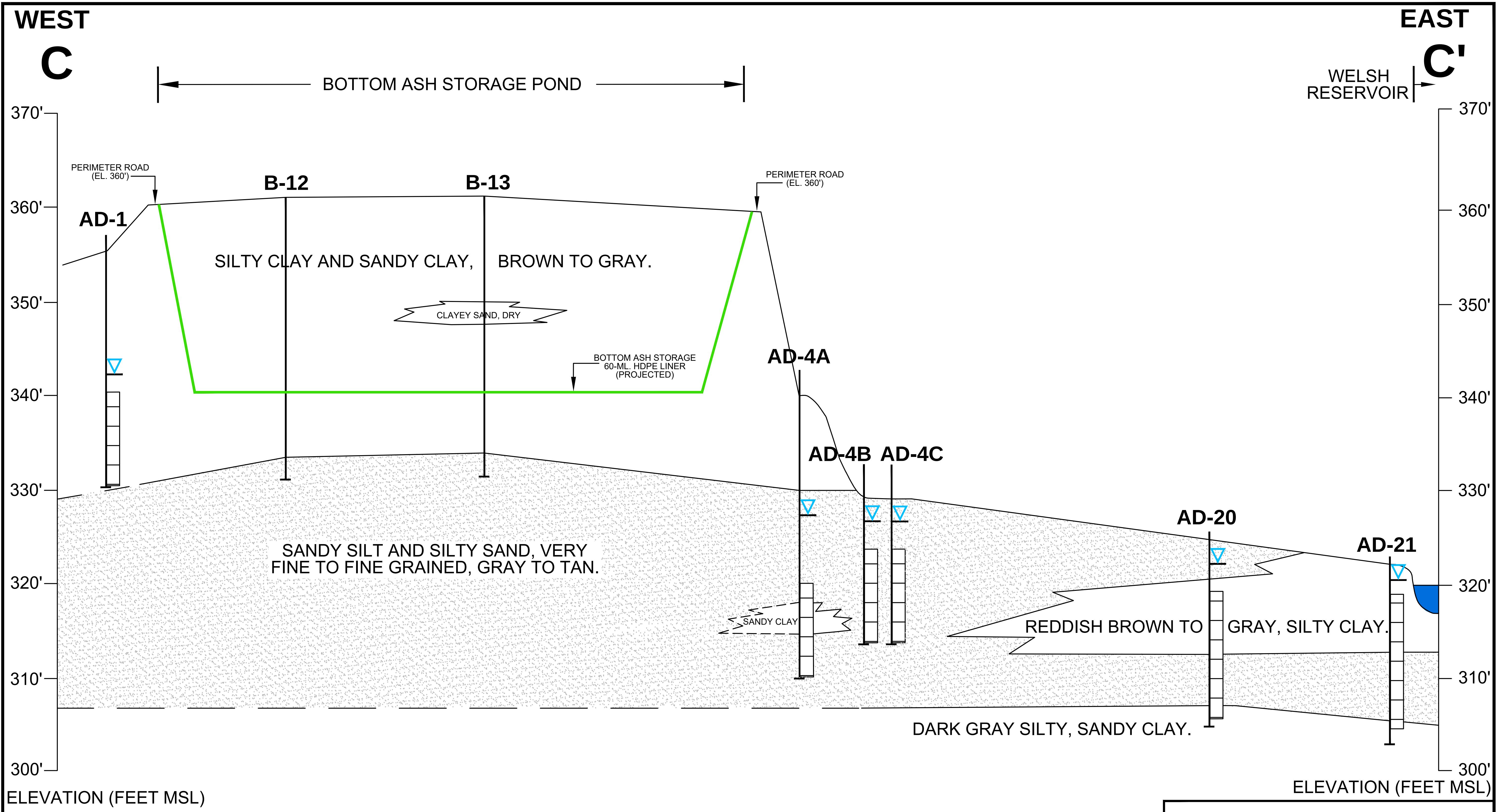
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0005 - Welsh Lithium ASD\Figures-Maps\Figure 2-3 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 3/11/2016 12:34 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/28/2019 3:30 PM BY: LEASE, DIANA



0 200'

HORIZONTAL SCALE

NOTE: BASE OF BOTTOM ASH STORAGE HAS A 60-ML. HDPE LINER AT ELEVATION 340.0' , TAKEN FROM FREESE AND NICHOLS "HYDRAULIC ANALYSIS OF WELSH POWER PLANT ASH PONDS, AMERICAN ELECTRIC POWER COMPANY", DATED DECEMBER 2010.

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (10/29/18)
🟩	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

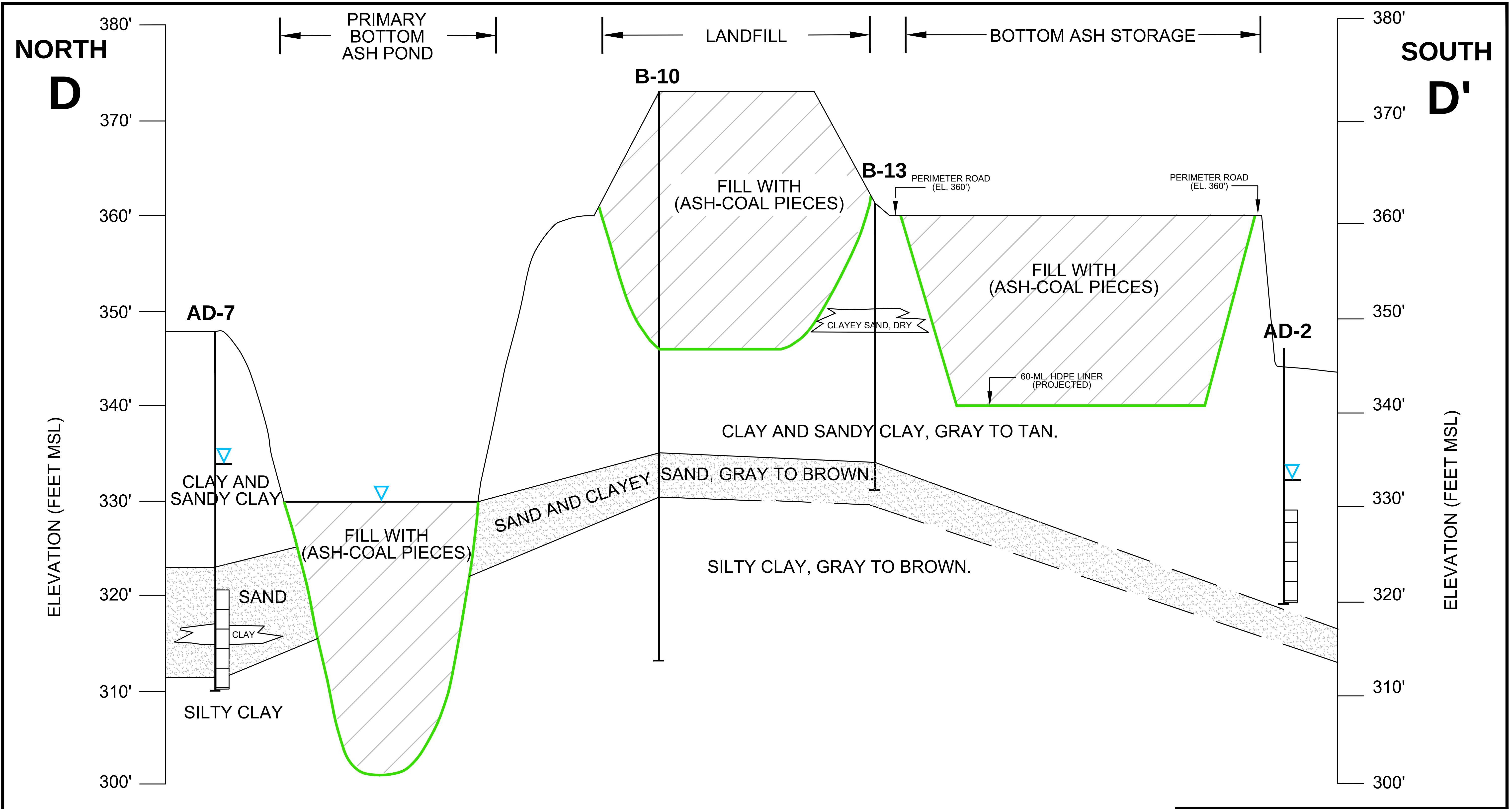
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0005 - Welsh Lithium ASD\Figures-Maps\Figure 2-4 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 11/13/2018 3:29 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/28/2019 3:35 PM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

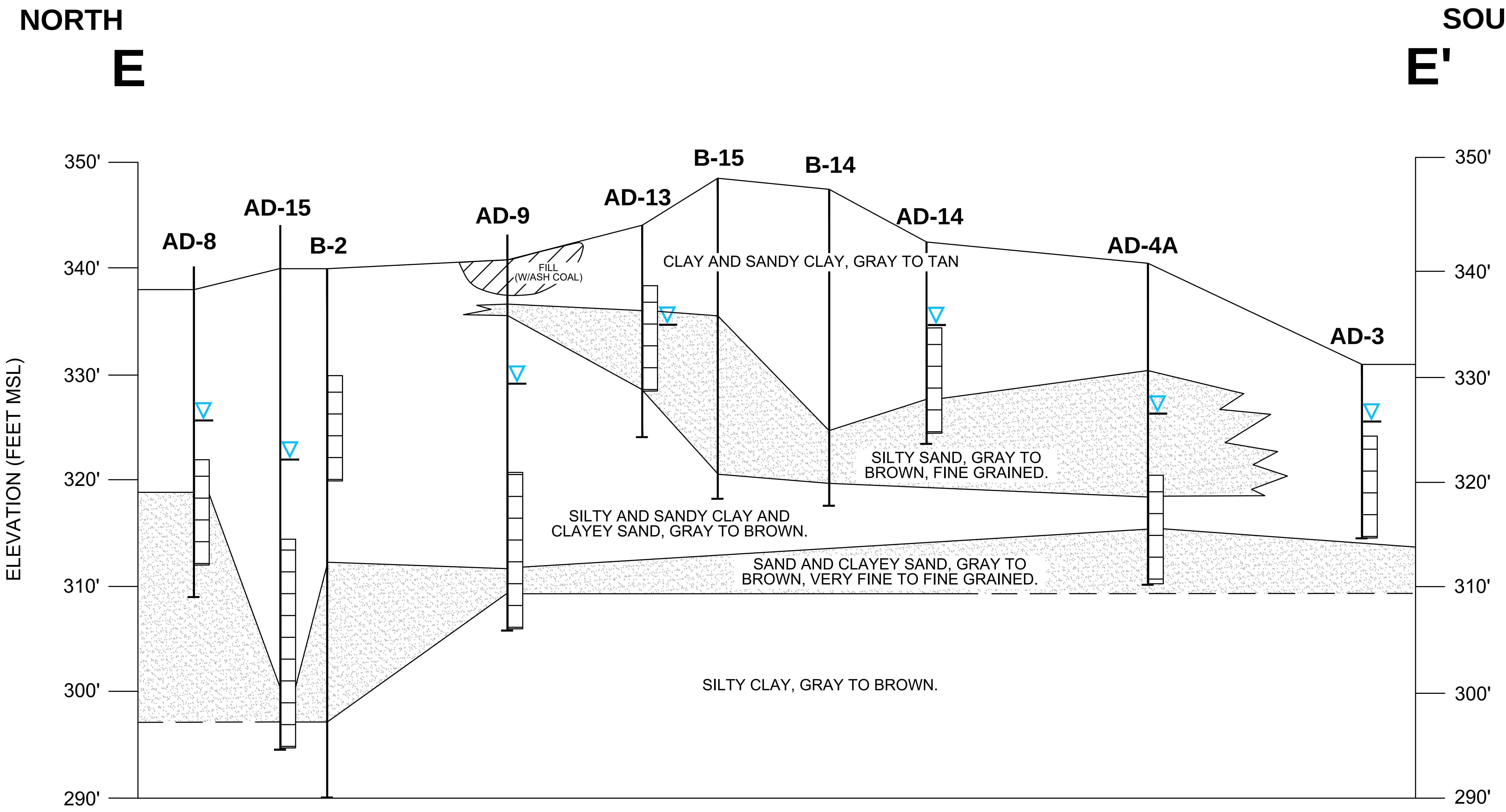
⌸	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
🟩	BASE OF CCR UNIT

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-7



0 ▬▬▭ 300'
HORIZONTAL SCALE

LEGEND

▤ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (3/4/16)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-8

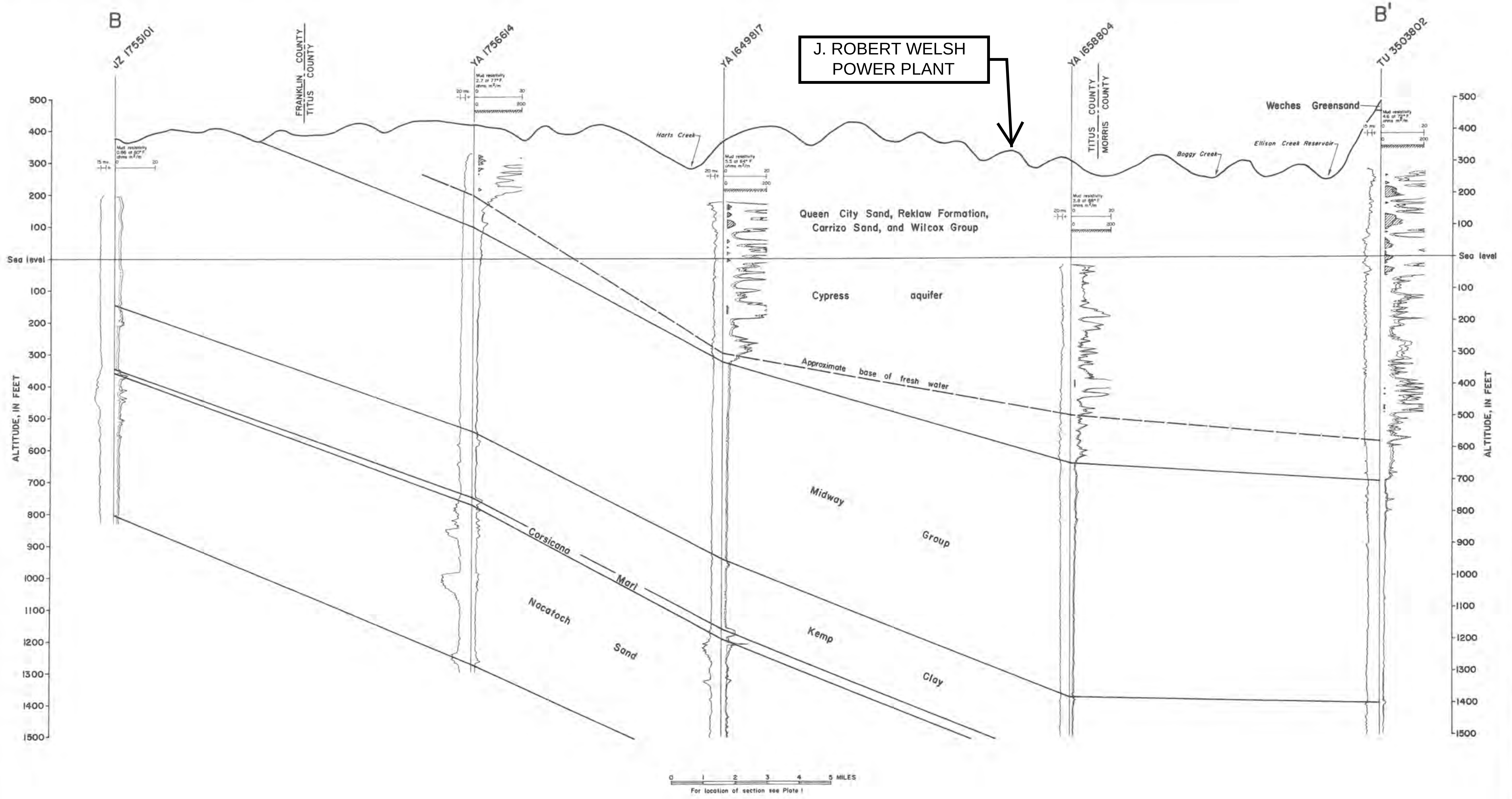


Plate 3

Geologic Section B–B', Franklin, Titus, and Morris Counties

U. S. Geological Survey in cooperation with the Texas Water Commission **(TWC BULLETIN 6517)**

REGIONAL GEOLOGIC CROSS SECTION

FIGURE 2-9

Legend

- Proposed Existing CCR Unit Upgradient Monitoring Well
- Proposed Existing CCR Unit Downgradient Monitoring Well
- Monitoring Well Location
- Piezometer/Temporary Monitoring Well Location
- Plugged Monitoring Well/Piezometer
- Site Features
- 339.74 Water Level Elevation (feet MSL)
- Groundwater Elevation Contour
- Groundwater Flow Direction

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
OCTOBER 29, 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-10

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Lithium_ASD_Report\Fig2-10-POT_Oct2018.mxd

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

LITHIUM CONCENTRATION IN SOIL (mg/kg)
MAY 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-1

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\May2018\Fig4-1-SoilBoring_LithiumConcentrationsSoilREV.mxd

Legend

- ◆ Existing CCR Unit Upgradient Monitoring Well
- ◆ Existing CCR Unit Downgradient Monitoring Well
- ◆ Monitoring Well Location
- ● Piezometer/Temporary Monitoring Well Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◐ Soil Boring (May 2018)
- G Geotechnical Soil Boring (October 2018)
- A Ash Pore Water Sample Location (May 2018)
- ▭ Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

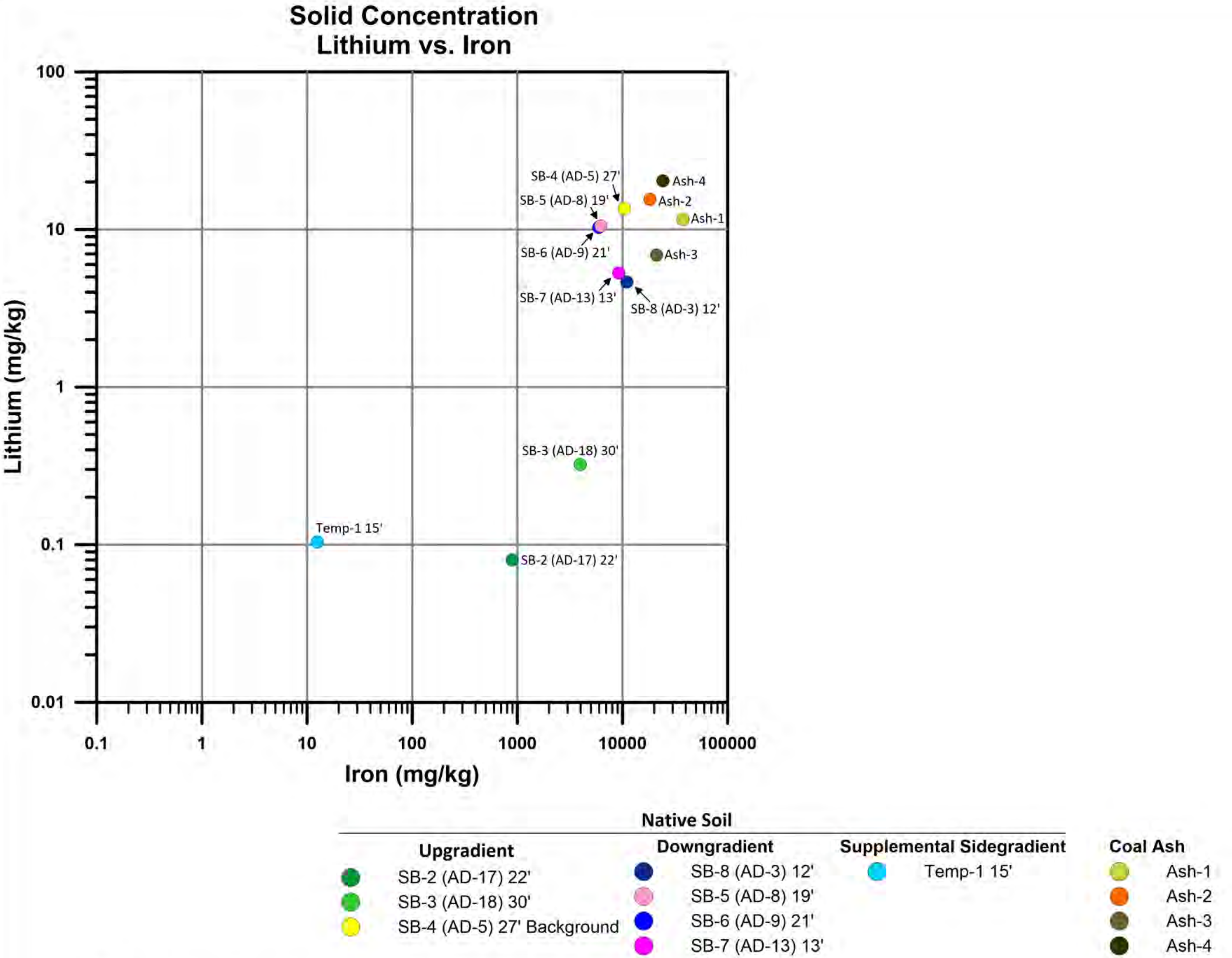
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

IRON CONCENTRATION IN SOIL (mg/kg) MAY 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-2

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\May2018\Fig4-2-SoilBoring_IronConcentrationsSoil.mxd



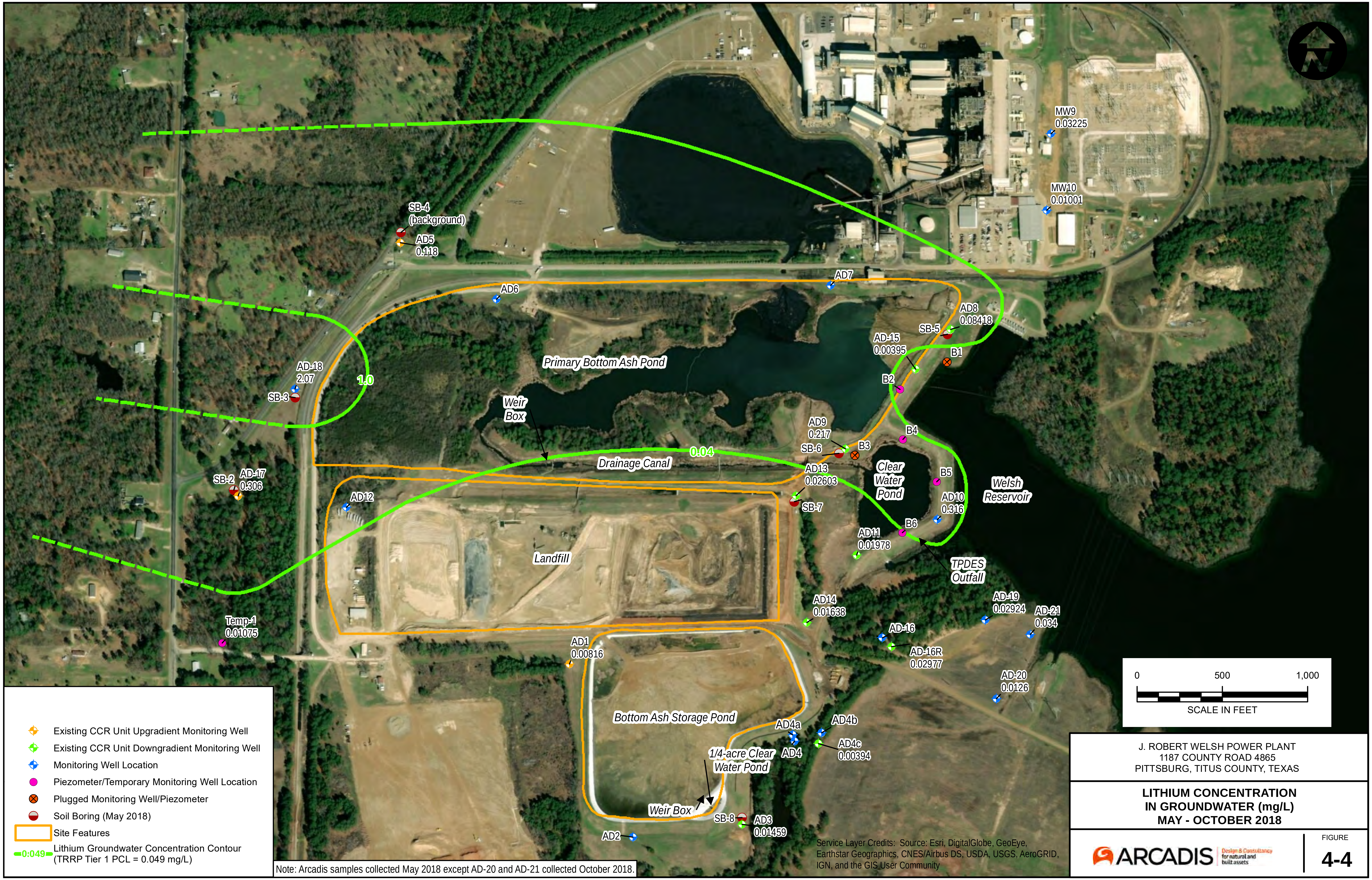
Notes:
mg/kg - milligrams per kilogram

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

LITHIUM VS. IRON SOLIDS CONCENTRATION PLOT

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-3



- 🔶 Existing CCR Unit Upgradient Monitoring Well
- 🟩 Existing CCR Unit Downgradient Monitoring Well
- 🔷 Monitoring Well Location
- ● Piezometer/Temporary Monitoring Well Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◓ Soil Boring (May 2018)
- ▭ Site Features
- 0.049 Lithium Groundwater Concentration Contour (TRRP Tier 1 PCL = 0.049 mg/L)

Note: Arcadis samples collected May 2018 except AD-20 and AD-21 collected October 2018.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

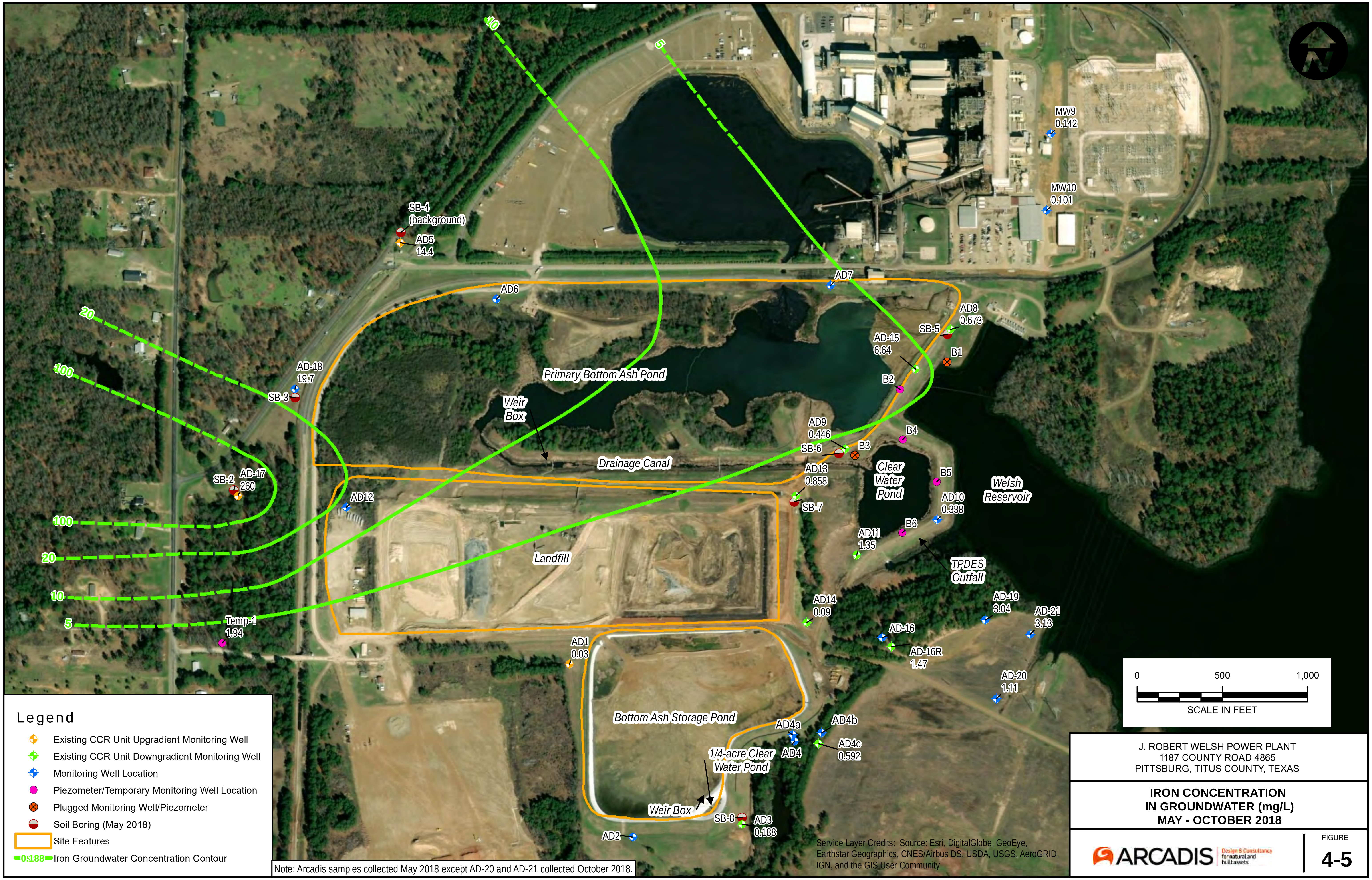
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

LITHIUM CONCENTRATION IN GROUNDWATER (mg/L) MAY - OCTOBER 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-4

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\May2018\Fig4-4-LithiumConcentrationsREV.mxd



Note: Arcadis samples collected May 2018 except AD-20 and AD-21 collected October 2018.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

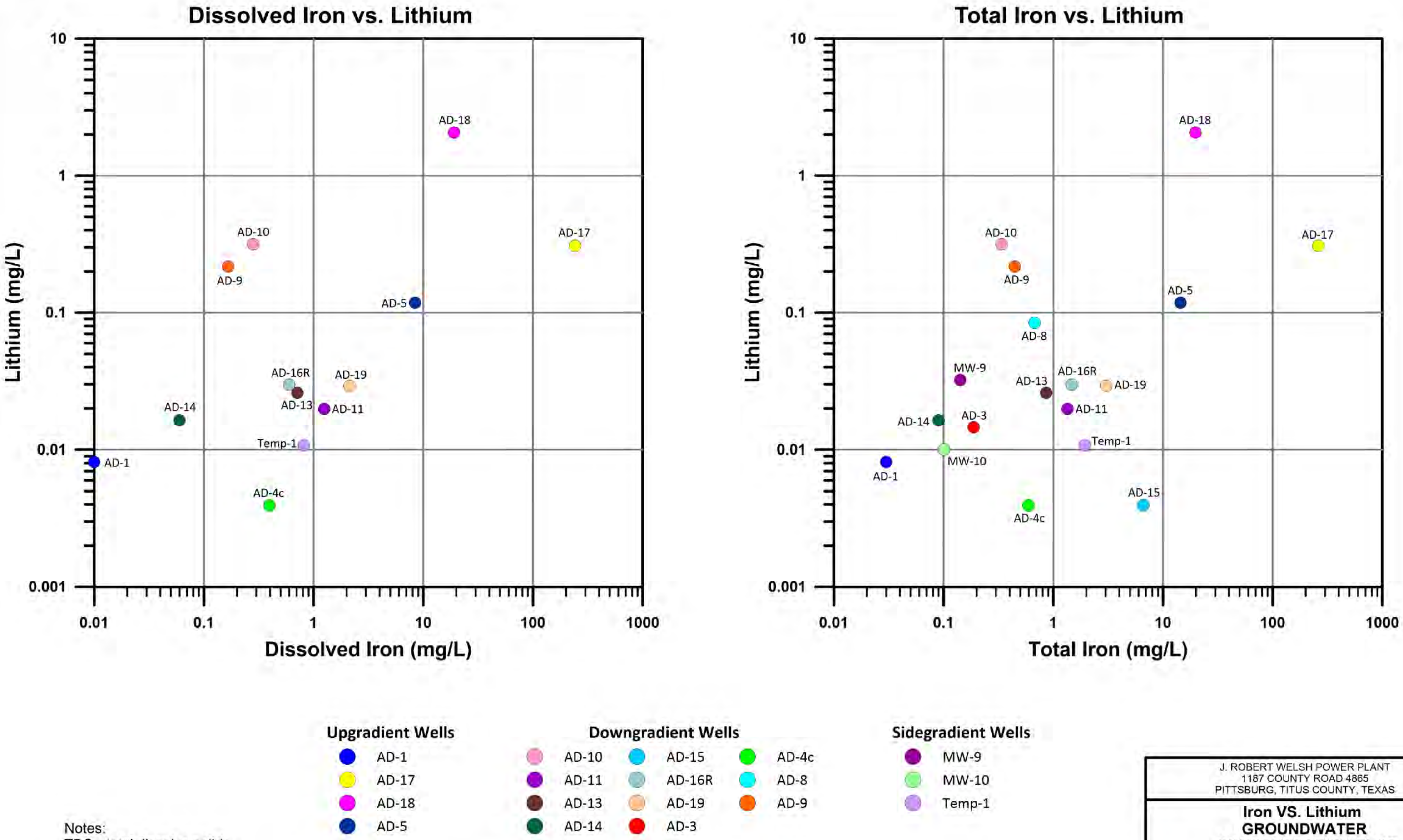
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

**IRON CONCENTRATION
IN GROUNDWATER (mg/L)
MAY - OCTOBER 2018**

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-5

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\May2018\Fig4-5-IronConcentrationsREV.mxd



Notes:
TDS - total dissolve solids
mg/L - milligrams per liter
Concentrations of iron and lithium in coal ash were below detection
Concentrations of lithium in coal ash porewater were less than 0.02 mg/L

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

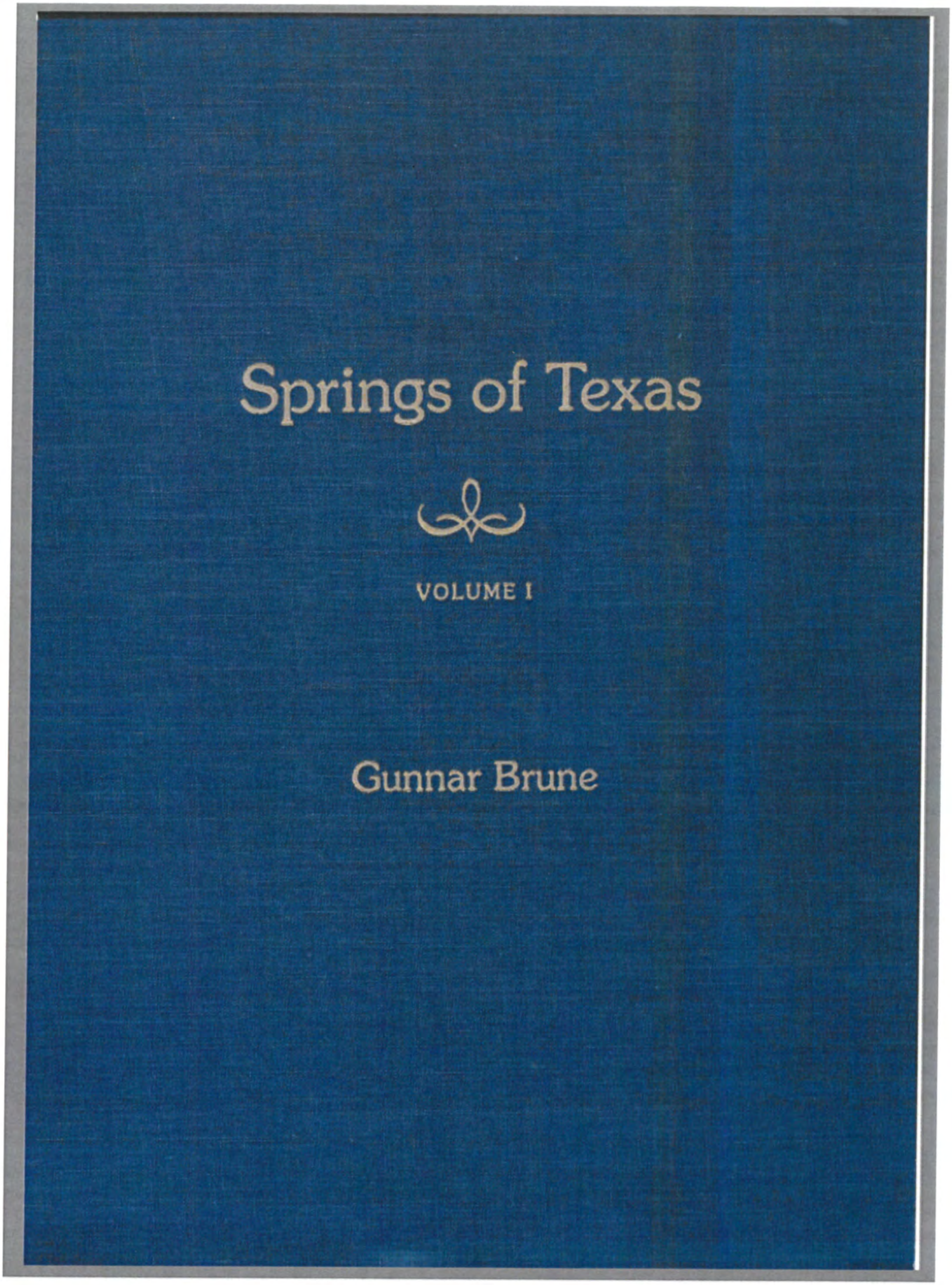
Iron VS. Lithium
GROUNDWATER
CONCENTRATION PLOT

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-6

APPENDIX A

Springs of Texas Reference



Springs of Texas

VOLUME I

Gunnar Brune

Manufactured in the United States of America

Second edition

The paper used in this book meets the minimum requirements of the American National Standard for Permanence of Paper for Printed Library Materials, Z39.48-1984. Binding materials have been chosen for durability.

∞

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INTRODUCTION TO THE SECOND EDITION

Helen C. Besse

When Gunnar Brune self-published *Springs of Texas, Volume I,* in 1981, most of the state water planning agencies and local environmental communities either did not recognize the importance of his work or were not aware of its existence. Brune had spent the previous decade conducting research and field studies, and then writing this book that describes the physical characteristics of springs, the archeology and history of springs' use, the ecological setting of springs, and the local use and lore surrounding springs for 183 out of 254 Texas counties. Gunnar Brune died before he could complete volume II.

Gunnar Brune described many of the large springs across the state as well as innumerable small springs present along river and stream courses that provide the base flow for waterways across the state. Brune repeatedly stated in the 1981 edition of this book that many of the springs he described had failed or were failing. With the pronounced influx of population in the last twenty years and the increased agricultural and industrial activities around the state, one can only wonder how many of the more than 2,000 springs have gone dry since he described them through the 1970s.

Nevertheless, this book is even more important today. Its value to water planners, elected officials, policy makers, municipal, county, and state administrators, wildlife stewards, environmentalists, and water lovers has not diminished. Springs are "the canary in the coal mine." The health of our springs reflects the health of our underground water resources and is seen in the state's surface resources as well.

In the section "The Prehistoric Setting of Springs," Brune provided a quote from another book on the beliefs that early Americans had about springs. It is appropriate to repeat those words here:

> Gods and heroes were born out of springs, and ever afterward came and went between the above and below worlds through their pools. Every pueblo had sacred springs somewhere near-by. There was every reason to sanctify them – physical, as life depended upon water; spiritual, as they had natural mystery which suggested supernatural qualities; for how could it be that when water fell as rain, or as snow, and ran away, or dried up, there should be other water which came and came, secretly and sweetly, out of the ground and never failed (Horgan, 1954).

F. Halley's farm. According to Dr. John Klein, a nearby resident and writer, the Klein settlement began here in 1848. The Sellars store was at the springs. They issued from Montgomery silt with many iron concretions at about 0.72 lps on April 11, 1978. The pools, containing duckweed, pennywort, and water primrose, were home to a family of ducks and ducklings. Probably the flow formerly continued down Spring Gully past Klein cemetery, 0.6 kilometer downstream, but on this date, even after rains, the channel here was dry except for some standing water. Many wells pump nearby.

Magnolia Garden Springs (15) are four kilometers northeast of Sheldon along the San Jacinto River. At Martha Dempsey's Good Times marina several very small springs trickle from Deweyville sand, including one which flows 0.15 lps from a pipe. Near the entrance to the nearby Magnolia Gardens marina, according to Jean Manson, springs flowed until about 1923. They are quite dry now. Very small springs are said to feed Simms Lake, across the river and 0.6 kilometer farther east. This formerly popular swimming hole is now closed to the public.

At Beaumont Place northeast of Houston, near the intersection of Highways 90 and 526, is another Spring Gully. The channel is now a drainage ditch into which very small springs and seeps (14) drain from Beaumont silt and sand.

Eight kilometers west of La Porte is Willow Springs Bayou, also called Willow Springs Gully or Ditch. **Willow Springs (8)** are chiefly between North L Street and Spencer Road. On April 9, 1978, the discharge of Willow Springs Bayou at North L Street was 0.18 lps, and at Spencer Road it was 0.70 lps. Many willows still fringe the channel, along with cattails.

A third Spring Gully is located eight kilometers southwest of La Porte. Springs (9) in Beaumont silt produced a discharge of about 0.18 lps in 1978 in the gully at the Red Bluff road crossing. Cottonmouths hide here among the willows and cattails.

HARRISON COUNTY

Harrison County is endowed with numerous springs of all types, some highly mineralized and valued for their healing properties. Most appear to be flowing as strongly as ever, because there has been little demand on the groundwater reservoirs. However, water levels in the artesian sands are declining as much as 4.6 meters per year in some areas. Most of the Caddo Indian villages were located at springs. Early French and Spanish explorers, some over 400 years ago, visited many of the same springs that can be seen today. The New Madrid earthquake of 1811 - 1812, which enlarged Caddo Lake, may have affected the flow of some springs. In general, however, the water-bearing formations were not greatly affected by the quake.

Most of the spring waters of the county issue from Eocene sands. They are usually fresh, soft, and acid, being of the sodium bicarbonate type. The iron content is often very high. Mineralized waters may also be high in aluminum and sulfate, may be slightly saline, and can be very hard. The analyses shown for 1942 in the table of Selected Chemical Analyses are probably too low in dissolved-solids content, perhaps because of high rainfall at the time the samples were collected. Most of the writer's field studies were made on January 23 - 28, 1976.

It was around **Locke Springs (1)** that the community of Marshall first appeared. In 1831 there were at least 20 springs flowing from the Reklaw sand near the intersection of Franklin and Houston Streets and up the hill toward the courthouse. In early times water was hauled from these springs in barrels to fill the cisterns on the town square. Most of the springs have now been paved over, but the remaining ones still flowed 1.4 liters per second in 1976.

Hynson Springs (10), also known as **Marshall**, **Noonday Camp**, and **Iron Springs**, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from Queen City sand. Now not more than 20 can be found, possibly because the water table has fallen. During the Civil War the water from the springs was used in a leather-tanning factory. From 1891 to 1905 the large Hotel Randell accommodated thousands of visitors to the springs. Today there are an open-air auditorium and a number of cabins, but everything is in a sad state of disrepair. A historical marker is located at the springs. The discharge record, in liters per second, is as follows:

Jan. 28, 1942	0.13	
Jul 21, 1964	0.06	
Jan. 27, 1976	0.13 (main spring)	1.6 (all springs)

Rock Springs (7) are just east of the Rock Springs church on Highway 449 about 13 kilometers west of Marshall. This and several other springs upstream flowed 2.3 lps from the Queen City sand in 1976. The Frenchman Henri Joutel of La Salle's party may have stopped here for refreshment in 1687.

Mulberry Springs (9), nine kilometers south-southwest of Harleton, are 100 meters north of the

Welsh Power Plant
Primary Bottom Ash Pond
Alternate Source Demonstration

The Welsh Power Plant Primary Bottom Ash Pond initiated an assessment monitoring program in accordance with 40 CFR 257.95 on April 13, 2018. Groundwater protection standards (GWPS) were set in accordance with 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. The statistical evaluation revealed an exceedance of the lithium GWPS on July 12, 2019. A successful alternate source demonstration (ASD) was completed per 257.95(g)(3), therefore, the Welsh Primary Bottom Ash Pond will remain in assessment monitoring. An ASD is documentation that shows a source other than the CCR unit was responsible for causing the statistics to exceed the GWPS. The ASD document will explain the alternate cause of the GWPS exceedance. The successful ASD is attached.

ALTERNATIVE SOURCE DEMONSTRATION - LITHIUM PRIMARY BOTTOM ASH POND

J. Robert Welsh Power Plant
1187 County Road 4865
Pittsburg, Titus County, Texas

September 24, 2019

STATE OF TEXAS
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ALTERNATIVE SOURCE DEMONSTRATION - LITHIUM PRIMARY BOTTOM ASH POND

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
Arcadis	Arcadis U.S., Inc.
ASD	Alternate Source Demonstration
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
ft	feet
GWPS	groundwater protection standard
MCL	maximum contaminant limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
PBAP	Primary Bottom Ash Pond
SPLP	Synthetic Precipitation Leaching Procedure
SSI	statistically significant increase
SSL	statistically significant level
USDA	United States Department of Agriculture
USGS	United States Geologic Survey

1 INTRODUCTION

This Alternate Source Demonstration (ASD) report has been prepared on behalf of American Electric Power Service Company for lithium detected in groundwater at hydraulically downgradient monitoring well AD-9 at the Primary Bottom Ash Pond (PBAP) at the J. Robert Welsh Plant site located in Titus County, Texas. This ASD report was prepared in accordance with the Coal Combustion Residual (CCR) Rule (the Rule) specified in 40 Code of Federal Regulations (CFR) §257 and based on recommendations provided in the Electric Power Research Institute “Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites” (Electric Power Research Institute [EPRI] 2017). As part of the Rule, CCR facility owners are required to conduct detection and assessment monitoring of “Appendix III” and “Appendix IV” constituents, respectively, to ensure compliance with applicable groundwater standards (described further below). Because the monitored constituents also have natural sources and can be influenced by sampling methodology implementation, the Rule allows owners or operators to evaluate and demonstrate whether a source other than the CCR unit caused a statistically significant increase (SSI) over background levels for an Appendix III constituent or at statistically significant levels (SSLs) over groundwater protection standards for an Appendix IV constituent, such as natural variation in groundwater quality or sampling methodology error.

The owner or operator must complete the written ASD within 90 days of identifying the SSI or SSL and include the certification from a qualified professional engineer to verify the accuracy of the information in the report. This ASD report was prepared by Arcadis U.S., Inc. (Arcadis) on behalf of American Electric Power Service Company within the 90-day period and has been certified by a qualified professional engineer.

1.1 Facility History

The J. Robert Welsh Plant is located within southern Titus County, approximately eight miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas (**Figure 1-1**). The Plant began operations in 1977 with three coal-fired generating units (Units 1, 2, and 3). Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash) have been generated. These byproducts were stored in the PBAP and in the adjacent Landfill that were constructed in the late 1970s. In 2000, the 22-acre Bottom Ash Storage Pond was installed south of the Landfill. The Bottom Ash Storage Pond was constructed with a 60-mil high-density polyethylene liner (**Figure 1-2**).

Presently bottom ash and economizer ash from the Plant are sluiced to the PBAP. Solids settle as the clear liquids flow through a drainage canal into the clear water pond (a non-CCR unit). Solids (bottom ash and economizer ash) in the PBAP are dredged and sluiced into the Bottom Ash Storage Pond. Marketable ash material from the PBAP is also temporarily stored in the western two thirds of the Landfill for processing, then loaded into trucks and sold for beneficial reuse (highway road base, etc.).

2 PHYSICAL SETTING

2.1 Regional Topography

The elevation at the Site ranges from approximately 300 feet (ft) above mean sea level (amsl) at Swauano Creek downstream of the Welsh Reservoir, to 360 ft amsl at a topographically high ridge at the west end of the Landfill. The PBAP is in a topographically low area that had been an un-named intermittent tributary of Swauano Creek prior to development of the Site. The Landfill is approximately 40 acres in size and is located in a topographically higher area directly south of the PBAP. The Bottom Ash Storage Pond is approximately 22 acres in size and in a topographically higher area directly south of the Landfill.

A topographically high ridge is present directly northwest of the Site where offsite monitoring wells AD-22 and AD-23 were installed along the FM 1735 right-of-way during June 2019. Ground surface elevation at these offsite monitoring wells ranges from approximately 361 ft amsl at AD-22 to 369 ft amsl at AD-23.

2.2 Geology and Soils

2.2.1 Regional and Local Geology

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 to the southeast. The Site, including all three CCR Units (PBAP, Landfill, Bottom Ash Storage Pond), is located along the outcrop of the Eocene-age Reklaw Formation, which consists of very fine to fine grained sand and clay (Flawn 1966). The Reklaw Formation attains a thickness of approximately 110 ft in Titus County, and is underlain by the Eocene-age Carrizo Sand which consists of fine to coarse sand, silt, and clay (United States Geologic Survey [USGS] 1965). In the topographically low areas underlying the Welsh Reservoir to the east of the PBAP, Quaternary alluvial sediments associated with Swauano Creek are present (Flawn 1966).

All of the CCR monitoring wells at the Site are completed in the Reklaw Formation. The two offsite monitoring wells (AD-22, AD-23) west of the Site are completed in the overlying Queen City Formation. Monitoring well locations are shown on **Figure 2-1**.

As shown on the regional geologic map and legend (**Figure 2-2A** and **Figure 2-2B**), the Reklaw Formation outcrop (Er) at the Site is relatively narrow (less than 1 mile in width). The Reklaw Formation is overlain by the Eocene-age Queen City Formation, which outcrops in topographically higher areas west of the Site, including the area where monitoring wells AD-22 and AD-23 are located. The Queen City Formation consists of fine to medium grained sand, shale, silt, and impure lignite, and attains a thickness of approximately 210 ft in Titus County (USGS 1965). The Queen City Formation also contains ironstone concretions (Flawn 1966).

2.2.2 Regional and Local Soil Composition

Information gathered from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Services soil data provides a detailed inventory of the regional soils and their characteristics, including the widespread distribution of clay-bearing soils, that support data collected at the Site from soil borings and groundwater monitoring locations. Two main named soil layers are present in the Pittsburgh, TX, area in the vicinity of the Site:

- Norfolk sandy loam
- Susquehanna fine sandy loam

Both soils are similar in the uppermost 1.5 ft of material, generally grayish in color and containing fine sand, silt, and clay. However, the subsoils of both units have subtle differences from one another and are described herein. Observations from soil borings at the Site are consistent with the characteristics of one or both of these soil units, as described in the USDA Natural Resources Conservation Services document.

The Norfolk sandy loam is a widely distributed soil unit that is uniformly developed in the lowland areas and is derived from weathering Eocene-aged deposits. It is a generally porous soil, allowing infiltrating water to migrate downward toward the water table. The soil layer is generally yellowish-gray in color, however the subsoil at greater depths is characterized by increased clay content and a mottled red and yellow appearance. As noted in the USDA soil descriptions, the soil and subsoils of the Norfolk sandy loam may be broken down into the grain size distributions presented in **Table 2-1**.

The Susquehanna fine sandy loam is also widely distributed and generally resembles the Norfolk sandy loam at the surface. Subsoils of the Susquehanna contain a greater component of clay, and likely contain increased iron content, as evidenced by observed iron concretions and iron crust formation within the subsoil. This soil is often mottled in appearance, ranging from red and yellow to a reddish brown or gray. Despite the greater clay content, the soil and subsoil is not impervious to infiltrating water that migrates toward the water table. As noted in the USDA soil descriptions, the soil and subsoils of the Susquehanna fine sandy loam may be broken down into the grain size distributions presented in **Table 2-2**.

These soil descriptions are important for the understanding of contributing sources of key constituents, such as lithium to the groundwater system. Lithium can occur in soils through natural weathering processes and the development of clay minerals. In particular, lithium can be incorporated into the structure of clays in the smectite group through cation substitution, which is further influenced by the presence of iron within the clay structure (Drever 2002; Stucki 2005). The widespread distribution of clay deposits in the native soils in and near the Site and the propensity for clays to contain trace constituents of potential concern supports the potential for natural sources of lithium.

Geologic cross-sections were generated to evaluate the stratigraphy in the area of the PBAP. The lines of geologic cross-section are shown on **Figure 2-3** and the cross-section details for cross-sections A-A’ through E-E’ are shown on **Figures 2-4** through **2-8**, respectively. As shown on **Figure 2-4**, an unsaturated brown to gray clay and sandy clay stratum is present in the area of the PBAP from the surface to a depth of approximately 20 ft below ground surface. The clay stratum is underlain by a saturated fine to medium grained clayey and silty sand stratum with an average thickness of approximately 10 ft and is consistent with the soils of the Susquehanna fine sandy loam deposits. As discussed below in Section 2.3.2, this saturated sand stratum is the uppermost water-bearing unit in the area of the PBAP. This sand stratum is underlain by an unsaturated gray to black silty clay stratum that locally serves as a lower confining layer (aquitard) for the uppermost water-bearing unit.

As shown on **Figures 2-2A** and **2-4**, the Queen City Formation outcrops in the topographically high area to the northwest of the Site. The geologic contact between the Queen City Formation, in which offsite monitoring wells AD-22 and AD-23 are completed, and the Reklaw Formation, in which the CCR monitoring wells are completed, is located near an elevation of 340 ft amsl as shown on **Figure 2-4**. The Queen City Formation directly west of the Site consists predominantly of clayey sand, and the underlying Reklaw Formation consists of interbedded sand, silt, and clay strata.

2.3 Hydrology

2.3.1 Regional Hydrology

The Reklaw Formation, which outcrops at the Site, and the overlying Queen City Formation, which outcrops west of the Site, are part of the Cypress Aquifer, which also includes the underlying Carrizo Sand and Wilcox Formation (USGS 1965). As shown on **Figure 2-9,** the Cypress Aquifer is approximately 900 ft thick in the Site area, and the base of fresh water in the Cypress Aquifer is approximately 800 ft below ground surface.

Regional groundwater characteristics are presented in Texas Water Commission Bulletin 6517 "*Ground-Water Resources of Camp, Franklin, Morris, and Titus Counties, Texas, Texas*" (USGS 1965). All of the regional aquifer units are combined in this document, and considered as one interconnected unit, referred to as the "Cypress aquifer". This singular aquifer unit, composed of all water bearing units of similar character, was divided into three zones based on water quality characteristics of each zone rather than lithology. The following three zones were identified, in order of increasing relative depth:

- Zone A: characterized by minimal iron content and low pH, ranging from 4.5 to 6.5.
- Zone B: characterized by increased dissolved iron content and pH ranging from 5.0 to 7.0
- Zone C: characterized by iron concentrations of less than 0.3 milligrams per liter (mg/L) and neutral to alkaline pH (7.0 to 8.0)

Groundwater at the Site is generally assumed to be influenced by groundwater from Zones A and B. As described in USGS, 1965, Zones A and B can be more simply described as:

- Zone A: zone of oxidation and acidic groundwater
- Zone B: intermediate zone

The dissolved iron content in the A and B zones (ranging from non-detect to greater than 10 mg/L; USGS 1965) is likely influenced by iron present in the soils and sediments, which are described in Section 2.2. Slow recharge rates and transmissive properties of these zones contributes to longer residence times whereby the infiltrating groundwater may react with soil and sediments, allowing for the oxidation of sulfides to generate sulfate and mobilizing ferrous iron into solution. In addition, groundwater from several wells completed in shallow (less than 60 ft in depth) sediments contained sulfate concentrations above

1,000 mg/L. Sulfate concentrations observed at the Site are consistent with the range of data for other similar depth wells in the four-county area (USGS 1965).

Additional regional groundwater information is provided in the 107th Annual Meeting of the Texas Academy of Science abstract titled “Natural Sources of Poor Water Quality in Streams of East Texas” (Ledger et. al. 2004). This study characterized surface water streams associated with the regional groundwater in the Eocene-aged Reklaw Formation as acidic with high concentrations of sulfate, and arsenic concentrations greater than 0.01 mg/L.

An observed decline in surface water quality was also noted if springs from the Reklaw Formation discharge to surface water bodies. Abundant sulfur is noted in the Reklaw formation and sediments undergo acid-sulfate weathering, as evidenced in the red-stained soils and sulfate concentrations of greater than 1,000 mg/L (Ledger et. al. 2004). In streams associated with the Reklaw Formation, sulfate levels may exceed 1,000 mg/L.

2.3.2 Local Hydrology

Groundwater flow direction at the Site is generally from west to east, following surface topography towards the Welsh Reservoir. Groundwater elevations and well construction information from monitoring wells completed in the uppermost water-bearing unit at the Site are summarized on **Table 2-3**. Depth to groundwater in the monitoring wells in the area of the PBAP ranges from approximately 10 to 15 ft below ground surface.

Figure 2-10 is a potentiometric surface map for the uppermost water-bearing unit at the Site based on June 19, 2019 water level data. As shown on **Figure 2-10**, shallow groundwater flow direction in the area of the CCR Units is in a general easterly direction toward the Welsh Reservoir at an average hydraulic gradient of approximately 0.01 foot per foot. Shallow groundwater flow direction in the area of monitoring wells AD-22 and AD-23, which are completed in the Queen City Formation, is southeasterly toward the CCR monitoring wells, which are completed in the Reklaw Formation. The groundwater flow direction and downward vertical flow indicates shallow groundwater in the Queen City Formation likely is hydraulically connected to the underlying Reklaw Formation. This is consistent with Texas Water Commission Bulletin 6517 description of the Cypress Aquifer: “The Wilcox Group and the Carrizo Sand, Reklaw Formation, and Queen City Sand of the Claiborne Group have similar hydrologic properties and are the principal source of freshwater in the four-county area. The units probably are interconnected hydraulically and they function as single aquifer” (USGS 1965). **Figure 2-11** is a regional hydrologic cross section of the site area.

The hydraulic conductivity of the uppermost water-bearing unit at the Site was determined by conducting aquifer tests. A constant-rate pumping test was conducted at monitoring well AD-6 on September 21, 2017. Based on the AD-6 pumping test data, the hydraulic conductivity for the uppermost water-bearing unit was calculated at 0.05 ft per day (1.83 x 10^{-5} centimeters per second).

To provide a broader understanding of the hydraulic conductivity distribution across the Site, bail down slug tests were performed in October 2018 on a total of 5 wells; 1 up gradient well (AD-17) and 4 down gradient wells (AD-6, AD-9, AD-13 and AD-19) on October 30 and 31, 2018. These wells are all screened in the uppermost water-bearing unit and were chosen based on their distribution across the Site. The hydraulic conductivity estimates from the five monitoring wells tested ranged from 0.15 ft per day (AD-6) to 2.0 ft per day (AD-13). The overall mean hydraulic conductivity estimate was 0.84 ft per day, while the overall geometric mean was 0.60 ft per day.

2.4 Surface Water

The Site is located directly west of Swauano Creek, which was dammed near the southern end of the Site during plant development to form the Welsh Reservoir. The PBAP normal operating water level is near the weir box which has a bottom elevation of 325 ft amsl. The surface water elevation of the Welsh Reservoir, located east of the PBAP, is maintained at approximately 320 ft amsl. The Welsh Reservoir is likely a gaining surface water feature, and groundwater elevations at the Site are higher than the normal stage elevation of the Welsh Reservoir (approximately 320 ft amsl) as shown on **Figure 2-10**.

There are no current or historic gauging stations on Swauano Creek; however, there was a historic gauging station on adjacent Boggy Creek, which has a drainage basin area of 72 square miles versus 21.2 square miles for Swauano Creek. The average annual flow of the Boggy Creek gauging station during the driest year on record (1956) was 10.65 cubic feet per second, which corresponds to a flow of approximately 3 cubic feet per second for Swauano Creek.

3 DETECTION AND ASSESSMENT MONITORING STATISTICAL EVALUATION

3.1 General

The groundwater monitoring network for the uppermost water-bearing unit at the PBAP consists of three upgradient monitoring wells (AD-1, AD-5, AD-17) and three downgradient monitoring wells (AD-8, AD-9, AD-15). Additional details regarding the groundwater monitoring network are provided in the August 22, 2017 report entitled "*Primary Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation*" (Arcadis 2017).

3.2 Detection Monitoring Results

Detection monitoring at the Site involves collection of groundwater samples from the groundwater monitoring network upgradient and downgradient monitoring wells for analyses of Appendix III CCR constituents, which includes boron, calcium, chloride, fluoride, sulfate, pH, and total dissolved solids. Following the baseline monitoring program, which included a minimum collection of eight independent samples from each of the background and downgradient wells that are part of the certified monitoring network, the first round of Detection Monitoring was conducted. Based on detection monitoring conducted at the PBAP in 2017, 2018, and 2019, an SSI over the background concentration was calculated for boron in AD-8 (Geosyntec 2019b). Because of the SSIs noted for boron in groundwater samples from AD-8, an Alternate Source Demonstration was completed which did not identify an alternate source for the boron SSI (Geosyntec 2018).

3.3 Assessment Monitoring Results

Groundwater protection standards (GWPSs) were established for the Appendix IV parameters in accordance with 40 CFR Part 257.95(h). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or regional screening level for each Appendix IV parameter.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells (AD-8, AD-9, AD-15) to assess whether Appendix IV parameters were present at an SSL above the GWPS. An SSL was identified for lithium in January 2019, which exceeded the GWPS of 0.390 mg/L at monitoring well AD-9 (0.935 mg/L), despite no observed SSIs in Appendix III parameters for this well (Geosyntec 2019a). An additional statistical analysis was completed from an assessment monitoring event in February and verification sampling April 2019 at downgradient wells AD-8 and AD-9 for Appendix III parameters. An update to the statistical analysis was completed in July to re-establish the GWPSs for Appendix IV parameters. The results similarly identified an SSL for lithium updated for AD-9 at 0.957 ug/L (Geosyntec 2019b). Additional details regarding the statistical evaluations of the groundwater monitoring data is provided in the January 8, 2019 and July 11, 2019 reports both entitled "*Statistical Analysis Summary, Primary Bottom Ash Pond*" (Geosyntec 2019a, 2019b).

Because the native soils have the potential to be a natural source of lithium in the regional and local groundwater and soil composition, an ASD report was prepared in February 2019 to provide additional information on the sources and distribution of lithium in groundwater at the Site from the data that was available (Arcadis 2019). The conclusions from the February 2019 ASD indicated several lines of evidence demonstrating that the lithium concentration in groundwater at AD-9 is from naturally occurring sources (ASD Type V), with some additional contributions from sampling methodology error (ASD Type I). This ASD report updates the previous report based on the recently collected Site-specific soil and groundwater data, including soil and groundwater analytical data collected outlined in Section 4.

4 SOIL AND GROUNDWATER ANALYTICAL DATA EVALUATION

4.1 General

In addition to the detection and assessment monitoring groundwater sampling events conducted at the PBAP in 2017, 2018, and February 2019 for statistical evaluation, a comprehensive site-wide groundwater sampling event was conducted by Arcadis during May 2018, and an offsite soil and groundwater sampling event was conducted by Arcadis during June 2019 to evaluate alternate potential sources of lithium detected in downgradient monitoring well AD-9. The May 2018 evaluation included the following tasks:

- Collection of groundwater samples from the PBAP upgradient monitoring wells (AD-1, AD-5, AD-17), the PBAP downgradient monitoring wells (AD-8, AD-9, AD-15), and other monitoring wells in the area completed in the uppermost water-bearing unit, including upgradient monitoring well AD-18; sidegradient monitoring wells MW-9, MW-10, and Temp-1; and downgradient monitoring wells AD-3, AD-4c, AD-10, AD-11, AD-13, AD-14, AD-16R, and AD-19.
- Collection of soil samples from eight soil borings (Temp-1, SB-2 through SB-8) around the perimeter of the CCR units at the site.
- Collection of three CCR material samples from the PBAP (Sample IDs: Ash-1, Ash-2, Ash-3) and one CCR material sample from the HDPE-lined Bottom Ash Storage Pond (Sample ID: Ash-4) for analysis of total metals, pore water concentrations, and leachate water using the Synthetic Precipitation Leaching Procedure (SPLP) (**Table 4-1**).

The June 2019 evaluation included the following tasks:

- Installation of two offsite monitoring wells (AD-22, AD-23) in the Queen City Formation northwest (hydraulically upgradient) of the Site. Monitoring well completion diagrams are provided in **Appendix A**.
- Collection of soil and groundwater samples from the Queen City Formation monitoring wells for Appendix III and Appendix IV parameter analyses.

Additionally, two sentinel downgradient monitoring wells (AD-20, AD-21) were installed in the uppermost water-bearing unit (Reklaw Formation) near the shoreline of the Welsh Reservoir east (hydraulically downgradient) of the CCR units during October 2018.

4.2 Soil and Groundwater Analytical Data Evaluation

4.2.1 Soil Evaluation

The soil evaluation results demonstrate a correlation between lithium and iron in soil. Boring logs from Site area monitoring locations highlight similarities with observations provided in the county-wide soil survey reports. For example, boring locations SB-04 (adjacent to AD-5), SB-05 (adjacent to AD-8), AD-22, and AD-23 contain a greater content of the reddish-brown clay subsoils as noted in the Susquehanna fine sandy loam, which directly overlie the water table in these locations. The reddish brown color generally denotes the presence of iron in these locations, which can be either incorporated directly into the clay mineral structure (e.g. smectite), or as a secondary mineral (e.g. iron hydroxide) that is also present in the aquifer matrix (Stucki 2005). The role of iron incorporated into the clay structure is important to localized geochemical processes, such as cation exchange, redox conditions, and hydrophilic properties, which can influence weathering characteristics and the mobility of trace constituents (i.e. lithium) in groundwater (Stucki 2005). Specifically, in the event that geochemical conditions are or become conducive to iron dissolution (e.g., if conditions become microbially/geochemically reducing), then the mobilization of iron associated with soil can result in the co-mobilization of trace constituents.

As shown on **Table 4-1** and **Figure 4-1**, the highest concentrations of lithium in soil were detected from 3 to 5 feet below ground surface in hydraulically upgradient and offsite Queen City Formation monitoring well AD-22 (up to 18 milligrams per kilogram [mg/kg]), and onsite Reklaw Formation soil boring SB-4 (13.6 mg/kg) located adjacent to monitoring well AD-5 which is hydraulically upgradient (northwest) of the PBAP. This upgradient (background) data indicates lithium concentrations in soil in the area of the PBAP are naturally occurring and not the result of impacts from CCR materials. This is one line of evidence that the lithium detected in groundwater at monitoring well AD-9 is from a naturally occurring source, and not the CCR unit. As shown on **Table 4-1** and **Figure 4-2**, the highest iron concentrations in soil are from soil borings AD-22 and AD-23 (17,600 to 85,500 mg/kg) which are located in the Queen City Formation upgradient of the Site; SB-4 (AD-5; 10,400 mg/kg), located in the Reklaw Formation upgradient (northwest) of the PBAP; and soil boring SB-8 (AD-3; 11,000 mg/kg), located in the Reklaw Formation over 1,000 ft south (side gradient) of the PBAP. **Figure 4-3** shows an apparent correlation between the iron and lithium content in the coal ash, upgradient locations, and downgradient locations. However, SPLP and pore water results from the coal ash samples show that the iron and lithium present in the coal ash is not in a mobile (leachable) form. Therefore, it is more likely that the regional groundwater interaction with naturally occurring lithium and iron in soil is responsible for the observed lithium concentrations and variability across the Site. As detailed below in Section 4.2.2, iron and lithium concentrations in groundwater at the Site show a similar distribution to iron and lithium concentrations in soil, indicating naturally occurring sources for iron and lithium.

4.2.2 Groundwater Evaluation

Groundwater analytical results for the PBAP, the landfill, and the bottom ash storage pond are summarized on **Tables 4-2**, **4-3**, and **4-4**, respectively. As shown on **Figure 4-4**, the highest lithium concentration in the most recent (2019) groundwater samples is at monitoring well AD-18 (1.27 mg/L), which is west (upgradient) relative to the PBAP. This data indicates lithium concentrations in groundwater in the area of the PBAP are from a source other than the PBAP.

As shown on **Figure 4-5**, iron concentrations in groundwater are also elevated upgradient (west) relative to the PBAP. **Figure 4-6** shows the relationship of total and dissolved iron concentrations to lithium concentrations in upgradient, side-gradient, and downgradient monitoring wells. These results demonstrate a clear correlation between aqueous iron and lithium, with higher lithium concentrations associated with elevated iron. The greatest concentrations of both iron and lithium are observed in the upgradient monitoring wells AD-17 and AD-18. As identified in **Table 4-1** and noted on **Figure 4-6**, SPLP leachate and pore water analyzed from coal ash samples contain lithium in concentrations below detection, or at very low concentrations less than 0.02 mg/L. This data indicates lithium concentrations in groundwater in the area of the PBAP are from a source other than the PBAP. As discussed above in Section 2.2.1, the Queen City Formation, which overlies the Reklaw Formation, is located directly west of the Site. Therefore, groundwater from the Queen City Formation west (upgradient) of the CCR units may be the source of lithium and iron detected in soils and groundwater in the area of the CCR units. As discussed above in Section 2.3.1, elevated naturally occurring iron is documented in the Cypress Aquifer, and as discussed above in Section 2.2.1, the Queen City Formation contains naturally-occurring iron concretions and correspondingly high iron concentrations in soil samples.

Another line of evidence the lithium detected in groundwater in the area of the PBAP is from a naturally occurring source is provided in the 2002 Publication "Springs of Texas" (Gunnar Brune 1981). The Springs of Texas publication states "*Hynson Springs, also known as Marshall, Noonday Camp, and Iron Springs, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from the Queen City Formation*." This spring, which contains naturally-occurring lithium, is located approximately 35 miles southeast of the Site. A copy of this reference is provided in **Appendix B**.

When reviewing historical and recent datasets, a broad relationship was noted between trace metal chemistry and turbidity. Where turbidity values were greatest, greater concentrations of selected CCR monitored constituents were also observed (e.g. arsenic and cadmium) and in some cases, in exceedance of Federal MCLs. As a result, low-flow sampling methodology was employed to reduce the amount of turbidity in the groundwater sample.

A comprehensive groundwater sampling event was conducted at the Site by Arcadis during May 2018 using low-flow methodology. A clean stainless steel low-flow sampling pump with new, well-dedicated polyethylene piping was slowly lowered into the mid-point of the water column at each monitoring well, and groundwater was then pumped at a low flow rate of less than 0.1 liters per minute until the produced water was visually clear. The turbidity of the produced water was measured using calibrated field instruments during well development, and groundwater samples were not collected until the turbidity measurements declined and stabilized. Once low-flow groundwater sampling techniques were properly followed by Arcadis during May 2018, water quality results indicated concentrations of selected constituents to be much less than previously reported and did not exceed criteria. Therefore, it was determined that the sediment disturbances generated during well purging and improper (turbid) groundwater sampling were causing most of the Federal MCL groundwater exceedances. Specifically, since CCR Rule monitoring requires analysis of unfiltered samples, the results suggest that the exceedances were associated with constituents present in undissolved suspended solid particulates rather than in a dissolved form, on a location by location basis. The May 2018 groundwater analytical results are most representative of groundwater quality at the Site because proper low-flow sampling protocols were adhered to and sediment contributions to the analytical results were minimized.

The most recently collected groundwater samples from PBAP downgradient monitoring well AD-9 support improper (turbid) groundwater sampling as a contributor to the lithium Federal MCL exceedance in February 2019. The lithium concentration in the May 2019 groundwater sample from monitoring well AD-9 (0.225 mg/L) is over 4 times lower than the lithium concentration in the February 2019 groundwater sample (1.12 mg/L), and correspondingly the field-measured turbidity in the May 2019 groundwater sample (27.2 nephelometric turbidity units) is over 4 times lower than the field-measured turbidity in the February 2019 groundwater sample (115 nephelometric turbidity units).

5 SUMMARY AND CONCLUSIONS

This ASD has been prepared in consultation with the Electric Power Research Institute “Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites”. The following lines of evidence indicate the SSL related to the lithium concentration in groundwater at AD-9 is from naturally occurring sources (ASD Type V), with some additional contributions from sampling methodology error (ASD Type I):

- An SSI was confirmed for boron within monitoring well AD-8 followed by a failed Alternate Source Demonstration for boron, triggering the assessment monitoring program for the PBAP. Under the assessment monitoring program, an SSL was identified for lithium which exceeded the GWPS of 0.390 mg/L at monitoring well AD-9 (0.957 mg/L), despite no observed SSIs in Appendix III parameters for this well. SSIs would be expected for Appendix III parameters if there was a CCR unit source for the lithium exceedance of the SSL, indicating that there may be an alternate source of lithium.
- As demonstrated in this ASD report, iron and lithium are associated in the sediments and in groundwater. The subsoils at the Site, particularly the Susquehanna fine sandy loam, contain naturally occurring high clay content. The role of iron incorporated into the clay structure is important to localized geochemical processes, such as cation exchange, redox conditions, and hydrophilic properties, which can influence weathering characteristics and the mobility of trace constituents (i.e. lithium) in groundwater (Stucki, 2005). This is a supporting line of evidence.
- The highest lithium concentrations in the soil samples collected during the Arcadis May 2018 and June 2019 investigations was from background soil samples (AD-22, 3-5 ft depth; SB-4, 27 ft depth) located upgradient (northwest) of the PBAP. This is a key line of evidence that the PBAP is not the source of elevated lithium concentrations in soil at the Site.
- Leachate and pore water analyzed from coal ash samples contain lithium in concentrations below detection, or at very low concentrations less than 0.02 mg/L. This data indicates lithium concentrations in groundwater in the area of the PBAP are from a source other than the PBAP. This is a key line of evidence.
- The highest lithium concentration in groundwater samples collected during the Arcadis May 2018 investigation was from an upgradient (background) monitoring well (AD-18) located west of the PBAP. This is a key line of evidence that the PBAP is not the source of elevated lithium concentrations in groundwater at the Site.
- Iron and lithium concentrations in soil and groundwater at the Site show a similar distribution, indicating there is likely a common source for these metals. The 1965 USGS publication “*Ground-Water Resources of Camp, Franklin, Morris and Titus Counties, Texas”* documents naturally occurring high iron concentrations within zones of the Cypress Aquifer, in which the monitoring wells at the Site are completed. The University of Texas at Austin Bureau of Economic Geology 1966 publication “*Geologic Atlas of Texas, Texarkana Sheet*” documents naturally occurring iron concretions in the Queen City Formation, which outcrops directly west (upgradient) of the PBAP. This is a supporting line of evidence.

- The 1981 Gunnar Brune publication "*Springs of Texas*" documents naturally occurring elevated lithium in groundwater in the Queen City Formation at Hynson Springs, which is approximately 35 miles from the Site. The publication states "*Hynson Springs, also known as Marshall, Noonday Camp, and Iron Springs, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from Queen City sand".* This publication, along with soil and groundwater analytical data at the Site, supports the conclusion that the primary source of lithium in groundwater at the PBAP is from the Queen City Formation, which outcrops directly west (upgradient) of the PBAP. This is a key line of evidence.
- The water quality sample exhibiting elevated lithium at AD-9 in February 2019 also showed elevated turbidity. Upon resampling in May 2019, both the lithium concentration and turbidity decreased, indicating that the elevated lithium observed in February 2019 was likely associated with suspended particulates and not entirely in a dissolved form. Effective well development and proper low flow sampling techniques minimize the potential for groundwater analyses to be unrepresentative of formation groundwater. This is a supporting line of evidence.
- This ASD report provides a strong demonstration of naturally occurring sources of lithium in groundwater (ASD Type V) as supported by five key lines of evidence and three supporting lines of evidence.

6 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 alternate source demonstration for lithium at the Primary Bottom Ash Pond meets the requirements of 40 CFR Part 257.95.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

KENNETH J. BRANDNER
69586

Kenneth J Brandner

Signature

69586

Registration No.

Texas

Registration State

9-24-19

Date

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TABLES

Table 2-1
Grain Size Distribution in Soil and Subsoil of the Norfolk Sandy Loam
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Grain Size	Soil	Subsoil
Fine Gravel	0.0%	0.0%
Coarse Sand	0.2%	0.1%
Medium Sand	0.4%	0.3%
Fine Sand	29.4%	29.9%
Very Fine Sand	37.9%	24.0%
Silt	25.9%	25.1%
Clay	5.9%	20.2%

Table 2-2
Grain Size Distribution in Soil and Subsoil of the Susquehanna Fine Sandy Loam
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Grain Size	Soil	Subsoil
Fine Gravel	0.4%	0.0%
Coarse Sand	0.7%	0.2%
Medium Sand	0.9%	0.8%
Fine Sand	53.4%	36.6%
Very Fine Sand	16.0%	10.8%
Silt	21.2%	19.0%
Clay	7.2%	32.8%

Table 2-3
Well Construction and Water Level Data - CCR Units
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

			Ground Surface Elevation	Top of Casing Elevation	Borehole Depth ft. bls	Date Installed	Screen Material	Well Diameter inches	Top of Screen		Bottom of Screen		6/7/2011	12/6/2011	5/2/2012	11/1/2012	5/14/2013	11/19/2013	5/12/2014	11/16/2014	5/12/2015	3/4/2016	5/26/2016	7/27/2016	10/19/2016	12/12/2016	1/17/2017	2/23/2017	10/6/2017	5/15/2018	10/29/2018	6/19/2019
Well ID	Latitude	Longitude							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	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																																
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	357.57	25.0	1/11/01	Sch. 40 PVC	2	15.0	340.57	25.0	330.57	338.46	334.92	337.88	337.18	337.43	336.73	338.03	337.64	340.82	342.83	344.89	342.89	341.23	340.58	341.18	339.74	337.70	340.57	339.10	345.37
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	346.16	25.0	4/26/01	Sch. 40 PVC	2	15.0	329.16	25.0	319.16	330.16	329.07	330.00	329.26	329.83	329.70	330.09	329.69	332.56	332.32	---	---	---	---	---	---	---	331.50	331.25	333.61
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	333.10	17.0	4/26/01	Sch. 40 PVC	2	7.0	324.10	17.0	314.10	323.81	323.19	323.99	323.29	323.77	323.98	324.12	323.28	325.58	325.12	324.59	323.70	323.47	323.78	325.04	324.92	323.24	324.30	324.15	325.42
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	342.61	30.0	4/26/01	Sch. 40 PVC	2	19.0	321.61	29.0	311.61	324.81	324.84	324.62	324.40	324.74	325.52	325.44	325.13	327.00	326.90	---	---	---	---	---	---	---	---	---	---
AD-4a (a)	33.04527	94.84258	340.19	342.85	30.0	9/22/09	Sch. 40 PVC	2	20.0	320.19	30.0	310.19	325.01	324.19	325.24	322.90	324.86	324.68	325.64	325.34	327.19	327.12	---	---	---	---	---	---	---	---	---	---
AD-4b (a)	33.04531	94.84230	329.55	333.23	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.55	15.0	314.55	324.35	324.32	324.50	324.30	324.30	325.21	325.22	324.90	326.58	326.67	---	---	---	---	---	---	---	---	---	---
AD-4c (a)	33.04507	94.84244	329.15	333.28	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.15	15.0	314.15	324.18	324.50	324.64	324.37	324.11	325.06	325.01	324.71	326.50	326.19	325.89	324.01	323.76	325.07	326.39	324.89	324.20	324.95	325.62	325.98
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	351.00	30.0	1/11/01	Sch. 40 PVC	2	20.0	329.00	30.0	319.00	336.34	336.58	336.82	336.99	336.78	336.47	336.80	336.01	339.07	338.04	337.62	337.24	337.74	337.01	338.34	336.17	337.40	337.25	336.98	337.18
AD-6 (a)	33.05235	94.84757	343.31	346.33	33.0	9/23/09	Sch. 40 PVC	2	23.0	320.31	33.0	310.31	333.04	333.02	332.83	333.02	333.11	332.81	333.11	332.81	333.38	334.00	---	---	---	---	---	---	---	---	333.42	333.42
AD-7 (a)	33.05257	94.84219	347.86	350.82	38.0	9/24/09	Sch. 40 PVC	2	28.0	319.86	38.0	309.86	334.32	334.12	334.19	334.20	334.13	334.58	333.77	333.98	334.09	333.61	---	---	---	---	---	---	---	---	---	335.00
AD-8 (a)	33.05187	94.84026	337.53	340.01	29.0	9/21/09	Sch. 40 PVC	2	16.0	321.53	26.0	311.53	325.41	324.09	325.69	325.15	325.79	325.75	325.98	325.77	326.05	325.70	325.68	325.05	325.29	325.92	326.76	324.27	326.12	325.63	326.36	326.17
AD-9 (a)	33.04995	94.84196	340.32	343.09	35.0	9/21/09	Sch. 40 PVC	2	20.0	320.32	35.0	305.32	328.46	328.53	328.63	328.44	328.74	329.38	NM	330.18	329.98	329.74	329.28	329.53	328.92	329.31	330.50	328.05	329.47	329.40	329.98	330.01
AD-10 (a)	33.04881	94.84047	340.23	343.01	35.0	9/22/09	Sch. 40 PVC	2	20.0	320.23	35.0	305.23	323.44	322.55	323.27	323.35	323.51	323.76	323.57	323.88	323.95	323.55	---	---	---	---	---	---	---	323.53	324.19	324.06
AD-11 (a)	33.04824	94.84177	339.61	342.18	20.0	9/22/09	Sch. 40 PVC	2	10.0	329.61	20.0	319.61	327.99	328.37	327.82	327.93	327.94	328.13	328.20	327.97	328.96	328.13	328.39	328.14	327.87	328.20	328.90	328.25	327.85	327.61	327.83	328.72
AD-12 (a)	33.04901	94.84977	366.27	369.33	30.0	9/24/09	Sch. 40 PVC	2	20.0	346.27	30.0	336.27	348.30	348.29	349.86	349.56	349.99	349.65	349.89	350.01	350.65	350.39	---	---	---	---	---	---	---	349.52	348.28	350.81
AD-13 (a)	33.04918	94.84275	344.12	347.00	20.0	9/22/09	Sch. 40 PVC	2	6.0	338.12	16.0	328.12	332.36	332.24	333.09	332.26	332.68	333.25	333.35	332.01	337.58	334.76	334.54	332.93	332.39	332.84	334.54	331.83	331.42	331.83	331.52	332.98
AD-14 (a)	33.04715	94.84256	342.32	345.43	19.0	9/22/09	Sch. 40 PVC	2	8.0	334.32	18.0	324.32	330.40	329.80	331.67	330.34	330.94	331.69	332.12	330.17	336.63	334.83	334.51	331.71	330.94	330.79	332.63	330.87	329.91	330.76	330.52	333.94
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	343.29	46.0	12/12/15	Sch. 40 PVC	2	25.5	314.71	45.5	294.71	---	---	---	---	---	---	---	---	---	322.14	321.93	321.28	321.42	321.71	321.64	322.81	322.07	321.74	322.01	322.24
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	353.97	21.0	12/10/15	Sch. 40 PVC	2	11.0	339.86	21.0	329.86	---	---	---	---	---	---	---	---	---	337.09	335.84	332.14	331.52	331.43	330.96	330.71	---	---	---	---
AD-16R (e)	33° 02' 49"	94° 50' 28.9"	350.55	353.49	27.0	4/12/17	Sch. 40 PVC	2	12.0	338.55	27.0	323.55	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	327.12	328.68	326.71	335.13
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	357.10	40.0	12/10/15	Sch. 40 PVC	2	24.0	329.99	39.0	314.99	---	---	---	---	---	---	---	---	---	334.64	334.26	334.30	334.45	334.64	334.05	333.94	334.17	334.35	333.91	335.39
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	349.28	29.0	12/11/15	Sch. 40 PVC	2	14.0	332.17	29.0	317.17	---	---	---	---	---	---	---	---	---	343.66	343.26	340.81	339.92	339.38	338.97	340.38	339.43	342.75	340.97	343.70
AD-19	33.047201°	94.839694°	323.58	326.35	15.0	5/8/18	Sch. 40 PVC	2	5.0	318.58	15.0	308.58	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	321.24	321.54	322.65
AD-20	33° 02' 45.6"	94° 50' 22.8"	324.85	327.65	20.0	10/23/18	Sch. 40 PVC	2	4.0	320.85	19.0	305.85	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	323.28	322.89
AD-21	33° 02' 49.6"	94° 50' 20"	322.04	325.29	20.0	10/23/18	Sch. 40 PVC	2	3.5	318.54	18.5	303.54	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	320.26	320.72
AD-22	33° 03' 35"	94° 51' 09"	360.94	360.22	20.0	6/18/19	Sch. 40 PVC	2	5.0	355.94	20.0	340.94	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	358.24
AD-23	33° 03' 56"	94° 51' 08"	369.37	368.82	20.0	6/18/19	Sch. 40 PVC	2	5.0	364.37	20.0	349.37	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	364.98
Piezometers																																
B-2 (b)	33° 03.078'	94° 50.449'	339.7	339.7	50.0	10/28/09	Sch. 40 PVC	2	10.0	329.70	20.0	319.70	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-4 (b)	33° 03.011'	94° 50.462'	340.6	340.6	50.0	10/27/09	Sch. 40 PVC	2	8.0	332.60	18.0	322.60	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-5 (b)	33° 02.964'	94° 50.428'	340.0	340.0	50.0	10/27/09	Sch. 40 PVC	2	10.0	330.00	20.0	320.00	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-6 (b)	33° 02.912'	94° 50.462'	340.1	340.1	50.0	10/28/09	Sch. 40 PVC	2	12.0	328.10	22.0	318.10	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Temp-1	33.046864°	94.852059°	356.36	358.17	28.0	5/8/18	Sch. 40 PVC	2	8.0	348.36	28.0	328.36	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	345.55	342.79	350.08
MW-9	33° 03' 18"	94° 50' 19.4"	342.00	344.54	18.0	11/19/01	Sch. 40 PVC	2	3.0	339.00	18.0	324.00	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	331.34	331.24	NM
MW-10	33° 03' 13.6"	94° 50' 19.4"	341.96	344.80	19.0	11/19/01	Sch. 40 PVC	2	4.0	337.96	19.0	322.96	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	332.29	332.75	337.26

NOTES:

NM = Not measured

(a) Source: Eagle Environmental Services Well Logs (2009).

(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).

(c) Source: Southwest Electric Power, State of Texas Well Report (2001).

(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.

(e) Monitoring well installed by ARCADIS on April 12, 2017 as a replacement for monitoring well AD-16.

Groundwater Elevation Source: AEP, Shallow Groundwater Data Summary through February 2017.

1983 State Plane Lambert Coordinate System

Datum: NAD 83

ft bls = feet below land surface

ft msl = feet above mean sea level

Elev. = Elevation

---- = No record

Table 4-1
Soil and Coal Ash Sample Analytical Results (mg/kg) - CCR Units
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Sample ID	Date Sampled	Sample Depth (feet)	Units	Appendix III Parameters						Appendix IV Parameters															
				Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Soil Samples																									
Temp-1	5/8/18	15'	mg/kg	14.3	43.3	15	<1	5.0	93	<0.25	1.77	16.8	<0.05	<0.05	5.22	0.28	1.77	0.104	0.004	1.18	<0.25	1.26	0.273	<12.5	5.4
SB-2	5/10/18	22'	mg/kg	11.9	35.8	13	2	3.9	878	<0.25	<0.25	18.3	0.08	<0.05	3.53	0.551	3.98	0.08	0.005	0.287	0.684	<0.25	0.159	890	4.46
(AD-17)																									
SB-3	5/10/18	30'	mg/kg	3.05	90.2	94	1	3.8	1,194	<0.25	3.83	13.6	<0.05	0.132	9.21	0.649	4.22	0.322	0.009	1.64	<0.25	<0.25	0.593	3,960	6.87
(AD-18)																									
SB-4	5/9/18	5'	mg/kg	(FOC = 0.00723 g/g)			---	4.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
(AD-5)		27'	mg/kg	7.76	634	8	1	6.4	724	<0.25	1.81	20.4	0.115	0.417	6.73	4.76	3.2	13.6	0.006	0.561	0.536	<0.25	0.657	10,400	65.5
(Background)		27'	mg/kg	(FOC = 0.00688 g/g)																					
SB-5	5/9/18	19'	mg/kg	5.45	655	16	3	7.2	69	<0.25	1.11	8.53	0.109	0.241	3.75	3.58	2.96	10.5	0.044	0.313	0.297	<0.25	0.216	6,210	35.5
(AD-8)																									
SB-6	5/9/18	21'	mg/kg	5.33	397	20	2	7.8	116	<0.25	1.11	17.9	0.09	0.24	3.5	3.37	2.67	10.3	0.051	0.299	0.471	<0.25	2.502	5,970	38.4
(AD-9)																									
SB-7	5/9/18	13'	mg/kg	8.11	1,360	19	<1	5.0	198	<0.25	10.1	65	0.154	0.356	6.87	3.21	3.14	5.3	0.004	1.39	<0.25	<0.25	0.262	9,220	28.4
(AD-13)																									
SB-8	5/9/18	12'	mg/kg	16.6	6,150	13	1	5.2	24	<0.25	3.3	213	0.409	0.452	8.22	4.13	9.05	4.63	0.013	0.488	<0.25	<0.25	0.433	11,000	25.4
(AD-3)																									
AD-20	10/23/18	15-17	mg/kg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.567	---	---
AD-21	10/23/18	15-17	mg/kg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.424	---	---
AD-22	6/18/19	3-5	mg/kg	16.7	110	---	---	4.84	---	<0.25	8.43	136	0.544	0.935	29.9	13	18.9	18	0.053	0.711	1.81	<0.25	---	25,800	---
		6-8	mg/kg	10.2	18.7	---	---	4.1	---	<0.25	20.9	30.4	0.246	0.723	17.7	9.65	8.95	2.9	0.009	0.446	1.08	<0.25	---	22,500	---
		11-13	mg/kg	8.83	219	---	---	4.26	---	<0.25	5.96	77.1	0.293	0.571	16.5	8.75	6.57	4.4	0.045	0.536	0.885	<0.25	---	17,600	---
AD-23	6/18/19	3-5	mg/kg	32.7	115	---	---	4.64	---	<0.25	14.1	45.5	0.805	3.23	49	30.8	11	7.74	0.035	1.14	4.27	<0.25	---	85,500	---
		5-7	mg/kg	10.2	22.7	---	---	4.25	---	<0.25	6.3	31.7	0.288	0.775	19	9.74	8.56	4.83	0.014	0.378	1.12	<0.25	---	22,700	---
		10-12	mg/kg	9.16	200	---	---	4.21	---	<0.25	4.13	28.3	0.288	0.613	23.9	8.19	7.03	3.41	0.015	1.03	0.635	<0.25	---	18,500	---
Coal Ash Samples																									
Ash-1	5/10/18	1-2'	mg/kg	34.4	33,800	30.5	8.21	7.1	219	<0.877	14.6	607	1.02	0.464	31.8	5.55	16.9	11.6	0.0473	2.66	2.27	<0.54	*2.92*	37,500	139
		SPLP:	*mg/L*	*0.594*	*30.2*	---	---	---	---	*<0.00344*	*<0.00411*	*0.284*	*<0.000333*	*<0.000164*	*0.00273*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0176*	*<0.00363*	*<0.00287*	*0.0991*	*<0.0305*	*<0.00267*
		Pore Water:	*mg/L*	*0.643*	*113*	*20.1*	*1.86*	*7.4*	*6.6*	*<0.00344*	*0.0095*	*3.43*	*<0.000333*	*<0.000164*	*0.00396*	*<0.000553*	*<0.00285*	*0.0123*	*<0.0000653*	*0.00484*	*<0.00363*	*<0.00287*	0.755	---	*0.357*
Ash-2	5/10/18	1-2'	mg/kg	92.6	96,000	53.8	11.2	7.3	293	<1.56	19.4	2,760	1.64	1.56	41.2	9.63	24.5	15.5	0.0967	2.08	5.25	<0.957	*2.32*	18,300	365
		SPLP:	*mg/L*	*0.526*	*24.1*	---	---	---	---	*<0.00344*	*<0.00411*	*0.192*	*<0.000333*	*<0.000164*	*0.00222*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0165*	*<0.00363*	*<0.00287*	*0.112*	*<0.0305*	*<0.00267*
		Pore Water:	*mg/L*	*0.772*	*143*	*20.4*	*0.28*	*7.6*	*8.73*	*<0.00344*	*0.0106*	*3.99*	*<0.000333*	*<0.000164*	*0.00196*	*<0.000553*	*0.00346*	*0.0173*	*<0.0000653*	*0.00428*	*<0.00363*	*<0.00287*	0.508	---	*0.376*
Ash-3	5/10/18	1-2'	mg/kg	29	14,300	11.5	10.7	7.4	152	<0.687	11.8	766	0.845	0.394	19.2	5.77	12.2	6.87	0.0403	1.79	1.44	<0.423	*1.754*	21,100	110
		SPLP:	*mg/L*	*0.958*	*19.8*	---	---	---	---	*<0.00344*	*<0.00411*	*0.0315*	*<0.000333*	*<0.000164*	*0.00389*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0222*	*<0.00363*	*<0.00287*	*<0.256*	*0.471*	*<0.00267*
		Pore Water:	*mg/L*	*1.000*	*103*	*13.0*	*0.998*	*7.6*	*51.1*	*<0.00344*	*0.0108*	*1.54*	*<0.000333*	*<0.000164*	*0.00110*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0111*	*<0.00363*	*<0.00287*	0.594	---	*0.715*
Ash-4	5/10/18	1-2'	mg/kg	281	106,000	27.6	1.34	10.5	961	<0.757	9.72	3,390	2.23	1.06	35.1	16.2	16.3	20.4	0.0340	2.21	1.30	<0.466	*3.18*	24,200	177
		SPLP:	*mg/L*	*1.3*	*25.1*	---	---	---	---	*<0.00344*	*<0.00411*	*0.0216*	*<0.000333*	*<0.000164*	*0.00329*	*<0.000553*	*<0.00285*	*<0.0086*	*<0.0000653*	*<0.00281*	*<0.00363*	*<0.00287*	*<0.407*	*<0.0305*	*<0.00267*
		Pore Water:	*mg/L*	*4.75*	*63.5*	*28.8*	*0.697*	*10.8*	*381*	*<0.00344*	*0.00745*	*0.217*	*<0.000333*	*<0.000164*	*0.00225*	*0.00093*	*<0.00285*	*<0.0086*	*<0.0000653*	*0.0798*	*<0.00363*	*<0.00287*	0.259	---	*0.00814*

NOTES:

mg/kg = Milligrams per kilogram

mg/L = Milligrams per liter

FOC = Fraction organic carbon (Walkley Black)

--- = Not analyzed

SPLP = Synthetic precipitation leaching procedure (concentrations shown in milligrams per liter)

Total concentrations (mg/kg) shown in normal font, SPLP and Pore Water concentrations (mg/L) shown in italics.

Radium concentrations for soil shown in picoCuries per gram. SPLP concentrations shown in picoCuries per liter.

Table 4-2
Groundwater Sampling Analytical Results (mg/L) - Primary Bottom Ash Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Background (Upgradient) Wells																									
AD-1	05/26/16	0.346	36.5	5	<1	5.93	--	42	252	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.010	0.000033	<0.005	<0.005	<0.002	1.18	--	--
	07/27/16	0.350	39.6	4	<1	5.93	--	36	239	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.019	<0.000025	<0.005	<0.005	<0.002	0.9952	--	--
	09/29/16	0.332	15	5	<1	5.37	--	35	173	<0.005	<0.005	0.141	<0.001	<0.001	0.005	<0.005	<0.005	0.014	<0.000025	<0.005	<0.005	<0.002	1.38	--	--
	10/19/16	0.398	19.1	4	<1	5.15	--	42	192	<0.005	<0.005	0.114	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	1.141	--	--
	12/12/16	0.394	8.74	4	<1	5.18	--	40	200	<0.005	<0.005	0.072	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	0.719	--	--
	01/17/17	0.656	129	4	<1	7.13	--	68	538	<0.005	<0.005	0.410	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.000025	<0.005	<0.005	<0.002	3.009	--	--
	02/23/17	0.700	147	9	<1	6.88	--	68	612	<0.005	<0.005	0.488	<0.001	<0.001	<0.001	<0.005	<0.005	0.001	<0.000025	<0.005	<0.005	<0.002	4.309	--	--
	06/07/17	0.449	15.1	4	<0.083	5.06	109	42	176	<0.00093	0.00114	0.09346	0.00037	<0.00007	0.00066	0.00077	<0.00068	0.00902	0.000007	<0.00029	0.0021	<0.00086	0.676	--	--
	10/06/17	--	--	--	--	5.25	97.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.352	12.1	3	<0.083	4.82	8.4	--	174	<0.00093	<0.00105	0.08823	0.00048	<0.00007	<0.00023	0.0008	<0.00068	0.00816	<0.000005	<0.00029	<0.00099	<0.00086	0.837	0.03	0.025
	Dissolved	*0.35*	*12*	--	--	4.82	8.4	--	--	*<0.00093*	*<0.00105*	*0.08582*	*0.00044*	*<0.00007*	*<0.00023*	*0.00083*	*<0.00068*	*0.00799*	*<0.000005*	*<0.00029*	*0.00197*	*<0.00086*	*0.531*	0.01	0.026
	05/24/18	0.345	10.2	4	<0.083	5.19	118	43	150	0.00317 J	<0.00105	0.0799	0.00039 J	<0.00007	<0.00023	0.00035 J	<0.00068	0.00814	0.000006 J	<0.00029	0.00138 J	<0.00086	1.983	--	--
	08/14/18	0.443	5.95	5	<0.083	5.18	102	44	160	0.00003 J	0.00021	0.063	0.000482	0.00002	0.00016	0.000797	0.000238	0.00708	0.000013 J	0.00021	0.0017	0.00003 J	1.10	--	--
	02/20/19	0.504	142	2.82	0.24	7.31	113	49.2	522	0.00016	0.00046	0.457	0.00009 J	0.00001 J	0.000306	0.000399	0.000124	0.00155	<0.000025	0.001 J	0.0007	<0.0005	3.16	--	--
	05/30/19	0.689	--	1.59	0.29	--	61.3	43.3	588	0.00016	0.00060	0.512	0.000244	0.00001 J	0.0001 J	0.000756	0.000197	<0.009	<0.000005	0.00243	0.0014	<0.0001	--	0.099	0.0625
AD-5	05/31/16	0.03	36.9	15	<1	6.38	--	123	337	<0.005	<0.005	0.057	<0.001	<0.001	<0.001	0.014	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	1.63	--	--
	07/28/16	0.04	44.7	16	<1	6.38	--	163	360	<0.005	<0.005	0.093	<0.001	<0.001	<0.001	0.015	<0.005	0.191	<0.000025	<0.005	<0.005	<0.002	4.75	--	--
	09/29/16	0.04	46.3	15	<1	5.29	--	190	416	<0.005	<0.005	0.087	<0.001	<0.001	<0.001	0.014	<0.005	0.186	<0.000025	<0.005	<0.005	<0.002	3.33	--	--
	10/20/16	0.05	50.7	14	<1	5.92	--	267	448	<0.005	<0.005	0.07	<0.001	<0.001	<0.001	0.009	<0.005	0.225	<0.000025	<0.005	<0.005	<0.002	2.319	--	--
	12/13/16	0.05	49.6	13	<1	6.29	--	233	484	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	0.013	<0.005	0.199	<0.000025	<0.005	<0.005	<0.002	2.182	--	--
	01/17/17	0.04	49.8	14	<1	6.27	--	234	438	<0.005	<0.005	0.047	<0.001	<0.001	<0.001	0.012	<0.005	0.239	<0.000025	<0.005	<0.005	<0.002	1.023	--	--
	02/23/17	0.04	33.0	15	<1	5.48	--	127	286	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	0.013	<0.005	0.166	<0.000025	<0.005	<0.005	<0.002	1.788	--	--
	06/07/17	0.05281	49.7	14	<0.083	5.96	867	82	300	<0.00093	0.00385	0.0877	0.00008	0.00039	0.00028	0.01193	<0.00068	0.124	<0.000005	<0.00029	<0.00099	<0.00086	2.32	--	--
	10/06/17	--	--	--	--	5.59	249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.05063	30.1	21	<0.083	5.79	<100	--	248	<0.00093	<0.00105	0.07627	0.00014	0.00037	<0.00023	0.01907	<0.00068	0.118	<0.000005	<0.00029	<0.00099	<0.00086	1.495	14.4	0.45
	Dissolved	*0.03752*	*29.1*	--	--	5.79	<100	--	--	*<0.00093*	*<0.00105*	*0.06865*	*<0.00002*	*<0.00007*	*<0.00023*	*0.01747*	*<0.00068*	*0.119*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.043*	*2.051*	8.38	0.43
	05/24/18	0.05007	28.1	22	<0.083	6.22	17.8	60	242	<0.00093	<0.00105	0.07116	<0.00002	0.00023 J	0.0008 J	0.01424	<0.00068	0.121	<0.000005	<0.00029	<0.00099	<0.00086	1.946	--	--
	08/15/18	0.05	40.5	19	<0.083	6.23	57.1	240	428	0.00001 J	0.00169	0.0637	0.000055	0.000008 J	0.000072	0.0114	0.000079	0.147	<0.000005	0.00013	0.00008 J	<0.00005	0.316	--	--
	02/21/19	0.033	33.9	24.7	0.21	5.38	164	46.5	220	0.00002 J	0.00159	0.0694	0.00008 J	<0.00005	0.000432	0.00858	0.000147	0.0807	<0.000025	<0.002	0.0001 J	<0.0005	1.27	--	--
	05/30/19	0.03 J	--	22.3	0.29	--	150	51.3	238	<0.00002	0.00305	0.0605	0.00008 J	<0.00001	0.00006 J	0.0118	0.00005 J	0.104	0.000006	<0.0004	0.00005 J	<0.0001	--	23.4	0.331
AD-17	05/26/16	0.121	200	43	<1	7.17	--	1,166	1,810	<0.005	<0.005	0.021	<0.001	0.002	0.001	0.063	<0.005	0.370	0.000032	<0.005	<0.005	<0.002	1.53	--	--
	07/27/16	0.119	195	32	<1	7.17	--	1,005	1,576	<0.005	<0.005	0.020	<0.001	0.004	0.001	0.068	<0.005	0.374	<0.000025	<0.005	<0.005	<0.002	2.78	--	--
	09/29/16	0.111	191	36	<1	6.17	--	1,055	1,663	<0.005	<0.005	0.031	<0.001	<0.001	0.003	0.058	<0.005	0.354	<0.000025	<0.005	<0.005	<0.002	2.358	--	--
	10/20/16	0.124	194	32	1.0	6.14	--	1,163	1,612	<0.005	<0.005	0.034	<0.001	0.002	0.004	0.065	<0.005	0.394	<0.000025	<0.005	<0.005	<0.002	2.224	--	--
	12/13/16	0.135	196	31	<1	6.03	--	1,096	1,560	<0.005	<0.005	0.017	<0.001	0.003	<0.001	0.068	<0.005	0.323	<0.000025	<0.005	<0.005	<0.002	2.384	--	--
	01/17/17	0.101	196	33	<1	5.96	--	1,445	1,686	<0.005	<0.005	0.014	<0.001	0.003	0.068	0.068	<0.005	0.341	<0.000025	<0.005	<0.005	<0.002	2.436	--	--
	02/22/17	0.135	189	30	<1	5.67	--	1,055	1,628	<0.005	<0.005	0.020	<0.001	0.002	0.001	0.073	<0.005	0.331	<0.000025	<0.005	<0.005	<0.002	2.288	--	--
	06/06/17	0.121	188	30	<0.083	5.81	156	1,105	1,578	<0.00093	<0.00105	0.01033	<0.00002	0.00606	<0.00023	0.0748	<0.00068	0.329	0.000013	<0.00029	<0.00099	<0.00086	1.598	--	--
	10/05/17	--	--	--	--	5.92	598	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.247	213	45	<0.083	5.51	<100	--	1,846	<0.00093	<0.00105	0.00978	<0.00002	0.00915	<0.00023	0.07451	<0.00068	0.306	<0.000005	<0.00029	0.00414	<0.00086	1.514	260	3.72
	Dissolved	*0.231*	*205*	--	--	5.51	<100	--	--	*<0.00093*	*<0.00105*	*0.00737*	*<0.00002*	*0.00609*	*<0.00023*	*0.07938*	*<0.00068*	*0.301*	*<0.000005*	*<0.00029*	*0.00515*	*0.02*	*1.57*	241	3.56
	05/24/18	0.239	193	39	<0.083	6.28	7.8	1,067	1,836	<0.00093	<0.00105	0.00965	<0.00002	0.00646	<0.00023	0.07173	<0.00068	0.308	<0.000005	<0.00029	<0.00099	<0.00086	1.939	--	--
	08/15/18	0.118	187	40	<0.083	5.60	418	1,170	1,750	0.00002 J	0.00183	0.0128	0.000069	0.00025	0.000604	0.0435	0.0011	0.243	0.000011 J	0.00035	0.0003	0.000074	2.35	--	--
	02/21/19	0.151	207	43.2	0.180	6.93	274	1,060	1,720	0.00008 J	0.00251	0.120	0.00024	0.00027	0.00334	0.0645	0.00249	0.268	0.000007 J	0.0007 J	0.0008	<0.0005	2.66	--	--
	05/30/19	0.158	--	41.7	<0.04	--	176	1,120	1,546	<0.00002	0.00041	0.0196	0.00002 J	0.00003 J	0.000246	0.0511	0.00003 J	0.341	<0.000005	<0.0004	0.00006 J	<0.0001	--	145	3.40
Offsite Background (Upgradient) Monitoring Wells																									
AD-22	06/19/19	0.04 J	2.61	17.3	0.1 J	5.59	<100	17.4	148	<0.0002	0.00163	0.104	0.0004 J	<0.0001	0.002 J	0.0181	0.0007 J	0.03 J	0.000003 J	<0.004	0.0006 J	<0.001	1.403	16.2	--
AD-23	06/19/19	0.03 J	1.16	6.04	0.05 J	5.72	44.1	0.8	52	<0.0002	0.00201	0.082	0.0006 J	<0.0001	0.00911	0.0111	0.001 J	<0.009	0.000004 J	<0.004	0.0009 J	<0.001	0.617	6.54	--
Background Statistical Evaluation Summary - Upper Prediction Limits:^{a}										0.005	0.005	0.58	0.00073	0.01	0.0036	0.075	0.005	0.39	0.000033	0.002	0.005	0.0013	4.18	--	--

Table 4-2
Groundwater Sampling Analytical Results (mg/L) - Primary Bottom Ash Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Point of Compliance Wells																									
AD-8	05/31/16	1.46	32.6	36	1	6.91	--	217	524	<0.005	<0.005	0.034	<0.001	<0.001	0.002	0.007	<0.005	0.122	<0.000025	<0.005	<0.005	<0.002	1.046	--	--
	07/28/16	1.44	25.9	26	<1	6.91	--	202	469	<0.005	<0.005	0.026	<0.001	<0.001	<0.001	0.009	<0.005	0.098	<0.000025	<0.005	<0.005	<0.002	1.584	--	--
	09/29/16	1.51	24.3	28	<1	7.65	--	186	432	<0.005	<0.005	0.023	<0.001	<0.001	<0.001	0.007	<0.005	0.111	<0.000025	<0.005	<0.005	<0.002	6.3	--	--
	10/20/16	1.54	25.9	30	<1	6.07	--	184	424	<0.005	<0.005	0.024	<0.001	<0.001	<0.001	0.007	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	0.345	--	--
	12/12/16	1.53	23.6	27	<1	5.62	--	168	442	<0.005	<0.005	0.021	<0.001	<0.001	<0.001	0.007	<0.005	0.11	<0.000025	<0.005	<0.005	<0.002	1.083	--	--
	01/19/17	1.53	18.7	24	1	6.21	--	153	352	<0.005	<0.005	0.02	<0.001	<0.001	<0.001	0.006	<0.005	0.094	<0.000025	<0.005	<0.005	<0.002	0.823	--	--
	02/22/17	1.67	19.3	22	<1	6.78	--	163	356	<0.005	<0.005	0.019	<0.001	<0.001	<0.001	0.006	<0.005	0.092	<0.000025	<0.005	<0.005	<0.002	0.536	--	--
	06/06/17	1.39	17.4	22	0.6628	5.63	54	151	368	<0.00093	<0.00105	0.01908	<0.00002	<0.00007	<0.00023	0.00386	<0.00068	0.09491	0.000008	<0.00029	<0.00099	<0.00086	1.0735	--	--
	10/05/17	--	--	--	--	6.68	41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/30/18	1.29	17.2	22	0.716	6.07	3.0	--	368	<0.00093	<0.00105	0.02283	0.00004	<0.00007	<0.00023	0.00521	<0.00068	0.08418	0.000009	<0.00029	<0.00099	<0.00086	1.106	0.673	0.388
	Dissolved	*1.31*	*17.1*	--	--	6.07	3.0	--	--	*<0.00093*	*<0.00105*	*0.02046*	*<0.00002*	*<0.00007*	*<0.00023*	*0.00513*	*<0.00068*	*0.08356*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*0.5773*	< 0.01	0.363
	05/23/18	--	--	--	0.501 J	6.20	*48.2*	--	--	0.00319 J	<0.00105	0.02212	<0.00002	<0.00007	<0.00023	0.00319 J	<0.00068	0.0956	<0.000005	<0.00029	0.00175 J	<0.00086	0.3366	--	--
	8/15/18[b]	1.30	15.0	24	0.615 J	6.77	104	122	288	0.00001 J	0.00031	0.0212	0.000008 J	0.000002 J	0.00005	0.00536	0.000039	0.0555	0.000007 J	0.00016	0.00007 J	0.000129	3.44	--	--
	02/21/19	1.47	17.6	23.2	0.660	6.40	88.2	163	352	<0.0001	0.00057	0.0281	0.00003 J	0.00003 J	0.000456	0.00288	0.000223	0.0911	<0.000025	<0.002	0.0001 J	<0.0005	0.417	--	--
	05/29/19	1.07	--	19.5	0.89	--	76.4	150	324	<0.00002	0.00037	0.0303	<0.00002	0.00002 J	0.0001 J	0.00603	0.00007 J	0.067	<0.000005	<0.0004	0.00006 J	0.0001 J	--	1.07	0.457
AD-9	05/31/16	0.12	229	88	<1	6.32	--	1,352	2,541	<0.005	<0.005	0.051	<0.001	0.001	<0.001	0.027	<0.005	1.32	<0.000025	<0.005	<0.005	<0.002	2.95	--	--
	07/28/16	0.105	255	98	<1	6.32	--	1,464	2,564	<0.005	<0.005	0.031	<0.001	0.002	<0.001	0.022	<0.005	1.38	0.000045	<0.005	0.008	<0.002	1.447	--	--
	09/29/16	0.115	220	86	<1	4.72	--	1,301	2,448	<0.005	<0.005	0.033	<0.001	<0.001	<0.001	0.012	<0.005	1.17	<0.000025	<0.005	<0.005	<0.002	3.199	--	--
	10/19/16	0.109	228	76	1	5.22	--	1,350	2,494	<0.005	<0.005	0.026	<0.001	<0.001	<0.001	0.016	<0.005	1.44	<0.000025	<0.005	<0.005	<0.002	1.311	--	--
	12/12/16	0.108	250	92	<1	5.72	--	1,639	2,667	<0.005	<0.005	0.027	<0.001	0.002	<0.001	0.024	<0.005	1.33	<0.000025	<0.005	<0.005	<0.002	3.0	--	--
	01/19/17	0.312	91.1	54	<1	5.43	--	884	1,360	<0.005	<0.005	0.098	0.002	<0.001	<0.001	0.042	<0.005	0.634	<0.000025	<0.005	<0.005	<0.002	2.349	--	--
	02/22/17	0.1	258	86	<1	5.77	--	1,774	2,662	<0.005	<0.005	0.022	<0.001	<0.001	<0.001	0.024	<0.005	1.41	<0.000025	<0.005	<0.005	<0.002	2.32	--	--
	06/06/17	0.146	191	19	<0.083	4.61	100	105	308	<0.00093	<0.00105	0.04227	0.00077	0.00222	<0.00023	0.02416	<0.00068	1.00	0.000006	<0.00029	<0.00099	<0.00086	1.586	--	--
	10/05/17	--	--	--	--	5.78	102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	0.08607	10.5	85	<0.083	4.20	<100		1,972	<0.00093	<0.00105	0.04937	0.00134	0.00023	<0.00023	0.01628	<0.00068	0.217	<0.000005	<0.00029	<0.00099	<0.00086	1.582	0.446	0.378
	Dissolved	*0.07126*	*10.2*	--	--	4.20	<100	--	--	*<0.00093*	*<0.00105*	*0.04695*	*0.00122*	*0.00012*	*<0.00023*	*0.01592*	*<0.00068*	*0.204*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.549*	0.166	0.369
	05/23/18	--	--	--	<0.083	5.30	44.6	--	--	<0.00093	<0.00105	0.03045	0.00032 J	0.00288	<0.00023	0.0267	<0.00068	1.20	<0.000005	<0.00029	<0.00099	0.00846	2.556	--	--
	8/15/18[b]	0.198	230	103	<0.083	4.96	237	1,910	2,694	<0.01	0.00168	0.0242	0.000268	0.00006	0.00042	0.0111	0.000262	0.851	0.000013 J	0.00011	0.0003	0.000062	1.864	--	--
	02/21/19	1.39	211	89	0.19	4.98	115	1,350	2,240	<0.0001	0.00118	0.0524	0.000474	0.00009	0.000313	0.0148	0.00008 J	1.12	0.00001 J	<0.002	0.0003	0.0001 J	2.51	--	--
	05/29/19	0.06 J	--	44	0.16	--	27.2	503	1,758	<0.00002	0.0002	0.0497	0.000941	0.00021	0.000346	0.0159	0.00007 J	0.225	<0.000005	<0.0004	0.0002	0.0002 J	--	0.485	0.363
AD-15	05/31/16	0.329	5.09	30	<1	5.58	--	24	188	<0.005	0.012	0.215	<0.001	<0.001	0.017	0.011	0.007	0.017	0.000054	<0.005	<0.005	<0.002	2.28	--	--
	07/28/16	0.407	3.83	34	<1	5.58	--	28	196	<0.005	0.006	0.124	<0.001	<0.001	0.004	0.006	<0.005	0.021	<0.000025	<0.005	<0.005	<0.002	1.322	--	--
	09/29/16	0.360	13.7	28	<1	4.57	--	23	367	<0.005	0.131	1.93	0.015	0.007	0.28	0.134	0.161	0.149	0.000707	<0.005	0.014	<0.002	9.92	--	--
	10/19/16	0.152	4.57	26	<1	4.35	--	17	152	<0.005	0.023	0.415	0.002	<0.001	0.054	0.019	0.022	0.036	0.0001	<0.005	<0.005	<0.002	3.567	--	--
	12/12/16	0.334	3.60	26	<1	4.67	--	19	204	<0.005	0.006	0.184	<0.001	<0.001	0.015	0.010	<0.005	0.013	0.000026	<0.005	<0.005	<0.002	3.36	--	--
	01/19/17	0.413	3.35	32	<1	5.77	--	25	176	<0.005	0.006	0.153	<0.001	<0.001	0.009	0.007	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	2.386	--	--
	02/22/17	0.100	4.21	20	<1	4.95	--	8	88	<0.005	0.020	0.353	0.002	<0.001	0.049	0.020	0.019	0.025	0.000058	<0.005	<0.005	<0.002	2.261	--	--
	06/06/17	0.321	3.57	27	<0.083	4.83	246	19	184	<0.00093	0.00854	0.166	0.00061	0.00048	0.01235	0.00844	0.00298	0.0108	0.000022	<0.00029	0.00271	<0.00086	2.491	--	--
	10/05/17	--	--	--	--	5.94	208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/30/18	0.08009	2.49	22	<0.083	4.60	7.32		94	<0.00093	0.00222	0.08419	0.00024	<0.00007	<0.00023	0.00403	<0.00068	0.00395	<0.000005	<0.00029	<0.00099	<0.00086	1.749	6.64	0.036
	Dissolved	*0.05773*	*2.49*	--	--	4.60	7.32	--	--	*<0.00093*	*<0.00105*	*0.08405*	*0.00019*	*<0.00007*	*<0.00023*	*0.00346*	*<0.00068*	*0.00378*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*0.748*	< 0.01	0.034
	Field Filtered[c]	*0.301*	*3.03*	*35*	*<0.083*	4.60	7.32	--	*8*	*<0.00093*	*0.00216*	*0.08611*	*0.00012*	*<0.00007*	*<0.00023*	*0.00421*	*<0.00068*	*0.00498*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.630*	7.09	0.061
	FF Dissolved[c]	*0.309*	*3*	--	--	4.60	7.32	--	--	*<0.00093*	*<0.00105*	*0.08373*	*0.00024*	*<0.00007*	*<0.00023*	*0.0038*	*<0.00068*	*0.00516*	*<0.000005*	*0.00048*	*<0.00099*	*<0.00086*	*5.743*	<0.01	0.062
	05/23/18	--	--	--	<0.083	4.76	147	--	--	<0.00093	0.00256 J	0.102	0.00003 J	0.0001 J	0.00263	0.00474 J	<0.00068	0.00562	<0.000005	<0.00029	0.00154 J	0.00137 J	1.46	--	--
	8/15/18[b]	0.341	3.04	37	<0.083	4.59	249	24	174	0.00003 J	0.00326	0.0852	0.000116	0.00001 J	0.000481	0.00371	0.000438	0.00338	0.000008 J	0.00005 J	0.0009	0.00009	1.076	--	--
	02/21/19	0.169	2.67	28.2	0.09	4.98	116	10.6	150	<0.0001	0.00221	0.0766	0.000208	0.00001 J	0.000225	0.0029	0.000104	0.00294	<0.000025	<0.002	0.0004	<0.0005	0.841	--	--
	05/29/19	<0.02	--	21.4	0.06	--	185	2.1	34	<0.0001	0.00410	0.199	0.00186	0.00008 J	0.0103	0.00595	0.0101	0.01 J	0.000081	<0.002	0.0057	<0.0005	--	18.4	0.0423

Table 4-2
Groundwater Sampling Analytical Results (mg/L) - Primary Bottom Ash Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Supplemental Downgradient Monitoring Wells																									
AD-10	5/16/2018	0.08311	15.5	40	<0.083	3.72	<100	--	280	<0.00093	0.0022	0.03855	0.00166	0.00033	<0.00023	0.02432	<0.00068	0.316	<0.000005	<0.00029	<0.00099	0.00098	1.704	0.338	0.25
	Dissolved	*0.07733*	*15.3*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.03712*	*0.00149*	*0.00009*	*<0.00023*	*0.02412*	*<0.00068*	*0.296*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.505*	0.282	0.251
Supplemental Sidegradient Monitoring Wells																									
MW-9	5/15/2018	0.578	44.8	93	<0.083	4.74	57.4	--	780	0.00097	<0.00105	0.01661	0.00021	0.00019	<0.00023	0.03083	<0.00068	0.03225	0.000127	<0.00029	<0.00099	<0.00086	0.779	0.142	0.306
	Dissolved	*0.556*	*44.7*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.01588*	*0.00015*	*0.00036*	*<0.00023*	*0.03189*	*0.00813*	*0.03151*	*0.00015*	*<0.00029*	*<0.00099*	*<0.00086*	*0.2578*	< 0.01	0.308
MW-10	5/15/2018	0.707	59.3	5	<0.083	6.68	1.7	--	346	<0.00093	0.00128	0.08634	0.00006	<0.00007	<0.00023	0.00385	<0.00068	0.01001	<0.000005	0.00079	0.01898	<0.00086	0.969	0.101	0.054
	Dissolved	*0.689*	*59.8*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.08253*	*<0.00002*	*<0.00007*	*<0.00023*	*0.00064*	*<0.00068*	*0.00924*	*<0.000005*	*0.00082*	*0.01651*	*<0.00086*	*1.026*	< 0.01	0.002
EPA MCLs:																									
MCL					4					0.006	0.01	2	0.004	0.005	0.1				0.002		0.05	0.002	5[e]		
Rule Specified																0.006	0.015	0.04		0.1					
Background Limit					1					0.005	0.005	0.36	0.00077	0.0065[d]	0.004	0.075[d]	0.005	0.39[d]	0.000033	0.005	0.005	0.0013	4.21[e]		
Interwell Background Value(s) (UPL, LPL where applicable) AD-8, AD-9, AD-15		0.775				4.8-7.1																			
Intrawell Background Value (UPL) AD-8			35.7	38.3	1.03			236	569																
Intrawell Background Value (UPL) AD-9			350	139	0.73			2527	3147																
Intrawell Background Value (UPL) AD-15			5.71	38.4	1.00			35.6	388																

NOTES:
All concentration data are provided in milligrams per liter (mg/L) unless otherwise noted.
J = Analyte was positively identified, though the quantitation was below Reporting Limit.
MCL - Maximum contaminant level
LPL = Lower prediction limit
UPL = Upper prediction limit
pCi/L = PicoCuries per liter
-- = Not analyzed
a = Data taken from Geosyntec "Statistical Analysis Summary, Primary Bottom Ash Pond" dated July 11, 2019.
b = Some inorganic analyte groundwater samples collected 9/17/18.
c = Sample ID "AD-15 DUP" was field filtered (FF) using a 5 micron filter.
d = Calculated Upper Tolerance Limit is higher than MCL.
e = Data is "Combined Radium, Total".
🟨 Denotes groundwater sample collected by ARCADIS using low-flow methods.
Unless otherwise noted, values shown are total (unfiltered) analyses.
Dissolved (0.45-micron lab filtered) parameter concentrations shown in italics.

Table 4-3
Groundwater Sampling Analytical Results (mg/L) - Landfill
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Background (Upgradient) Wells																									
AD-5	05/31/16	0.03	36.9	15	<1	6.38	--	123	337	<0.005	<0.005	0.057	<0.001	<0.001	<0.001	0.014	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	1.63	--	--
	07/28/16	0.04	44.7	16	<1	6.38	--	163	360	<0.005	<0.005	0.093	<0.001	<0.001	<0.001	0.015	<0.005	0.191	<0.000025	<0.005	<0.005	<0.002	4.75	--	--
	09/29/16	0.04	46.3	15	<1	5.29	--	190	416	<0.005	<0.005	0.087	<0.001	<0.001	<0.001	0.014	<0.005	0.186	<0.000025	<0.005	<0.005	<0.002	3.33	--	--
	10/20/16	0.05	50.7	14	<1	5.92	--	267	448	<0.005	<0.005	0.07	<0.001	<0.001	<0.001	0.009	<0.005	0.225	<0.000025	<0.005	<0.005	<0.002	2.319	--	--
	12/13/16	0.05	49.6	13	<1	6.29	--	233	484	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	0.013	<0.005	0.199	<0.000025	<0.005	<0.005	<0.002	2.182	--	--
	01/17/17	0.04	49.8	14	<1	6.27	--	234	438	<0.005	<0.005	0.047	<0.001	<0.001	<0.001	0.012	<0.005	0.239	<0.000025	<0.005	<0.005	<0.002	1.023	--	--
	02/23/17	0.04	33.0	15	<1	5.48	--	127	286	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	0.013	<0.005	0.166	<0.000025	<0.005	<0.005	<0.002	1.788	--	--
	06/07/17	0.05281	49.7	14	<0.083	5.96	867	82	300	<0.00093	0.00385	0.0877	0.00008	0.00039	0.00028	0.01193	<0.00068	0.124	<0.000005	<0.00029	<0.00099	<0.00086	2.32	--	--
	10/06/17	--	--	--	--	5.59	249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.05063	30.1	21	<0.083	5.79	<100	--	248	<0.00093	<0.00105	0.07627	0.00014	0.00037	<0.00023	0.01907	<0.00068	0.118	<0.000005	<0.00029	<0.00099	<0.00086	1.495	14.4	0.45
	Dissolved	*0.03752*	*29.1*	--	--	5.79	<100	--	--	*<0.00093*	*<0.00105*	*0.06865*	*<0.00002*	*<0.00007*	*<0.00023*	*0.01747*	*<0.00068*	*0.119*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.043*	*2.051*	8.38	0.43
	05/24/18	0.05007	28.1	22	<0.083	6.22	17.8	60	242	<0.00093	<0.00105	0.07116	<0.00002	0.00023 J	0.0008 J	0.01424	<0.00068	0.121	<0.000005	<0.00029	<0.00099	<0.00086	1.946	--	--
	08/15/18	0.05	40.5	19	<0.083	6.23	57.1	240	428	0.00001 J	0.00169	0.0637	0.000055	0.000008 J	0.000072	0.0114	0.000079	0.147	<0.000005	0.00013	0.00008 J	<0.01	0.316	--	--
	02/21/19	0.033	33.9	24.7	0.21	5.38	164	46.5	220	0.00002 J	0.00159	0.0694	0.00008 J	<0.00005	0.000432	0.00858	0.000147	0.0807	<0.000025	<0.002	0.0001 J	<0.0005	1.27	--	--
	05/30/19	0.03 J	--	22.3	0.29	--	150	51.3	238	<0.00002	0.00305	0.0605	0.00008 J	<0.00001	0.00006 J	0.0118	0.00005 J	0.104	0.000006	<0.0004	0.00005 J	<0.0001	--	23.4	0.331
AD-18[d]	05/26/16	0.146	409	422	<1	5.1	--	5,135	10,000	<0.005	<0.005	0.012	0.014	0.003	<0.001	0.922	<0.005	2.07	0.000168	<0.005	0.006	0.003	12.58	--	--
	07/27/16	0.148	457	432	2	5.1	--	4,930	9,476	<0.005	<0.005	0.019	0.005	0.002	<0.001	0.734	<0.005	1.94	0.000091	<0.005	0.007	0.003	10.62	--	--
	09/29/16	0.156	469	637	4	5.59	--	4,632	9,569	<0.005	<0.005	0.02	0.004	<0.001	<0.001	0.666	<0.005	1.86	0.000117	<0.005	0.007	<0.002	7.05	--	--
	10/20/16	0.188	498	876	0.8664	5.7	--	5,537	9,540	<0.005	<0.005	0.021	0.002	0.001	<0.001	0.569	<0.005	2.06	0.000053	<0.005	<0.005	<0.002	5.82	--	--
	12/13/16	0.178	510	695	5	5.75	--	4,382	8,912	<0.005	<0.005	0.021	0.007	0.001	<0.001	0.641	<0.005	1.74	0.00005	<0.005	<0.005	<0.002	9.6	--	--
	01/17/17	0.050	412	159	5	4.49	--	5,414	8,562	<0.005	0.01	0.014	0.022	0.001	<0.001	0.929	<0.005	1.95	0.000224	<0.005	<0.005	0.002	22.51	--	--
	02/22/17	0.090	401	151	6	4.37	--	5,169	8,412	<0.005	<0.005	0.014	0.026	0.002	<0.001	0.961	<0.005	1.82	0.000107	<0.005	<0.005	0.00228	19.11	--	--
	06/06/17	0.125	428	304	6.53	4.27	121	5,920	9,394	<0.00093	0.00331	0.01038	0.01883	0.00303	<0.00023	0.940	<0.00068	2.15	0.000113	<0.00029	0.00212	<0.00086	16.12	--	--
	10/05/17	--	--	--	--	5.87	165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.163	433	362	9.4	3.61	104.1	--	9,952	0.00224	0.00276	0.00813	0.01733	0.0036	0.00098	0.928	<0.00068	2.07	0.000043	<0.00029	0.00194	0.00144	19.95	19.7	14.1
	Dissolved	*0.153*	*423*	--	--	--	--	--	--	*0.00467*	*0.00189*	*0.00748*	*0.01676*	*0.00316*	*<0.00023*	*0.898*	*<0.00068*	*2.06*	*0.000012*	*<0.00029*	*0.00135*	*0.01466*	*18.09*	19.1	13.7
	05/30/19	0.09 J	--	390	3.56	--	91.3	6,120	9,564	<0.0002	0.040	0.009 J	0.021	0.004 J	<0.004	1.130	0.005 J	1.27	0.000035	<0.04	0.103	<0.01	--	11.2	7.53
Background Statistical Evaluation Summary - Upper Prediction Limits:[a]										0.005	0.005	0.36	0.00077	0.0065	0.004	0.075	0.005	0.39	0.000033	0.005	0.005	0.002	4.21	--	--
Point of Compliance Wells																									
AD-11	05/31/16	2.47	8.47	9	2	5.21	--	518	388	<0.005	<0.005	0.014	0.004	<0.001	0.003	0.026	<0.005	0.032	<0.000025	<0.005	<0.005	<0.002	1.77	--	--
	07/28/16	2.83	8.88	10	2	5.21	--	596	1,000	<0.005	<0.005	0.012	0.004	<0.001	<0.001	0.026	<0.005	0.047	<0.000025	<0.005	<0.005	<0.002	2.23	--	--
	09/29/16	3.4	10.7	12	2	4.08	--	683	1,065	<0.005	<0.005	0.052	0.005	<0.001	0.007	0.03	<0.005	0.047	<0.000025	<0.005	<0.005	<0.002	3.92	--	--
	10/19/16	3.77	8.78	11	<1	3.68	--	706	1,024	<0.005	<0.005	0.02	0.005	<0.001	0.002	0.027	<0.005	0.047	<0.000025	<0.005	<0.005	<0.002	2.56	--	--
	12/12/16	3.36	8.98	10	2	3.75	--	548	1,044	<0.005	<0.005	0.013	0.004	<0.001	<0.001	0.025	<0.005	0.041	<0.000025	<0.005	<0.005	<0.002	1.569	--	--
	01/17/17	2.81	10.3	11	2	4.41	--	760	1,048	<0.005	<0.005	0.013	0.004	<0.001	<0.001	0.025	<0.005	0.046	<0.000025	<0.005	<0.005	<0.002	1.082	--	--
	02/22/17	2.88	9.31	10	2	4.34	--	558	876	<0.005	<0.005	0.019	0.004	<0.001	0.002	0.024	<0.005	0.035	<0.000025	<0.005	<0.005	<0.002	1.45	--	--
	06/06/17	2.79	9.93	10	1.366	3.86	219	556	960	<0.00093	0.00123	0.01012	0.00279	0.00041	0.00032	0.02216	<0.00068	0.03654	<0.000005	<0.00029	<0.00099	<0.00086	1.902	--	--
	10/05/17	--	--	--	--	4.43	162	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	1.48	4.37	10	<0.083	3.77	75.3		558	0.00417	0.00127	0.01281	0.00148	0.00053	0.00041	0.00935	<0.00068	0.01978	<0.000005	0.00094	0.00103	<0.00086	1.264	1.35	0.063
	Dissolved	*1.45*	*4.28*	--	--	3.77	75.3	--	--	*<0.00093*	*0.00278*	*0.01202*	*0.00098*	*<0.00007*	*<0.00023*	*0.00877*	*<0.00068*	*0.01836*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.656*	1.25	0.062
	05/23/18	--	--	--	<0.083	*4.05*	*49.8*	--	--	<0.00093	0.0026 J	0.01627	0.00089 J	0.00018 J	0.0008 J	0.00863	<0.00068	0.01875	0.000007 J	<0.00029	0.00134 J	0.046	1.912	--	--
	08/15/18	1.84	6.61	15	<0.083	4.73	112	410	720	--	0.00105	0.0119	0.00118	0.00037	0.000257	0.0153	--	0.0175	<0.000005	--	0.0024	0.0002	2.6	--	--
	05/29/19	1.40	--	6.96	0.47	--	67.6	367	680	<0.0001	0.00113	0.0182	0.00138	0.0002 J	0.0004 J	0.00969	0.000804	0.02 J	<0.000005	<0.002	0.0022	<0.0005	--	1.46	0.0669
AD-13	05/31/16	1.19	8.02	12	<1	6.05		177	900	<0.005	<0.005	0.062	<0.001	<0.001	<0.001	<0.005	<0.005	0.011	<0.000025	<0.005	<0.005	<0.002	1.22	--	--
	07/27/16	1.23	3.7	15	1	6.05		187	--	<0.005	<0.005	0.036	<0.001	<0.001	<0.001	<0.005	<0.005	0.026	<0.000025	<0.005	<0.005	<0.002	1.601	--	--
	09/29/16	1.37	2.7	17	1	4.56		207	431	<0.005	<0.005	0.04	<0.001	<0.001	<0.001	<0.005	<0.005	0.02	<0.000025	<0.005	<0.005	<0.002	2.213	--	--
	10/19/16	1.67	3.66	19	1	4.34		226	482	<0.005	<0.005	0.03	<0.001	<0.001	<0.001	<0.005	<0.005	0.022	<0.000025	<0.005	<0.005	<0.002	3.662	--	--
	12/05/16	--	--	--	--	--		--	532	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	12/13/16	1.96	3.77	18	1	4.79		287	596	<0.005	<0.005	0.051	0.001	<0.001	0.007	0.007	<0.005	0.025	<0.000025	<0.005	<0.005	<0.002	2.27	--	--
	01/19/17	0.402	33.5	7	<1	5.38		90	222	<0.005	0.006	0.112	<0.001	<0.001	0.004	<0.005	<0.005	0.004	<0.000025	<0.005	<0.005	<0.002	2.228	--	--
	02/23/17	1.27	10.3	13	<1	5.06		183	392	<0.005	<0.005	0.041	<0.001	<0.001	<0.001	<0.005	<0.005	0.015	<0.000025	<0.005	<0.005	<0.002	1.556	--	--
	06/06/17	1.68	3.03	15	0.6679	4.22	171	244	494	0.00153	<0.00105	0.01712	0.00089	0.00014	<0.00023	0.00624	<0.00068	0.02082	<0.000005	<0.00029	0.00103	<0.00086	1.565	--	--
	10/06/17	--	--	--	--	4.61	173	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	1.42	7.48	10	0.5362	4.20	1.4		532	<0.00093	<0.00105	0.0216	0.00088	0.00011	<0.00023	0.00809	<0.00068	0.02603	<0.000005	<0.00029	<0.00099	<0.00086	2.064	0.858	0.046
	Dissolved	*1.41*	*7.31*	--	--	4.20	1.4	--	--	*<0.00093*	*<0.00105*	*0.02097*	*0.0008*	*<0.00007*	*<0.00023*	*0.00784*	*<0.00068*	*0.02439*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.407*	0.712	0.045
	05/23/18	--	--	--	0.6534 J	*4.52*	*52.7*	--	--	<0.00093	<0.00105	0.02653	0.00087 J	<0.00007	0.00073 J	0.00937	<0.00068	0.0291	0.000008 J	<0.00029	<0.00099	<0.043	2.16	--	--
	08/14/18	1.49	10.1	18	0.7442	4.82	131	316	620	--	0.00137	0.0169	0.000971	0.00031	0.000503	0.0131	--	0.0321	<0.000005	--	0.0017	0.000277	4.0	--	--
	05/30/19	0.477	--	3.6	0.53	--	83.6	94	196	0.00003 J	0.00032	0.0609	0.000385	0.00007	0.00031	0.00315	0.00005 J	0.009 J	<0.000005	<0.0004	0.0004	<0.0001	--	0.086	0.0141

Table 4-3
Groundwater Sampling Analytical Results (mg/L) - Landfill
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
AD-14	05/31/16	1.28	2.88	4	<1	4.75	--	115	285	<0.005	<0.005	0.031	<0.001	<0.001	<0.001	0.010	<0.005	0.012	0.00003	<0.005	<0.005	<0.002	0.87	--	--
	07/27/16	1.14	2.51	5	<1	4.75	--	111	267	<0.005	<0.005	0.084	<0.001	<0.001	0.001	0.009	<0.005	0.024	<0.000025	<0.005	<0.005	<0.002	1.487	--	--
	09/29/16	1.14	1.19	5	<1	4.17	--	111	252	<0.005	<0.005	0.03	<0.001	<0.001	<0.001	0.009	<0.005	0.015	<0.000025	<0.005	<0.005	<0.002	4.817	--	--
	10/19/16	1.25	2.48	4	<1	3.88	--	118	276	<0.005	<0.005	0.039	<0.001	0.001	<0.001	0.009	<0.005	0.014	<0.000025	<0.005	<0.005	<0.002	1.972	--	--
	12/12/16	1.25	2.41	5	<1	4.11	--	101	296	<0.005	<0.005	0.047	<0.001	0.001	0.001	0.009	<0.005	0.013	0.000037	<0.005	<0.005	<0.002	1.271	--	--
	01/17/17	0.915	10.3	4	<1	6.07	--	92	254	<0.005	<0.005	0.038	<0.001	<0.001	<0.001	<0.005	<0.005	0.013	<0.000025	<0.005	<0.005	<0.002	1.825	--	--
	02/22/17	1.06	9.48	4	<1	5.39	--	90	212	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	<0.005	<0.005	0.012	<0.000025	<0.005	<0.005	<0.002	0.512	--	--
	06/06/17	1.26	7.69	6	<0.083	4.77	167	108	256	<0.00093	<0.00105	0.04483	0.00038	0.00067	0.00127	0.00678	<0.00068	0.0127	0.000021	<0.00029	0.00261	<0.00086	1.138	--	--
	10/06/17	--	--	--	--	4.57	150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	1.61	4.67	11	<0.083	4.11	5.1	--	332	<0.00093	<0.00105	0.03161	0.00094	0.00204	<0.00023	0.01501	<0.00068	0.01638	0.000137	<0.00029	0.00221	<0.00086	1.097	0.09	0.008
	Dissolved	*1.56*	*4.55*	--	--	4.11	5.1	--	--	*<0.00093*	*<0.00105*	*0.02938*	*0.00094*	*0.00193*	*<0.00023*	*0.01476*	*<0.00068*	*0.01523*	*0.000149*	*<0.00029*	*0.00387*	*<0.00086*	*0.5903*	0.06	0.007
	05/23/18	--	--	--	<0.083	4.17	43.2	--	--	<0.00093	<0.00105	0.02817	0.00078 J	0.00161	<0.00023	0.01434	<0.00068	0.0152	0.000145	<0.00029	0.00362	<0.043	1.601	--	--
	08/14/18	1.51	4.51	12	<0.083	4.27	198	204	384	--	0.00039	0.024	0.000854	0.00199	0.000276	0.0176	--	0.011	0.000181	--	0.0037	0.000242	1.5	--	--
	05/29/19	1.21	--	3.65	0.19	--	20.6	122	274	<0.0001	0.0005	0.0434	0.000709	0.00087	0.0002 J	0.00774	0.0001 J	0.02 J	0.000181	<0.0002	0.0019	<0.0005		0.005 J	0.00023
Supplemental Downgradient Monitoring Well																									
AD-10	5/16/2018	0.08311	15.5	40	<0.083	3.72	<100	--	280	<0.00093	0.0022	0.03855	0.00166	0.00033	<0.00023	0.02432	<0.00068	0.316	<0.000005	<0.00029	<0.00099	0.00098	1.704	0.338	0.25
	Dissolved	*0.07733*	*15.3*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.03712*	*0.00149*	*0.00009*	*<0.00023*	*0.02412*	*<0.00068*	*0.296*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*1.505*	0.282	0.251
Supplemental Sidegradient Monitoring Wells																									
Temp-1	5/17/2018	0.662	26.2	34	<0.083	4.90	23.8	--	556	<0.00093	<0.00105	0.07752	0.00058	<0.00007	0.00102	0.01058	<0.00068	0.01075	<0.000005	<0.00029	<0.00099	<0.00086	1.277	1.94	0.203
	Dissolved	*0.621*	*24.6*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.06778*	*0.00042*	*<0.00007*	*<0.00023*	*0.00946*	*<0.00068*	*0.00986*	*<0.000005*	*<0.00029*	*<0.00099*	*0.00191*	*2.278*	0.813	0.192
AD-12	6/19/2019	0.569	34.1	44.1	0.32	6.3	40.1	131	436	<0.0001	0.00123	0.0581	0.0004 J	0.00005 J	0.0003 J	0.0126	<0.0001	0.042	<0.000002	<0.002	0.0005 J	<0.0005	2.007	25.9	--
EPA MCLs:																									
MCL					4					0.006	0.01	2	0.004	0.005	0.1				0.002		0.05	0.002	5[c]		
Rule Specified																0.006	0.015	0.04		0.1					
Background Limit					1					0.005	0.005	0.36	0.00077	0.0065[b]	0.004	0.075[b]	0.005	0.39[b]	0.000033	0.005	0.005	0.0013	4.21[c]		
Interwell Background Value(s) (UPL, LPL where applicable) AD-8, AD-9, AD-15		0.775				4.8-7.1																			
Intrawell Background Value (UPL) AD-8			35.7	38.3	1.03			236	569																
Intrawell Background Value (UPL) AD-9			350	139	0.73			2527	3147																
Intrawell Background Value (UPL) AD-15			5.71	38.4	1.00			35.6	388																

NOTES:

All concentration data are provided in milligrams per liter (mg/L) unless otherwise noted.

J = Analyte was positively identified, though the quantitation was below Reporting Limit.

MCL = Maximum contaminant level

LPL = Lower prediction limit

UPL = Upper prediction limit

pCi/L = PicoCuries per liter

-- = Not analyzed

a = Data taken from Geosyntec "Statistical Analysis Summary, Primary Bottom Ash Pond" dated July 11, 2019.

b = Calculated Upper Tolerance Limit is higher than MCL.

c = Data is "Combined Radium, Total".

d = AD-18 is not part of the designated CCR Monitoring Well Network and used for background understanding only

🟨 Denotes groundwater sample collected by ARCADIS using low-flow methods.

Unless otherwise noted, values shown are total (unfiltered) analyses.

Dissolved (0.45-micron lab filtered) parameter concentrations shown in italics.

Table 4-4
Groundwater Sampling Analytical Results (mg/L) - Bottom Ash Storage Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters																
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Background (Upgradient) Wells																									
AD-1	05/26/16	0.346	36.5	5	<1	5.93	--	42	252	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.010	0.000033	<0.005	<0.005	<0.002	1.18	--	--
	07/27/16	0.350	39.6	4	<1	5.93	--	36	239	<0.005	<0.005	0.191	<0.001	<0.001	<0.001	<0.005	<0.005	0.019	<0.000025	<0.005	<0.005	<0.002	0.9952	--	--
	09/29/16	0.332	15	5	<1	5.37	--	35	173	<0.005	<0.005	0.141	<0.001	<0.001	0.005	<0.005	<0.005	0.014	<0.000025	<0.005	<0.005	<0.002	1.38	--	--
	10/19/16	0.398	19.1	4	<1	5.15	--	42	192	<0.005	<0.005	0.114	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	1.141	--	--
	12/12/16	0.394	8.74	4	<1	5.18	--	40	200	<0.005	<0.005	0.072	<0.001	<0.001	<0.001	<0.005	<0.005	0.008	<0.000025	<0.005	<0.005	<0.002	0.719	--	--
	01/17/17	0.656	129	4	<1	7.13	--	68	538	<0.005	<0.005	0.410	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.000025	<0.005	<0.005	<0.002	3.009	--	--
	02/23/17	0.700	147	9	<1	6.88	--	68	612	<0.005	<0.005	0.488	<0.001	<0.001	<0.001	<0.005	<0.005	0.001	<0.000025	<0.005	<0.005	<0.002	4.309	--	--
	06/07/17	0.449	15.1	4	<0.083	5.06	109	42	176	<0.00093	0.00114	0.09346	0.00037	<0.00007	0.00066	0.00077	<0.00068	0.00902	0.000007	<0.00029	0.0021	<0.00086	0.676	--	--
	10/06/17	--	--	--	--	5.25	97.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.352	12.1	3	<0.083	4.82	8.4	--	174	<0.00093	<0.00105	0.08823	0.00048	<0.00007	<0.00023	0.0008	<0.00068	0.00816	<0.000005	<0.00029	<0.00099	<0.00086	0.837	0.03	0.025
	Dissolved	*0.35*	*12*	--	--	4.82	8.4	--	--	*<0.00093*	*<0.00105*	*0.08582*	*0.00044*	*<0.00007*	*<0.00023*	*0.00083*	*<0.00068*	*0.00799*	*<0.000005*	*<0.00029*	*0.00197*	*<0.00086*	*0.531*	0.01	0.026
	05/24/18	0.345	10.2	4	<0.083	5.19	118	43	150	0.00317 J	<0.00105	0.0799	0.00039 J	<0.00007	<0.00023	0.00035 J	<0.00068	0.00814	0.000006 J	<0.00029	0.00138 J	<0.00086	1.983	--	--
	08/14/18	0.443	5.95	5	<0.083	5.18	102	44	160	0.00003 J	0.00021	0.063	0.000482	0.00002	0.00016	0.000797	0.000238	0.00708	0.000013 J	0.00021	0.0017	0.00003 J	1.10	--	--
	02/20/19	0.504	142	2.82	0.24	7.31	113	49.2	522	0.00016	0.00046	0.457	0.00009 J	0.00001 J	0.000306	0.000399	0.000124	0.00155	<0.000025	0.001 J	0.0007	<0.0005	3.16	--	--
	05/30/19	0.689	--	1.59	0.29	--	61.3	43.3	588	0.00016	0.00060	0.512	0.000244	0.00001 J	0.0001 J	0.000756	0.000197	<0.009	<0.000005	0.00243	0.0014	<0.0001	--	0.099	0.0625
AD-5	05/31/16	0.03	36.9	15	<1	6.38	--	123	337	<0.005	<0.005	0.057	<0.001	<0.001	<0.001	0.014	<0.005	0.135	<0.000025	<0.005	<0.005	<0.002	1.63	--	--
	07/28/16	0.04	44.7	16	<1	6.38	--	163	360	<0.005	<0.005	0.093	<0.001	<0.001	<0.001	0.015	<0.005	0.191	<0.000025	<0.005	<0.005	<0.002	4.75	--	--
	09/29/16	0.04	46.3	15	<1	5.29	--	190	416	<0.005	<0.005	0.087	<0.001	<0.001	<0.001	0.014	<0.005	0.186	<0.000025	<0.005	<0.005	<0.002	3.33	--	--
	10/20/16	0.05	50.7	14	<1	5.92	--	267	448	<0.005	<0.005	0.07	<0.001	<0.001	<0.001	0.009	<0.005	0.225	<0.000025	<0.005	<0.005	<0.002	2.319	--	--
	12/13/16	0.05	49.6	13	<1	6.29	--	233	484	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	0.013	<0.005	0.199	<0.000025	<0.005	<0.005	<0.002	2.182	--	--
	01/17/17	0.04	49.8	14	<1	6.27	--	234	438	<0.005	<0.005	0.047	<0.001	<0.001	<0.001	0.012	<0.005	0.239	<0.000025	<0.005	<0.005	<0.002	1.023	--	--
	02/23/17	0.04	33.0	15	<1	5.48	--	127	286	<0.005	<0.005	0.042	<0.001	<0.001	<0.001	0.013	<0.005	0.166	<0.000025	<0.005	<0.005	<0.002	1.788	--	--
	06/07/17	0.05281	49.7	14	<0.083	5.96	867	82	300	<0.00093	0.00385	0.0877	0.00008	0.00039	0.00028	0.01193	<0.00068	0.124	<0.000005	<0.00029	<0.00099	<0.00086	2.32	--	--
	10/06/17	--	--	--	--	5.59	249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.05063	30.1	21	<0.083	5.79	<100	--	248	<0.00093	<0.00105	0.07627	0.00014	0.00037	<0.00023	0.01907	<0.00068	0.118	<0.000005	<0.00029	<0.00099	<0.00086	1.495	14.4	0.45
	Dissolved	*0.03752*	*29.1*	--	--	5.79	<100	--	--	*<0.00093*	*<0.00105*	*0.06865*	*<0.00002*	*<0.00007*	*<0.00023*	*0.01747*	*<0.00068*	*0.119*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.043*	*2.051*	8.38	0.43
	05/24/18	0.05007	28.1	22	<0.083	6.22	17.8	60	242	<0.00093	<0.00105	0.07116	<0.00002	0.00023 J	0.0008 J	0.01424	<0.00068	0.121	<0.000005	<0.00029	<0.00099	<0.00086	1.946	--	--
	08/15/18	0.05	40.5	19	<0.083	6.23	57.1	240	428	0.00001 J	0.00169	0.0637	0.000055	0.000008 J	0.000072	0.0114	0.000079	0.147	<0.000005	0.00013	0.00008 J	<0.01	0.316	--	--
	02/21/19	0.033	33.9	24.7	0.21	5.38	164	46.5	220	0.00002 J	0.00159	0.0694	0.00008 J	<0.00005	0.000432	0.00858	0.000147	0.0807	<0.000025	<0.002	0.0001 J	<0.0005	1.27	--	--
	05/30/19	0.03 J	--	22.3	0.29	--	150	51.3	238	<0.00002	0.00305	0.0605	0.00008 J	<0.00001	0.00006 J	0.0118	0.00005 J	0.104	0.000006	<0.0004	0.00005 J	<0.0001	--	23.4	0.331
AD-17	05/26/16	0.121	200	43	<1	7.17	--	1,166	1,810	<0.005	<0.005	0.021	<0.001	0.002	0.001	0.063	<0.005	0.370	0.000032	<0.005	<0.005	<0.002	1.53	--	--
	07/27/16	0.119	195	32	<1	7.17	--	1,005	1,576	<0.005	<0.005	0.020	<0.001	0.004	0.001	0.068	<0.005	0.374	<0.000025	<0.005	<0.005	<0.002	2.78	--	--
	09/29/16	0.111	191	36	<1	6.17	--	1,055	1,663	<0.005	<0.005	0.031	<0.001	<0.001	0.003	0.058	<0.005	0.354	<0.000025	<0.005	<0.005	<0.002	2.358	--	--
	10/20/16	0.124	194	32	1.0	6.14	--	1,163	1,612	<0.005	<0.005	0.034	<0.001	0.002	0.004	0.065	<0.005	0.394	<0.000025	<0.005	<0.005	<0.002	2.224	--	--
	12/13/16	0.135	196	31	<1	6.03	--	1,096	1,560	<0.005	<0.005	0.017	<0.001	0.003	<0.001	0.068	<0.005	0.323	<0.000025	<0.005	<0.005	<0.002	2.384	--	--
	01/17/17	0.101	196	33	<1	5.96	--	1,445	1,686	<0.005	<0.005	0.014	<0.001	0.003	0.068	0.068	<0.005	0.341	<0.000025	<0.005	<0.005	<0.002	2.436	--	--
	02/22/17	0.135	189	30	<1	5.67	--	1,055	1,628	<0.005	<0.005	0.020	<0.001	0.002	0.001	0.073	<0.005	0.331	<0.000025	<0.005	<0.005	<0.002	2.288	--	--
	06/06/17	0.121	188	30	<0.083	5.81	156	1,105	1,578	<0.00093	<0.00105	0.01033	<0.00002	0.00606	<0.00023	0.0748	<0.00068	0.329	0.000013	<0.00029	<0.00099	<0.00086	1.598	--	--
	10/05/17	--	--	--	--	5.92	598	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.247	213	45	<0.083	5.51	<100	--	1,846	<0.00093	<0.00105	0.00978	<0.00002	0.00915	<0.00023	0.07451	<0.00068	0.306	<0.000005	<0.00029	0.00414	<0.00086	1.514	260	3.72
	Dissolved	*0.231*	*205*	--	--	5.51	<100	--	--	*<0.00093*	*<0.00105*	*0.00737*	*<0.00002*	*0.00609*	*<0.00023*	*0.07938*	*<0.00068*	*0.301*	*<0.000005*	*<0.00029*	*0.00515*	*0.02*	*1.57*	241	3.56
	05/24/18	0.239	193	39	<0.083	6.28	7.8	1,067	1,836	<0.00093	<0.00105	0.00965	<0.00002	0.00646	<0.00023	0.07173	<0.00068	0.308	<0.000005	<0.00029	<0.00099	<0.00086	1.939	--	--
	08/15/18	0.118	187	40	<0.083	5.6	418	1,170	1,750	0.00002 J	0.00183	0.0128	0.000069	0.00025	0.000604	0.0435	0.0011	0.243	0.000011 J	0.00035	0.0003	0.000074	2.35	--	--
	02/21/19	0.151	207	43.2	0.180	6.93	274	1,060	1,720	0.00008 J	0.00251	0.120	0.00024	0.00027	0.00334	0.0645	0.00249	0.268	0.000007 J	0.0007 J	0.0008	<0.0005	2.66	--	--
	05/30/19	0.158	--	41.7	<0.04	--	176	1,120	1,546	<0.00002	0.00041	0.0196	0.00002 J	0.00003 J	0.000246	0.0511	0.00003 J	0.341	<0.000005	<0.0004	0.00006 J	<0.0001	--	145	3.40
AD-18[c]	05/26/16	0.146	409	422	<1	5.1	--	5,135	10,000	<0.005	<0.005	0.012	0.014	0.003	<0.001	0.922	<0.005	2.07	0.000168	<0.005	0.006	0.003	12.58	--	--
	07/27/16	0.148	457	432	2	5.1	--	4,930	9,476	<0.005	<0.005	0.019	0.005	0.002	<0.001	0.734	<0.005	1.94	0.000091	<0.005	0.007	0.003	10.62	--	--
	09/29/16	0.156	469	637	4	5.59	--	4,632	9,569	<0.005	<0.005	0.02	0.004	<0.001	<0.001	0.666	<0.005	1.86	0.000117	<0.005	0.007	<0.002	7.05	--	--
	10/20/16	0.188	498	876	0.8664	5.7	--	5,537	9,540	<0.005	<0.005	0.021	0.002	0.001	<0.001	0.569	<0.005	2.06	0.000053	<0.005	<0.005	<0.002	5.82	--	--
	12/13/16	0.178	510	695	5	5.75	--	4,382	8,912	<0.005	<0.005	0.021	0.007	0.001	<0.001	0.641	<0.005	1.74	0.00005	<0.005	<0.005	<0.002	9.60	--	--
	01/17/17	0.050	412	159	5	4.49	--	5,414	8,562	<0.005	0.01	0.014	0.022	0.001	<0.001	0.929	<0.005	1.95	0.000224	<0.005	<0.005	0.002	22.51	--	--
	02/22/17	0.090	401	151	6	4.37	--	5,169	8,412	<0.005	<0.005	0.014	0.026	0.002	<0.001	0.961	<0.005	1.82	0.000107	<0.005	<0.005	0.00228	19.11	--	--
	06/06/17	0.125	428	304	6.53	4.27	121	5,920	9,394	<0.00093	0.00331	0.01038	0.01883	0.00303	<0.00023	0.940	<0.00068	2.15	0.000113	<0.00029	0.00212	<0.00086	16.12	--	--
	10/05/17	--	--	--	--	5.87	165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/17/18	0.163	433	362	9.4	3.61	104.1	--	9,952	0.00224	0.00276	0.00813	0.01733	0.0036	0.00098	0.928	<0.00068	2.07	0.000043	<0.00029	0.00194	0.00144	19.95	19.7	14.1
	Dissolved	*0.153*	*423*	--	--	--	--	--	--	*0.00467*	*0.00189*	*0.00748*	*0.01676*	*0.00316*	*<0.00023*	*0.898*	*<0.00068*	*2.06*	*0.000012*	*<0.00029*	*0.00135*	*0.01466*	*18.09*	19.1	13.7
	05/30/19	0.09 J	--	390	3.56	--	91.3	*6,120*	9,564	<0.0002	0.04	0.009 J	0.021	0.004 J	<0.004	1.130	0.005 J	1.27	0.000035	<0.04	0.103	<0.01	--	11.2	7.53

Table 4-4
Groundwater Sampling Analytical Results (mg/L) - Bottom Ash Storage Pond
AEP J. Robert Welsh Power Plant
Pittsburg, Titus County, Texas

Well	Date Sampled	Appendix III Parameters								Appendix IV Parameters															
		Boron (total)	Calcium (total)	Chloride	Fluoride	pH (field)	Turbidity (field)	Sulfate	TDS	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226 and 228 (pCi/L)	Iron	Manganese
Point of Compliance Wells																									
AD-3	05/31/16	0.02	1.41	9	<1	6.58	--	4	106	<0.005	<0.005	0.053	<0.001	<0.001	<0.001	<0.005	<0.005	0.010	0.00085	<0.005	<0.005	<0.002	1.02	--	--
	07/27/16	0.02	0.706	8	<1	6.58	--	5	118	<0.005	<0.005	0.036	<0.001	<0.001	<0.001	<0.005	<0.005	0.024	0.000589	<0.005	<0.005	<0.002	0.1786	--	--
	09/30/16	0.02	<0.5	9	<1	4.75	--	6	127	<0.005	<0.005	0.043	<0.001	<0.001	<0.001	<0.005	<0.005	0.019	0.00039	<0.005	<0.005	<0.002	0.552	--	--
	10/19/16	0.06	0.794	8	<1	3.71	--	9	112	<0.005	<0.005	0.041	<0.001	<0.001	<0.001	<0.005	<0.005	0.018	0.000351	0.006	<0.005	<0.002	1.589	--	--
	12/12/16	0.02	1.05	8	<1	4.67	--	11	138	<0.005	<0.005	0.045	<0.001	<0.001	<0.001	<0.005	<0.005	0.017	0.000321	<0.005	<0.005	<0.002	0.546	--	--
	01/19/17	0.02	0.746	9	<1	4.60	--	4	76	<0.005	<0.005	0.041	<0.001	<0.001	<0.001	<0.005	<0.005	0.014	0.000504	<0.005	<0.005	<0.002	0.229	--	--
	02/23/17	0.02	0.573	9	<1	4.69	--	5	104	<0.005	<0.005	0.037	<0.001	<0.001	<0.001	<0.005	<0.005	0.014	0.000501	<0.005	<0.005	<0.002	0.4592	--	--
	06/07/17	0.03326	0.543	9	0.2625	4.49	56.6	5	104	<0.00093	0.00191	0.038	0.00024	0.00008	0.00075	0.00128	<0.00068	0.01503	0.000365	<0.00029	<0.00099	<0.00086	0.459	--	--
	10/06/17	--	--	--	--	5.15	65.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/15/18	0.01869	0.56	9	<0.083	4.31	11.1		132	0.00166	0.0016	0.0365	0.00034	0.00008	<0.00023	0.00136	<0.00068	0.01459	0.00037	<0.00029	0.00323	0.00127	0.016	0.188	0.004
	Dissolved	*0.01132*	*0.595*	--	--	4.31	11.1	--	--	*<0.00093*	*<0.00105*	*0.0361*	*0.00023*	*<0.00007*	*<0.00023*	*0.00133*	*<0.00068*	*0.01445*	*0.000379*	*<0.00029*	*<0.00099*	*<0.00086*	*0.242*	< 0.01	0.004
	05/24/18	0.0069 J	0.545	8	<0.083	4.58	8.50	3	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/30/19	<0.02	--	9.03	0.18	--	57.2	2.3	110	0.00006 J	0.00103	0.0632	0.000158	0.00005 J	0.000316	0.00171	0.000382	0.03 J	0.000245	<0.0004	0.0003	<0.0001	--	*1.54*	0.011
AD-4c	05/31/16	0.05	0.798	10	<1	5.41	--	32	204	<0.005	<0.005	0.088	<0.001	<0.001	0.009	<0.005	<0.005	0.004	0.000191	<0.005	<0.005	<0.002	1.29	--	--
	07/27/16	0.03	0.666	12	<1	5.41	--	35	208	<0.005	<0.005	0.059	<0.001	<0.001	0.004	<0.005	<0.005	0.015	0.000185	<0.005	<0.005	<0.002	0.5075	--	--
	09/29/16	0.02	<0.5	11	<1	4.96	--	45	212	<0.005	<0.005	0.074	<0.001	<0.001	0.008	<0.005	<0.005	0.006	0.00016	<0.005	<0.005	<0.002	2.572	--	--
	10/19/16	0.04	0.578	10	<1	4.30	--	35	212	<0.005	<0.005	0.069	<0.001	<0.001	0.009	<0.005	<0.005	0.006	0.000141	<0.005	<0.005	<0.002	1.657	--	--
	12/12/16	0.02	0.341	11	<1	4.62	--	36	252	<0.005	<0.005	0.021	<0.001	<0.001	<0.001	<0.005	<0.005	0.004	0.000143	<0.005	<0.005	<0.002	0.685	--	--
	01/19/17	0.02	0.761	10	<1	4.67	--	43	184	<0.005	<0.005	0.075	<0.001	<0.001	0.004	<0.005	<0.005	0.005	0.000125	<0.005	<0.005	<0.002	2.045	--	--
	02/23/17	0.02	0.467	9	<1	5.10	--	40	196	<0.005	<0.005	0.030	<0.001	<0.001	<0.001	<0.005	<0.005	0.004	0.000098	<0.005	<0.005	<0.002	0.517	--	--
	06/07/17	0.03331	0.573	10	<0.083	4.88	351	39	228	<0.00093	0.00119	0.05142	0.00019	0.00008	0.00403	0.00075	<0.00068	0.00482	0.000147	<0.00029	<0.00099	<0.00086	0.953	--	--
	10/06/17	--	--	--	--	5.38	308	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/16/18	0.0186	0.498	14	<0.083	4.67	6.40		232	<0.00093	<0.00105	0.02572	0.0001	<0.00007	0.00044	0.00049	<0.00068	0.00394	0.000228	<0.00029	<0.00099	<0.00086	0.435	0.592	< 0.001
	Dissolved	*0.02017*	*0.468*	--	--	4.67	6.40	--	--	*<0.00093*	*<0.00105*	*0.02223*	*0.00006*	*<0.00007*	*<0.00023*	*0.00043*	*<0.00068*	*0.0039*	*0.000031*	*<0.00029*	*<0.00099*	*<0.00086*	*0.354*	0.394	0.002
	05/24/18	0.02505	0.434	14	<0.083	*5.17*	*48.1*	42	224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	08/14/18	--	--	15	--	--	125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/29/19	<0.02	--	14.8	0.16	--	158	52.8	208	<0.0004	0.0006 J	0.0295	<0.0004	<0.0002	<0.0008	<0.0004	<0.0004	<0.009	0.000206	<0.008	<0.0006	<0.002	--	0.327	0.0007 J
AD-16	01/26/16	0.05	2.81	6	<1	3.84	--	49	180	<0.005	0.02	0.198	0.002	<0.001	0.054	0.013	0.016	0.015	0.000259	<0.005	<0.005	<0.002	4.478	--	--
	03/21/16	0.04	2.04	6	<1	4.20	--	47	104	<0.005	<0.005	0.119	<0.001	<0.001	0.009	<0.005	<0.005	0.007	0.000114	<0.005	<0.005	<0.002	4.44	--	--
	05/31/16	0.03	1.55	6	<1	4.44	--	40	96	<0.005	<0.005	0.127	<0.001	<0.001	0.001	<0.005	<0.005	0.002	0.000037	<0.005	<0.005	<0.002	5.99	--	--
	07/27/16	0.04	3.42	7	<1	4.44	--	70	184	<0.005	0.01	0.123	0.002	<0.001	0.011	0.022	<0.005	0.035	0.000212	<0.005	<0.005	<0.002	7.21	--	--
AD-16R	06/06/17	0.04198	2.75	7	0.3438	3.68	46.9	54	204	<0.00093	0.00707	0.0464	0.00221	0.00103	0.00176	0.04174	<0.00068	0.0293	<0.000005	<0.00029	0.00198	<0.00086	6.66	--	--
	06/28/17	0.06398	1.24	6	0.2512	3.91	--	55	200	<0.00093	0.00528	0.04143	0.00216	0.00092	0.00095	0.04087	<0.00068	0.02932	<0.000005	<0.00029	<0.00099	<0.00086	12.11	--	--
	07/28/17	0.02841	1.92	7	<0.083	2.77	--	48	162	<0.00093	0.0037	0.04851	0.00217	0.00128	0.00107	0.04533	<0.00068	0.02617	0.000006	<0.00029	0.00127	0.00143	8.52	--	--
	08/02/17	0.03177	1.86	7	<0.083	3.00	--	49	174	<0.00093	0.00446	0.04961	0.00206	0.00122	0.00095	0.04311	<0.00068	0.02498	<0.000005	<0.00029	0.00174	0.00202	5.45	--	--
	10/06/17	--	--	--	--	3.29	31.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/15/18	0.04030	2.73	6	<0.083	3.18	0.0		212	0.00269	0.0074	0.04301	0.00278	0.00129	0.0007	0.04123	<0.00068	0.02977	<0.000005	0.00103	<0.00099	<0.00086	5.89	1.47	0.053
	Dissolved	*0.02614*	*2.59*	--	--	3.18	0.0	--	--	*<0.00093*	*0.00294*	*0.04155*	*0.0022*	*0.00071*	*0.00025*	*0.03996*	*<0.00068*	*0.0278*	*<0.000005*	*<0.00029*	*<0.00099*	*<0.00086*	*5.90*	0.599	0.05
	05/23/18	0.03202	2.53	6	<0.083	*3.79*	*36.9*	67	204	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	08/14/18	--	--	--	--	--	142	44	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	05/30/19	<0.02	--	5.43	0.19	--	77.1	41.6	80	0.00002 J	0.00176	0.0724	0.000424	0.00008	0.000334	0.00438	0.00006 J	0.01 J	0.000296	<0.0004	0.0006	0.0002 J	--	0.072	0.0079
Supplemental Downgradient Monitoring Wells																									
AD-19	5/17/2018	0.07234	9.4	34	<0.083	5.72	42.1	--	372	<0.00093	<0.00105	0.05026	0.00073	<0.00007	0.00117	0.0111	<0.00068	0.02924	<0.000005	0.00078	0.00194	<0.00086	1.421	3.04	0.089
	Dissolved	*0.06293*	*8.76*	--	--	--	--	--	--	*<0.00093*	*<0.00105*	*0.04*	*0.00025*	*<0.00007*	*<0.00023*	*0.00965*	*<0.00068*	*0.02842*	*<0.000005*	*0.00041*	*<0.00099*	*0.012*	*2.577*	2.13	0.08
AD-20	10/31/18	0.029	3.14	18.4	0.09	4.88	13	12.5	140	0.00004	0.00185	0.205	0.000651	0.00114	0.000514	0.0161	0.000425	0.0126	<0.00005	<0.0004	0.0008	0.0003	4.16	1.11	0.0742
AD-21	10/30/18	0.025	5.0	17	0.23	5.04	0.0	27.4	180	0.00006	0.00124	0.0868	0.00181	0.00065	0.000263	0.0337	0.000148	0.034	<0.00005	<0.0004	0.0011	0.0002	3.76	3.13	0.154
EPA MCLs:																									
MCL					4					0.006	0.01	2	0.004	0.005	0.1				0.002	N/A	0.05	0.002	5[b]		
Rule Specified																0.006	0.015	0.04		0.1					
Background Limit					1					0.005	0.005	0.36	0.00077	0.0065[a]	0.004	0.075[a]	0.005	0.39[a]	0.000033	0.005	0.005	0.0013	4.21[b]		
Interwell Background Value(s) (UPL, LPL where applicable) AD-8, AD-9, AD-15		0.775				4.8-7.1																			
Intrawell Background Value (UPL) AD-8			35.7	38.3	1.03			236	569																
Intrawell Background Value (UPL) AD-9			350	139	0.73			2527	3147																
Intrawell Background Value (UPL) AD-15			5.71	38.4	1.00			35.6	388																

NOTES:

All concentration data are provided in milligrams per liter (mg/L) unless otherwise noted.

J = Analyte was positively identified, though the quantitation was below Reporting Limit.

MCL = Maximum contaminant level

LPL = Lower prediction limit

UPL = Upper prediction limit

pCi/L = PicoCuries per liter.

-- = Not analyzed.

a = Calculated Upper Tolerance Limit is higher than MCL.

b = Data is "Combined Radium, Total".

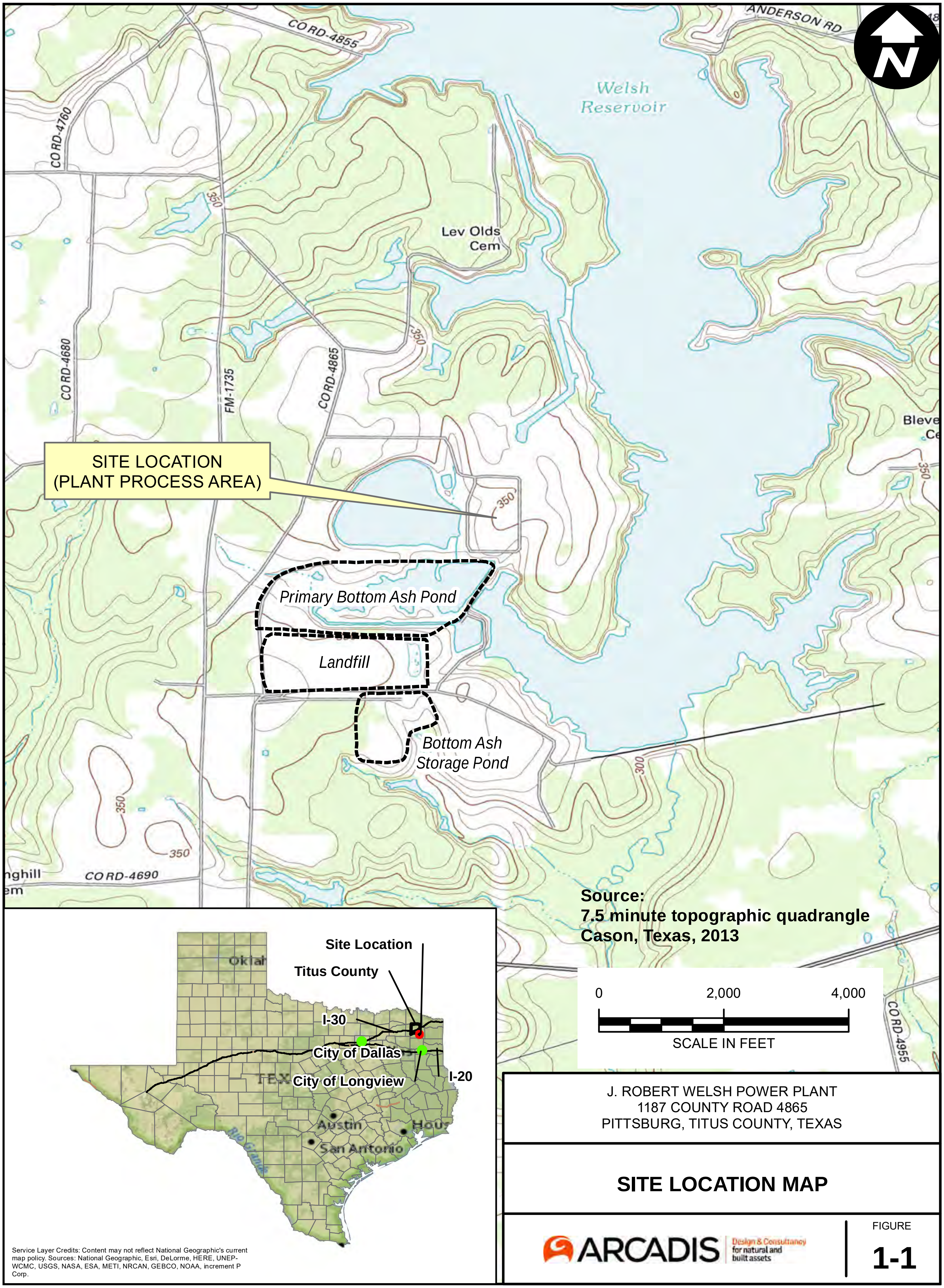
c = AD-18 is not part of the designated CCR Monitoring Well Network and used for background understanding only

🟨 Denotes groundwater sample collected by ARCADIS using low-flow sampling methods.

Unless otherwise noted, values shown are total (unfiltered) analyses.

Dissolved (0.45-micron lab filtered) parameter concentrations shown in italics.

FIGURES



Source:
7.5 minute topographic quadrangle
Cason, Texas, 2013

Service Layer Credits: Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

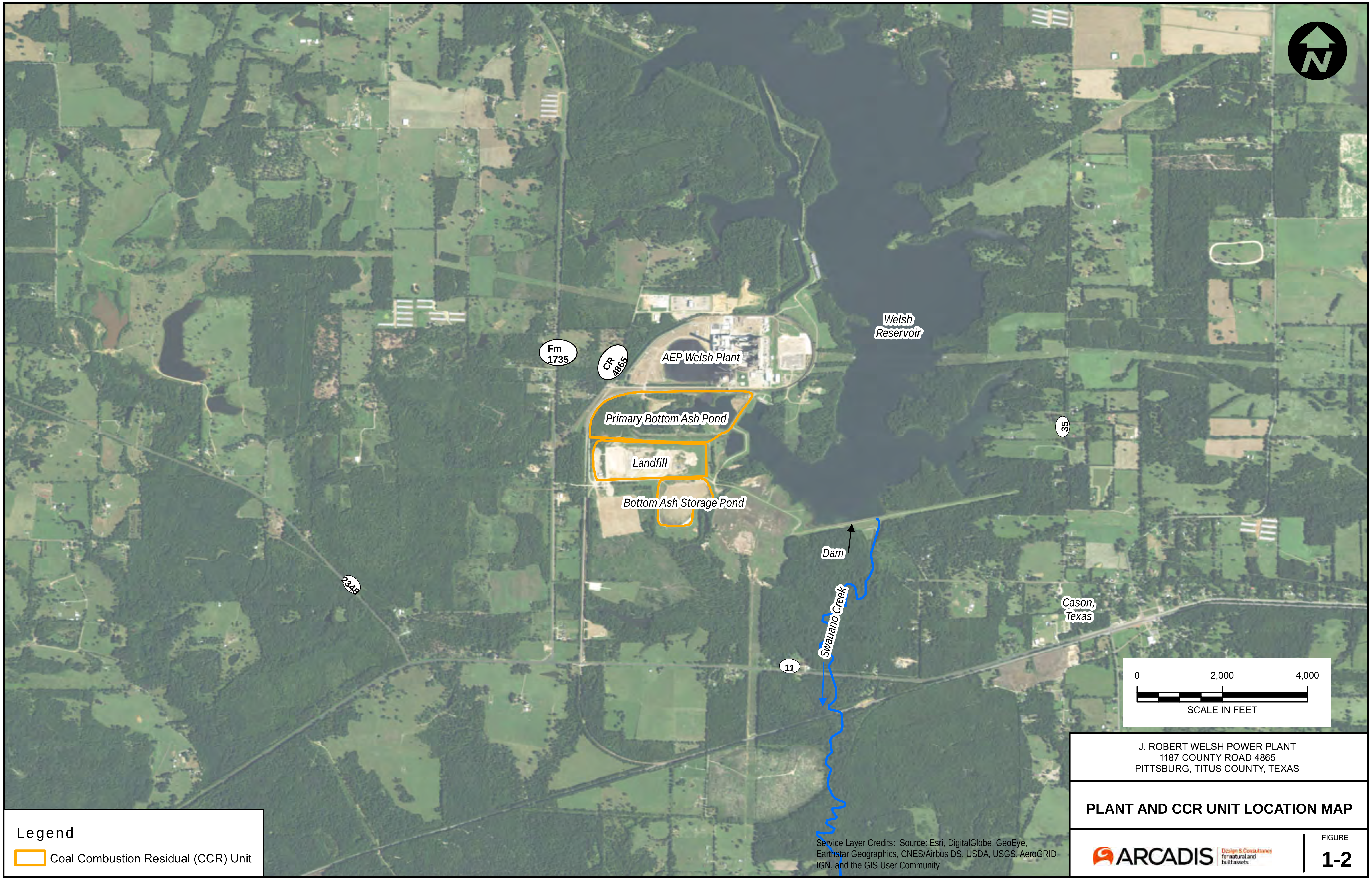
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-1

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\Dec2017Update\fig 1 - site map.mxd



Legend

🟧 Coal Combustion Residual (CCR) Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

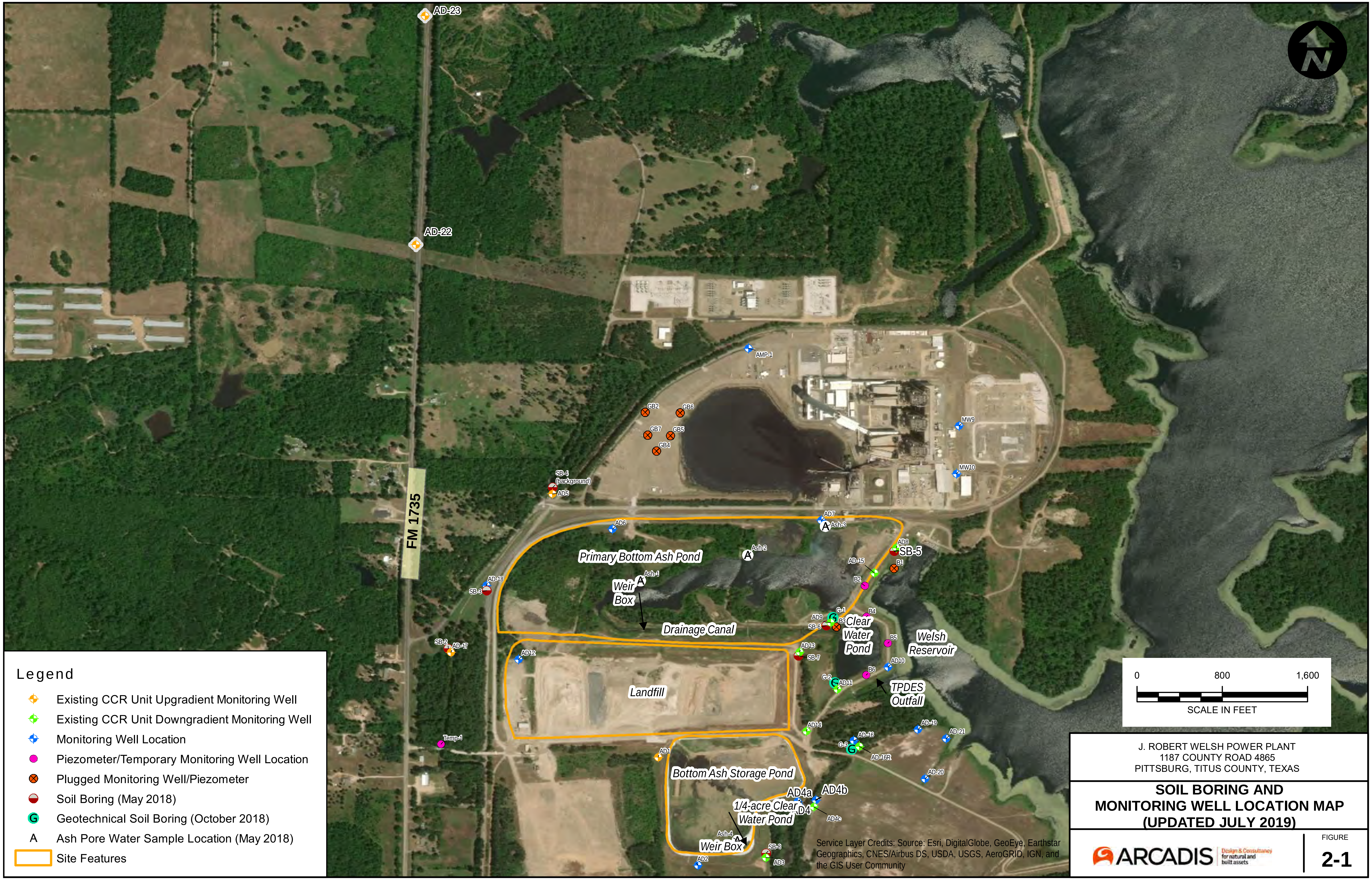
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-2

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\Dec2017Update\fig 1-2 - CCR location.mxd



Legend

- ◆ Existing CCR Unit Upgradient Monitoring Well
- ◆ Existing CCR Unit Downgradient Monitoring Well
- ◆ Monitoring Well Location
- ● Piezometer/Temporary Monitoring Well Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◐ Soil Boring (May 2018)
- G Geotechnical Soil Boring (October 2018)
- A Ash Pore Water Sample Location (May 2018)
- ▭ Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

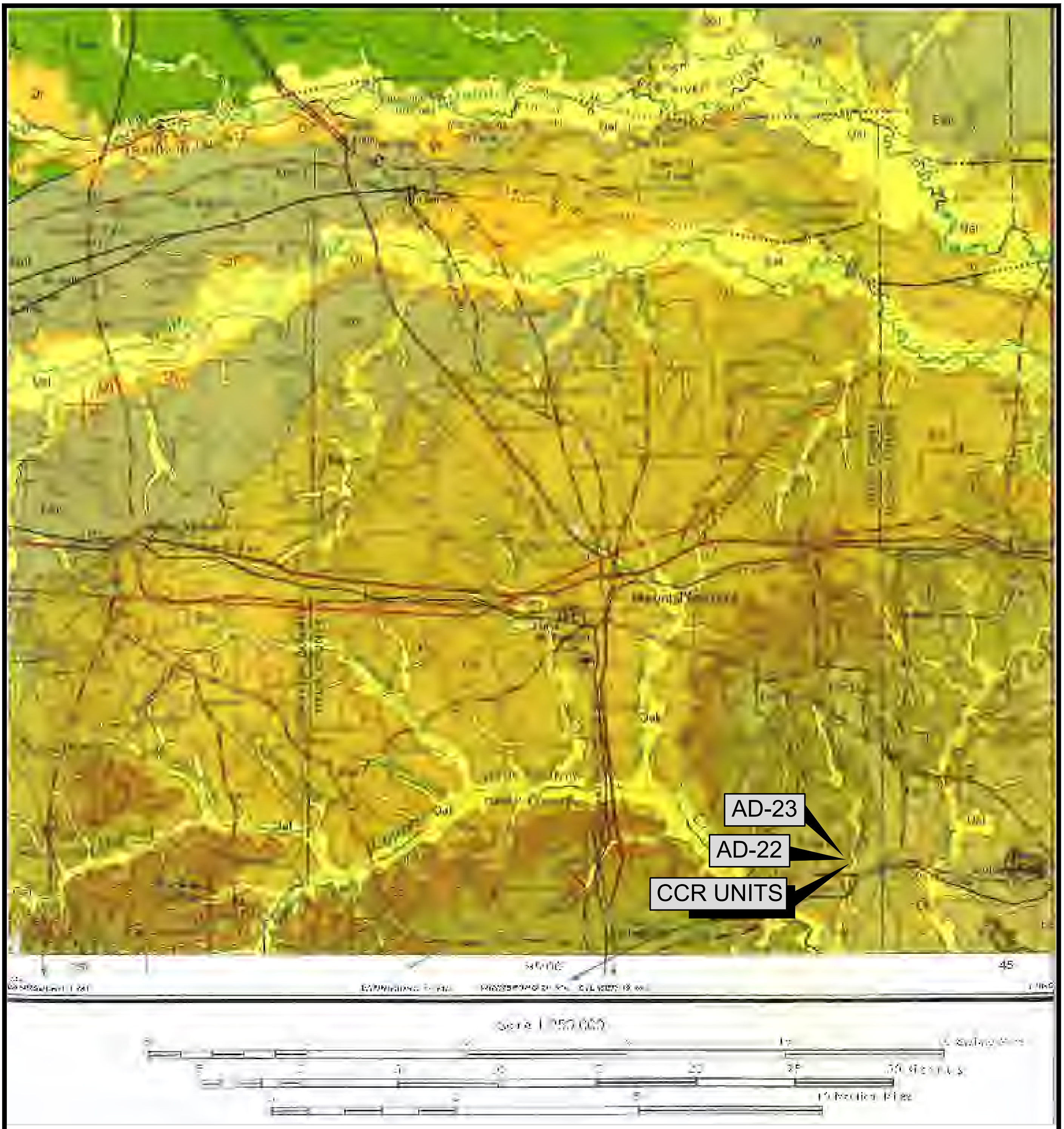
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SOIL BORING AND MONITORING WELL LOCATION MAP (UPDATED JULY 2019)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-1

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\September 2019\Fig 2-1-SoilBoring_MonitoringWellLocations.mxd



REF: "GEOLOGIC ATLAS OF TEXAS, TEXARKANA SHEET", UNIVERSITY OF TEXAS AT AUSTIN BUREAU OF ECONOMIC GEOLOGY, 1966.

J. ROBERT WELSH POWER PLANT
PITTSBURG, TITUS COUNTY, TEXAS

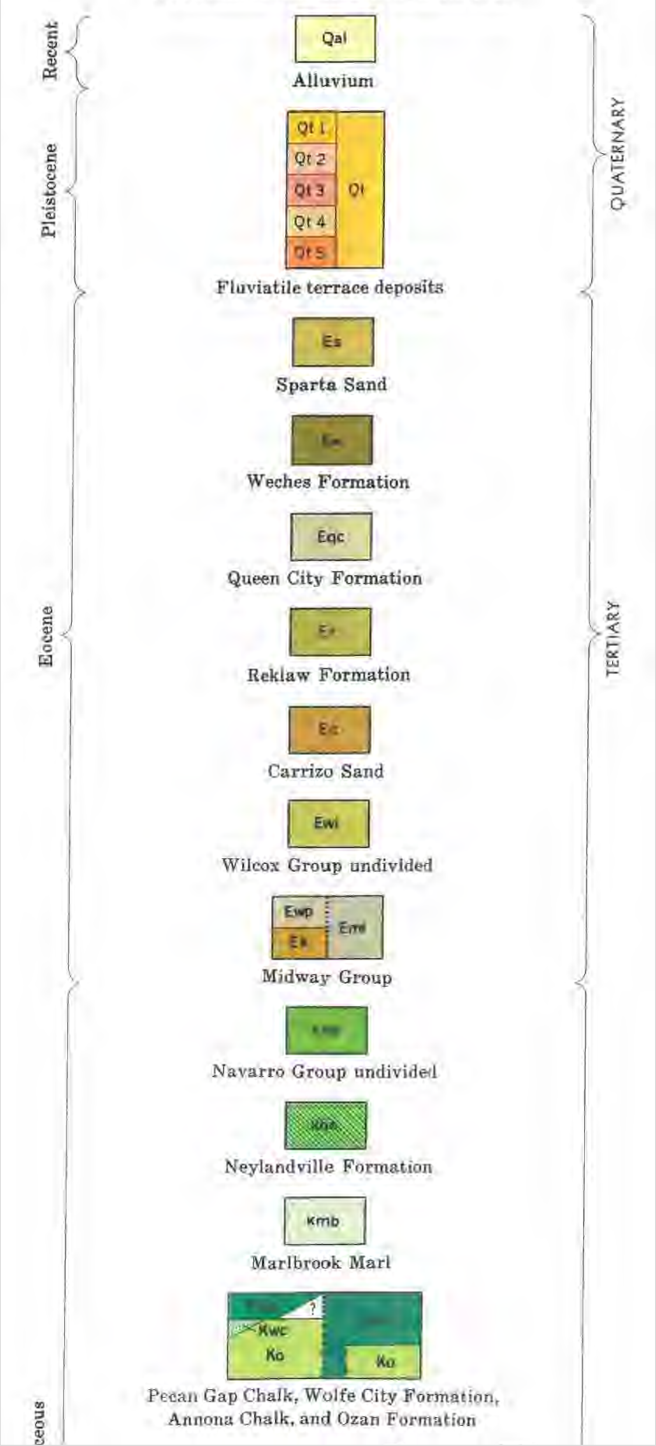
REGIONAL GEOLOGIC MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-2A

EXPLANATION

(Formations Described in Separate Text)



Alluvium

Fluviatile terrace deposits

Sparta Sand

Weches Formation

Queen City Formation

Reklaw Formation

Carrizo Sand

Wilcox Group undivided

Midway Group

Navarro Group undivided

Neylandville Formation

Marlbrook Marl

Pecan Gap Chalk, Wolfe City Formation,
Annona Chalk, and Ozan Formation

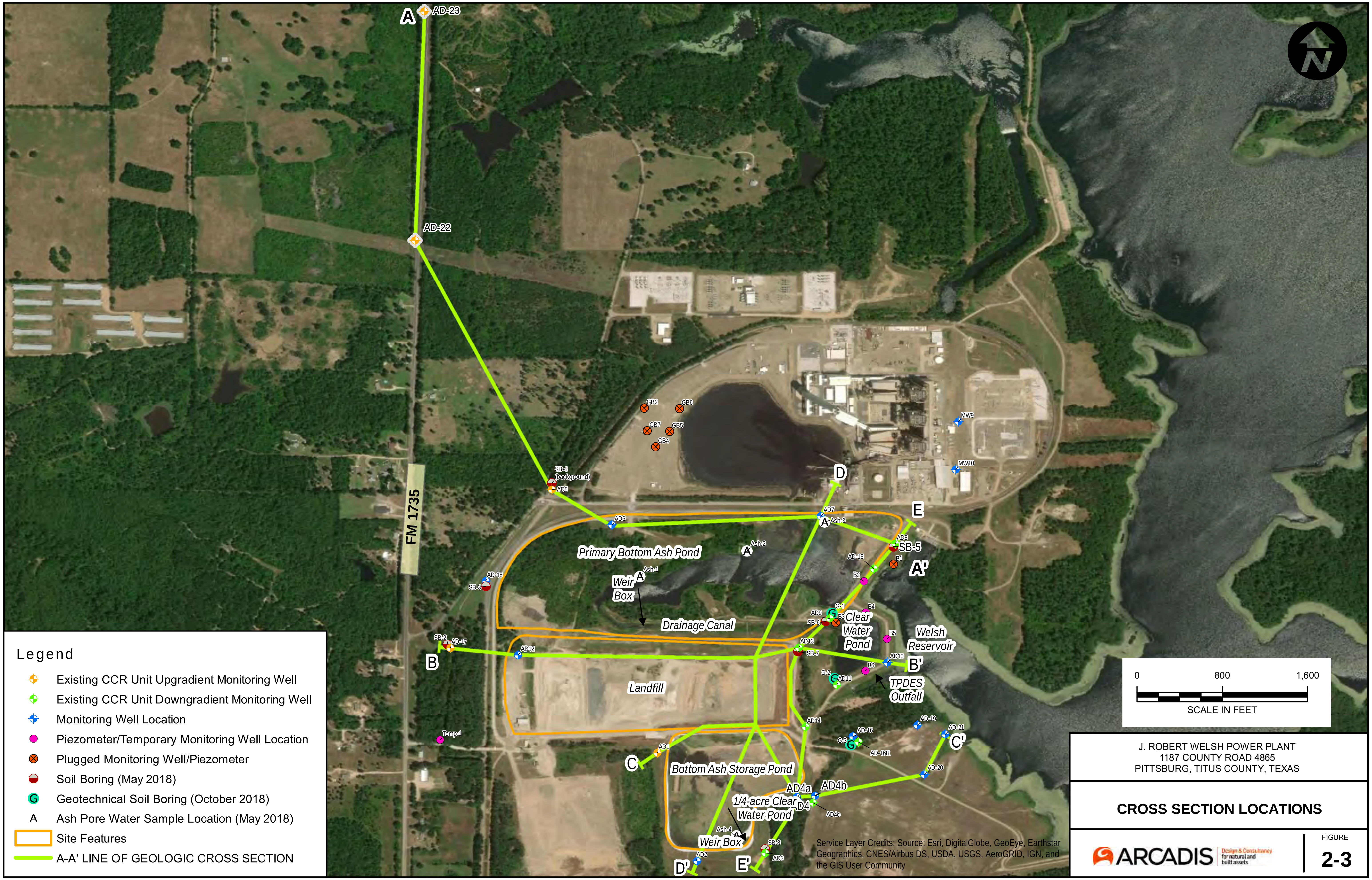
J. ROBERT WELSH POWER PLANT
PITTSBURG, TITUS COUNTY, TEXAS

REGIONAL GEOLOGIC MAP LEGEND

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-2B

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\30034022 - Welsh Lithium ASD August 2019\Figures-Maps\Figure 2-2B Reg Geo Map Legend.dwg LAYOUT: MODEL SAVED: 8/6/2019 9:19 AM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/9/2019 10:37 AM BY: LEASE, DIANA



Legend

- Existing CCR Unit Upgradient Monitoring Well
- Existing CCR Unit Downgradient Monitoring Well
- Monitoring Well Location
- Piezometer/Temporary Monitoring Well Location
- Plugged Monitoring Well/Piezometer
- Soil Boring (May 2018)
- G Geotechnical Soil Boring (October 2018)
- A Ash Pore Water Sample Location (May 2018)
- Site Features
- A-A' LINE OF GEOLOGIC CROSS SECTION

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

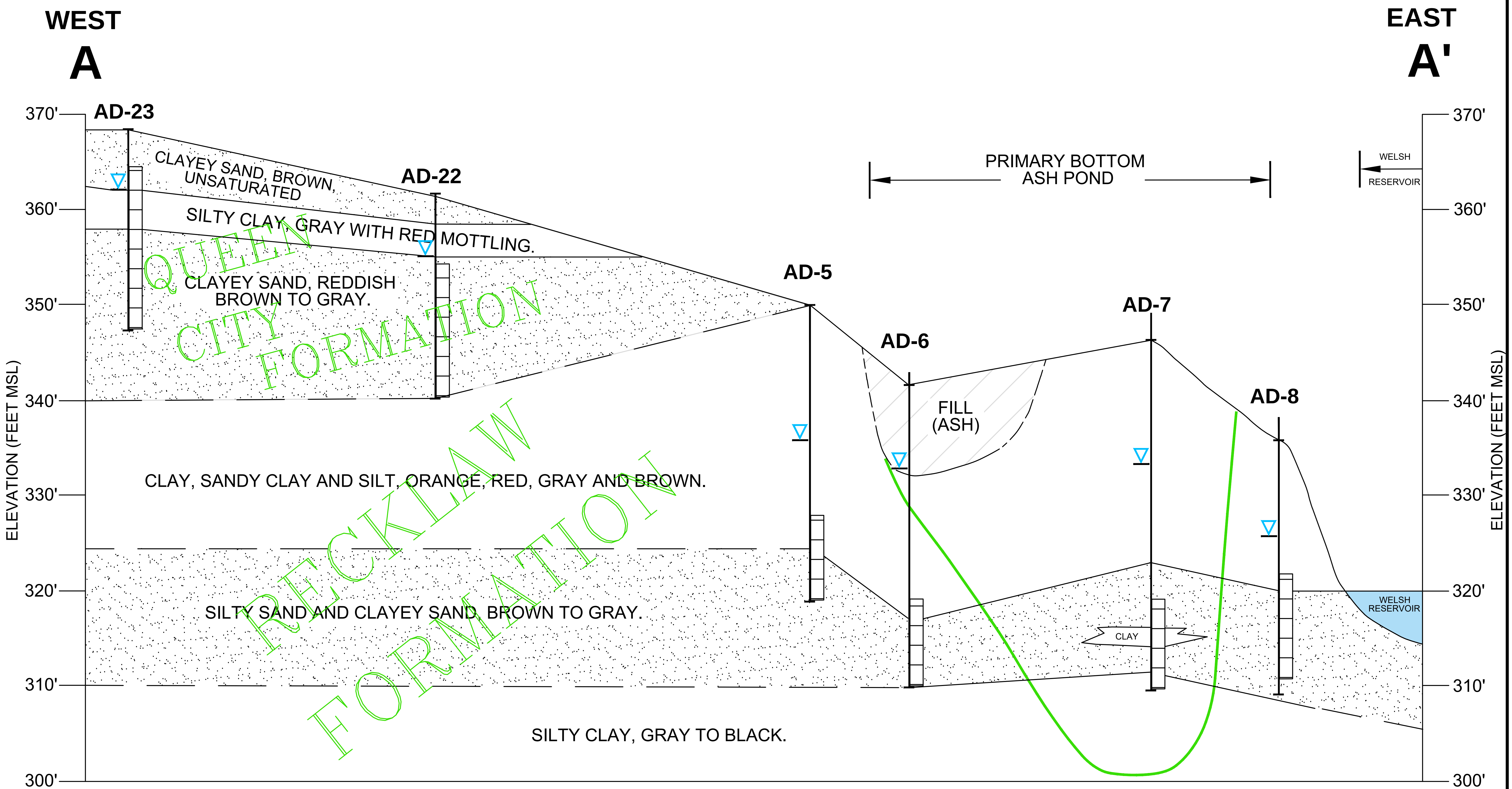
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-3

Document Path: Z:\GISProjects_ENVAEP\Welsh Plant\MXD\Landfill report\September 2019\Fig2-3-Cross Section LocationsREV.mxd



0 600'
HORIZONTAL SCALE

NOTE: BASE OF ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN EVALUATION (6/19/19)
- — PROJECTED BASE OF PRIMARY BOTTOM ASH POND (SEE NOTE)

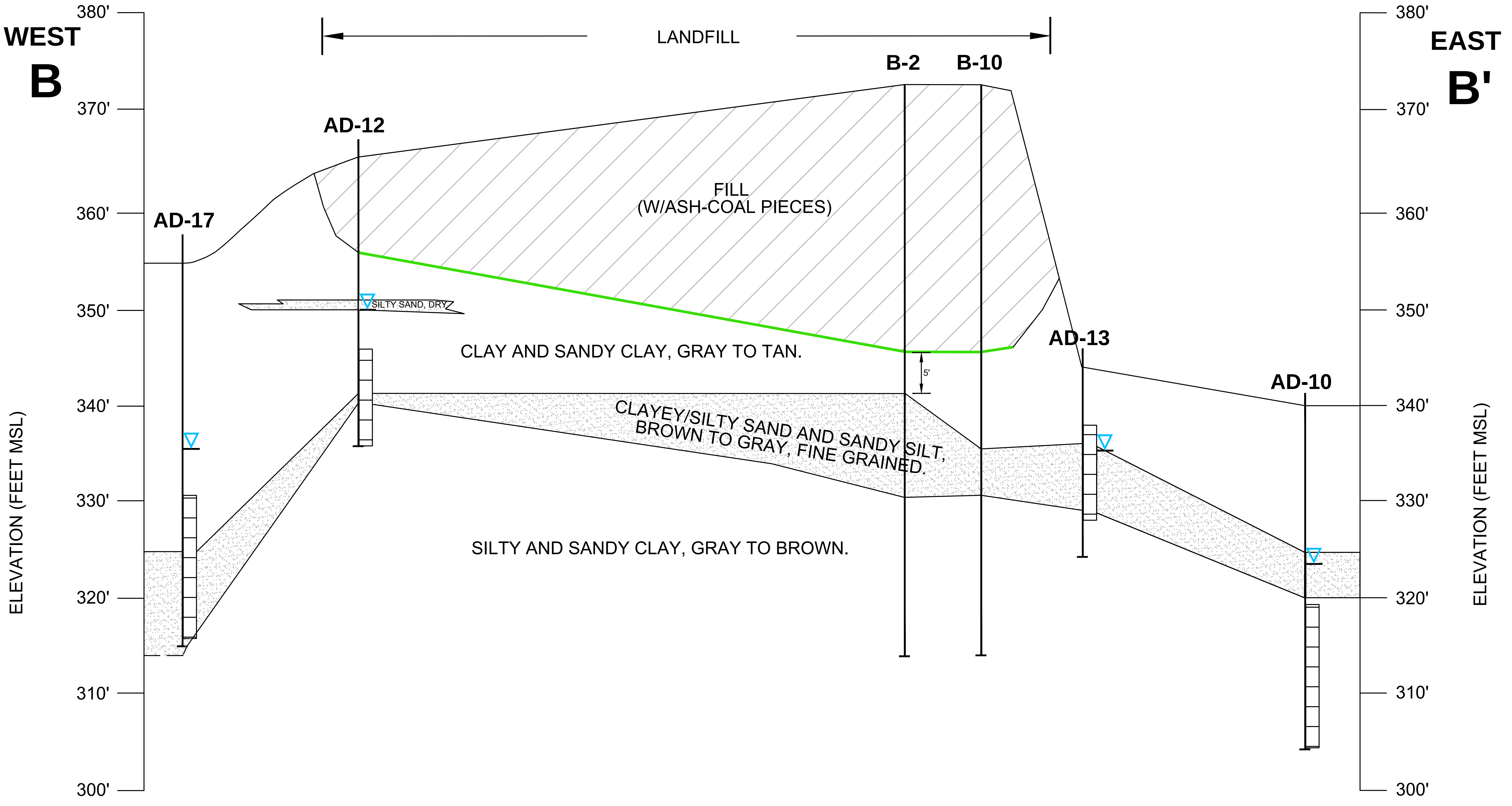
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\30034022 - Welsh Lithium ASD August 2019\Figures-Maps\Figure 2-4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 8/7/2019 9:49 AM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/9/2019 10:45 AM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

NOTE: BASE OF LANDFILL ELEVATION TAKEN FROM "WELSH POWER PLANT- UNIT 1 FLY ASH STORAGE AREA PHASE I" DRAWING ID WEPX-88, DATED 12/3/76.

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
🟩	BASE OF LANDFILL (SEE NOTE)

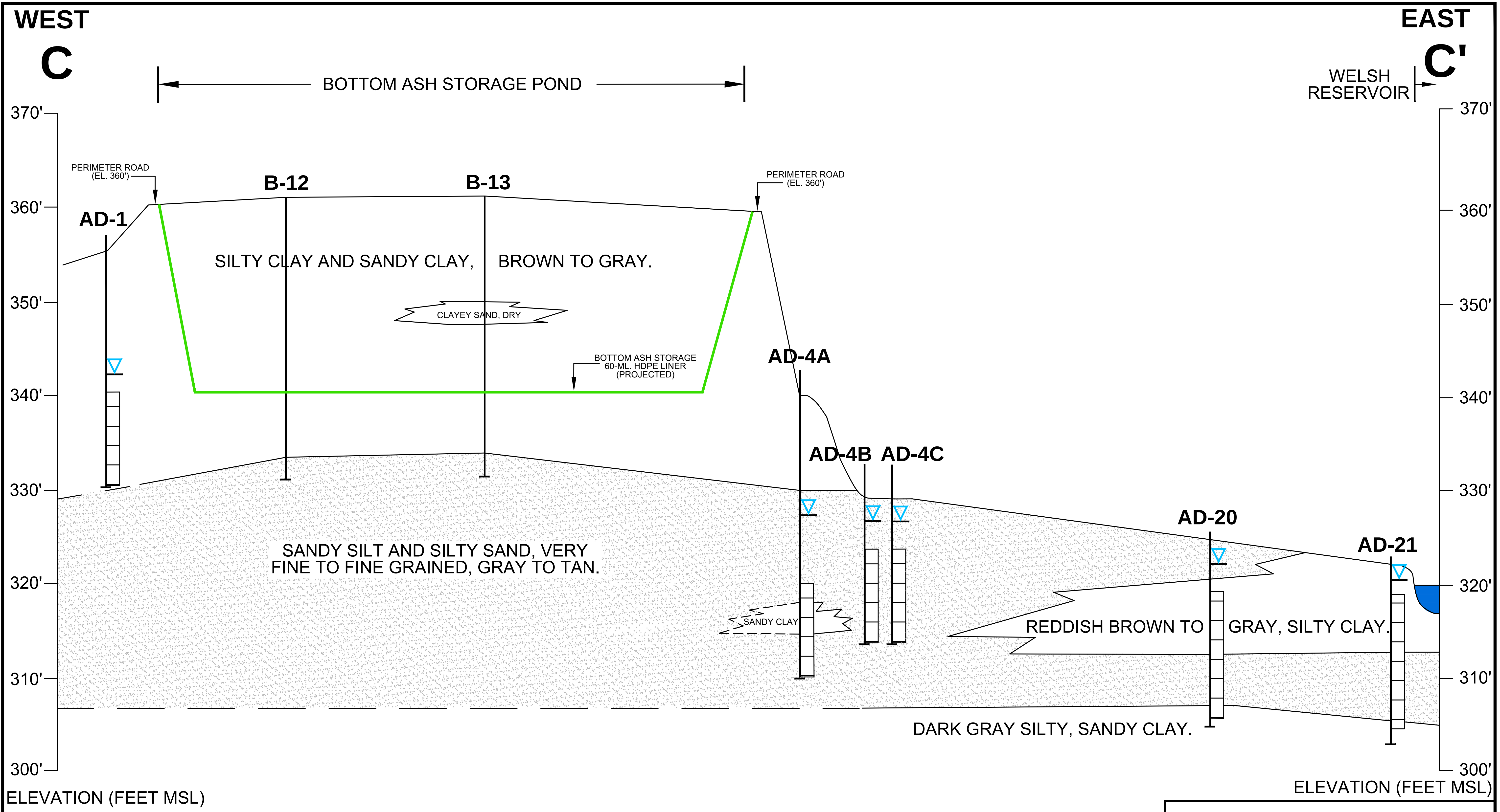
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
2-5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0005 - Welsh Lithium ASD\Figures-Maps\Figure 2-3 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 3/11/2016 12:34 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/28/2019 3:30 PM BY: LEASE, DIANA



0 ▭ 200'
HORIZONTAL SCALE

NOTE: BASE OF BOTTOM ASH STORAGE HAS A 60-ML. HDPE LINER AT ELEVATION 340.0', TAKEN FROM FREESE AND NICHOLS "HYDRAULIC ANALYSIS OF WELSH POWER PLANT ASH PONDS, AMERICAN ELECTRIC POWER COMPANY", DATED DECEMBER 2010.

LEGEND

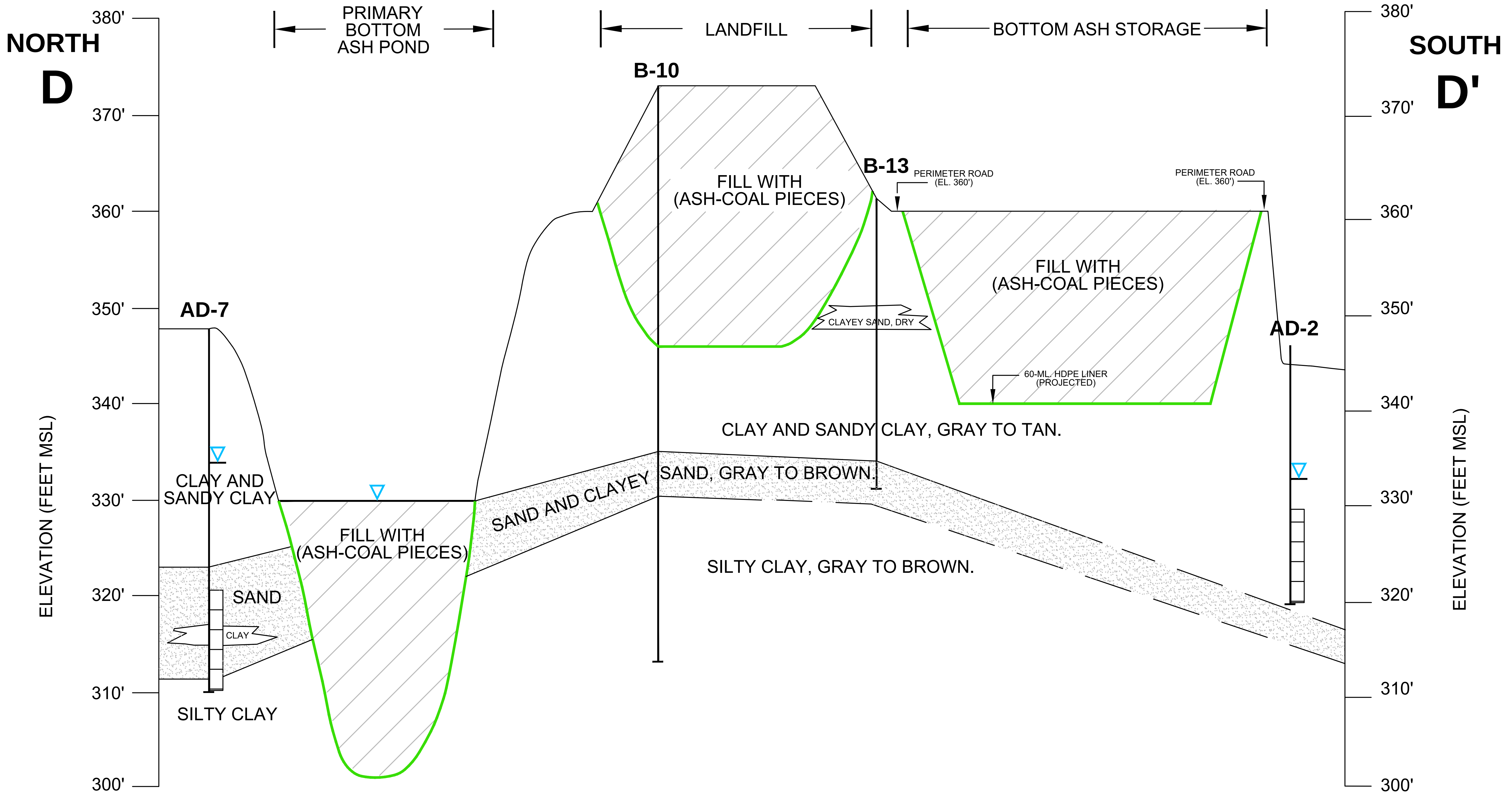
▯	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (10/29/18)
🟩	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-6



0 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

▯	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
🟩	BASE OF CCR UNIT

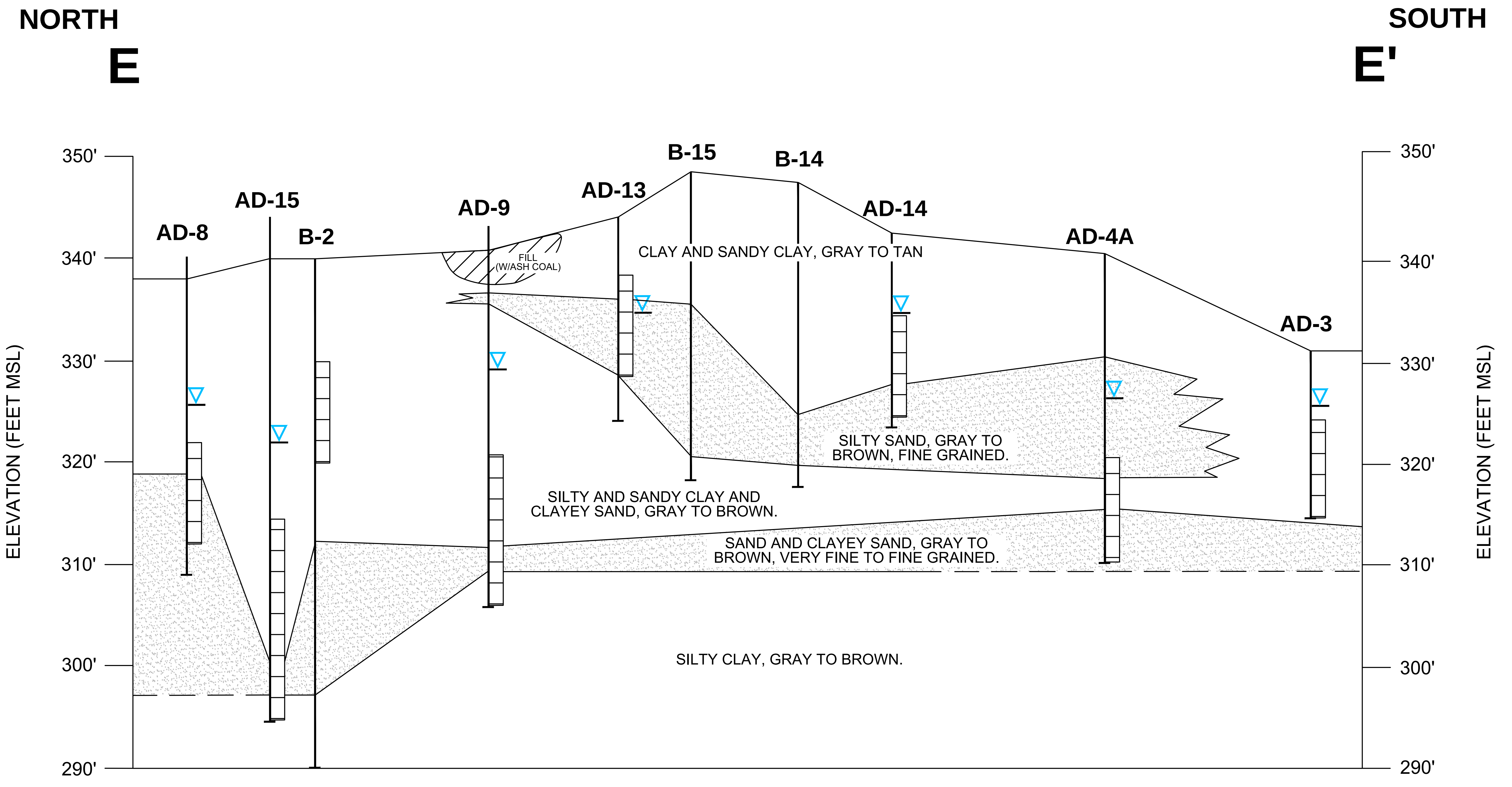
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION D - D'

ARCADIS

FIGURE
2-7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0005 - Welsh Lithium ASD\Figures-Maps\Figure 2-5 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 6/23/2016 9:39 AM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/28/2019 3:41 PM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
2-8

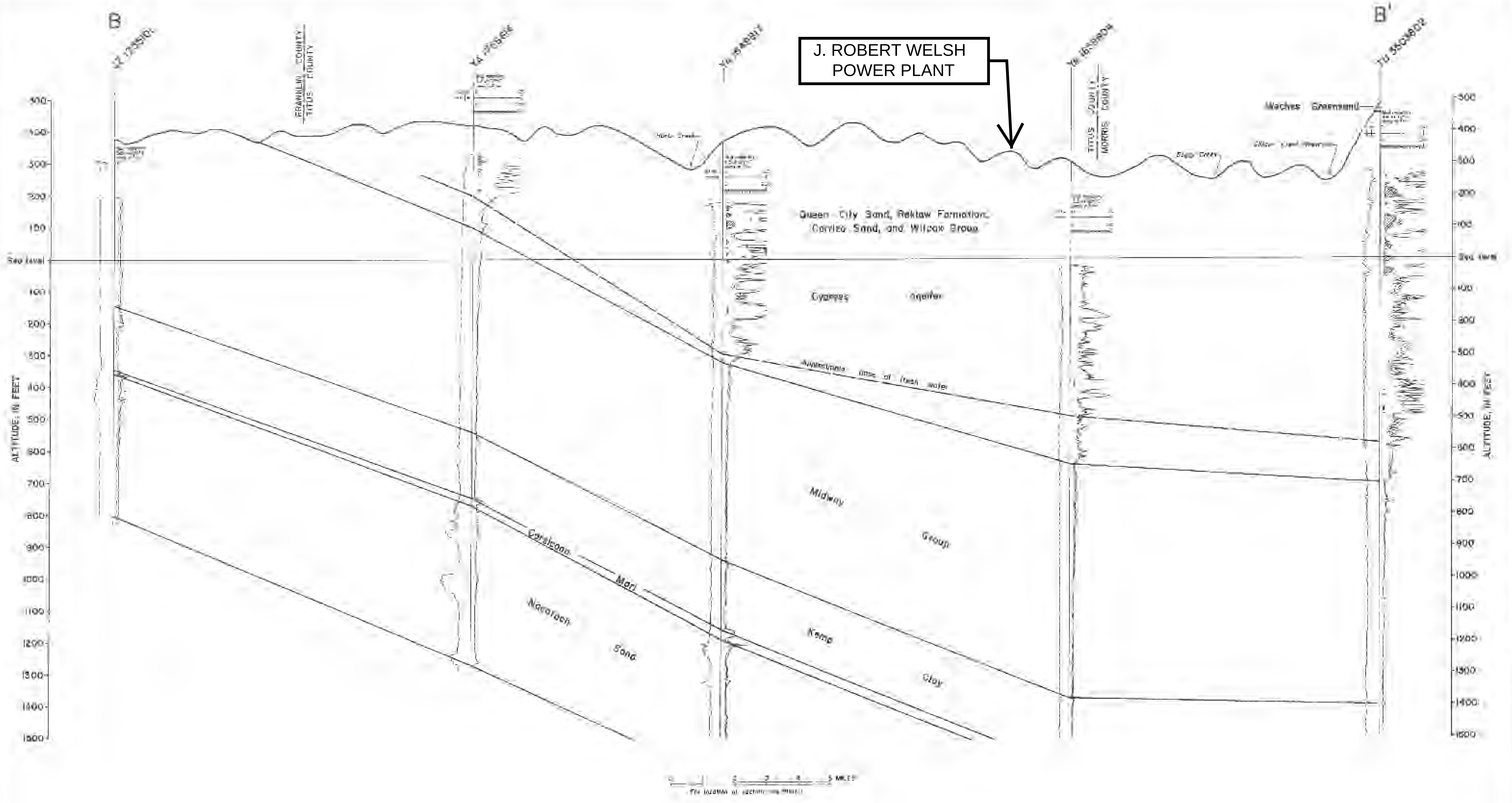


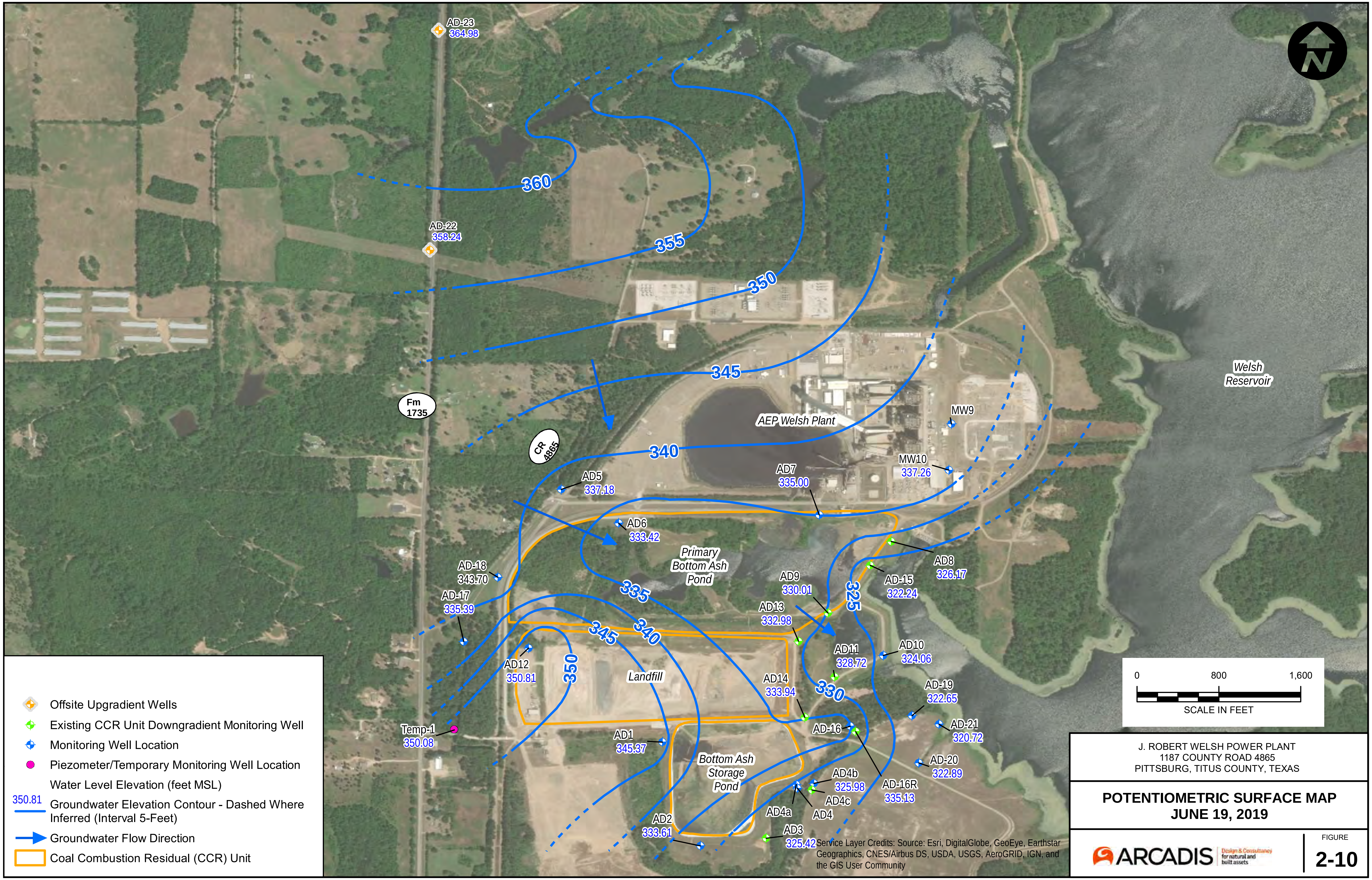
Plate 3

Geologic Section B–B′, Franklin, Titus, and Morris Counties

U. S. Geological Survey in cooperation with the Texas Water Commission **(TWC BULLETIN 6517)**

REGIONAL GEOLOGIC CROSS SECTION

FIGURE 2-9



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

◈	Offsite Upgradient Wells
◈	Existing CCR Unit Downgradient Monitoring Well
◈	Monitoring Well Location
●	Piezometer/Temporary Monitoring Well Location
350.81	Water Level Elevation (feet MSL)
—	Groundwater Elevation Contour - Dashed Where Inferred (Interval 5-Feet)
→	Groundwater Flow Direction
▭	Coal Combustion Residual (CCR) Unit

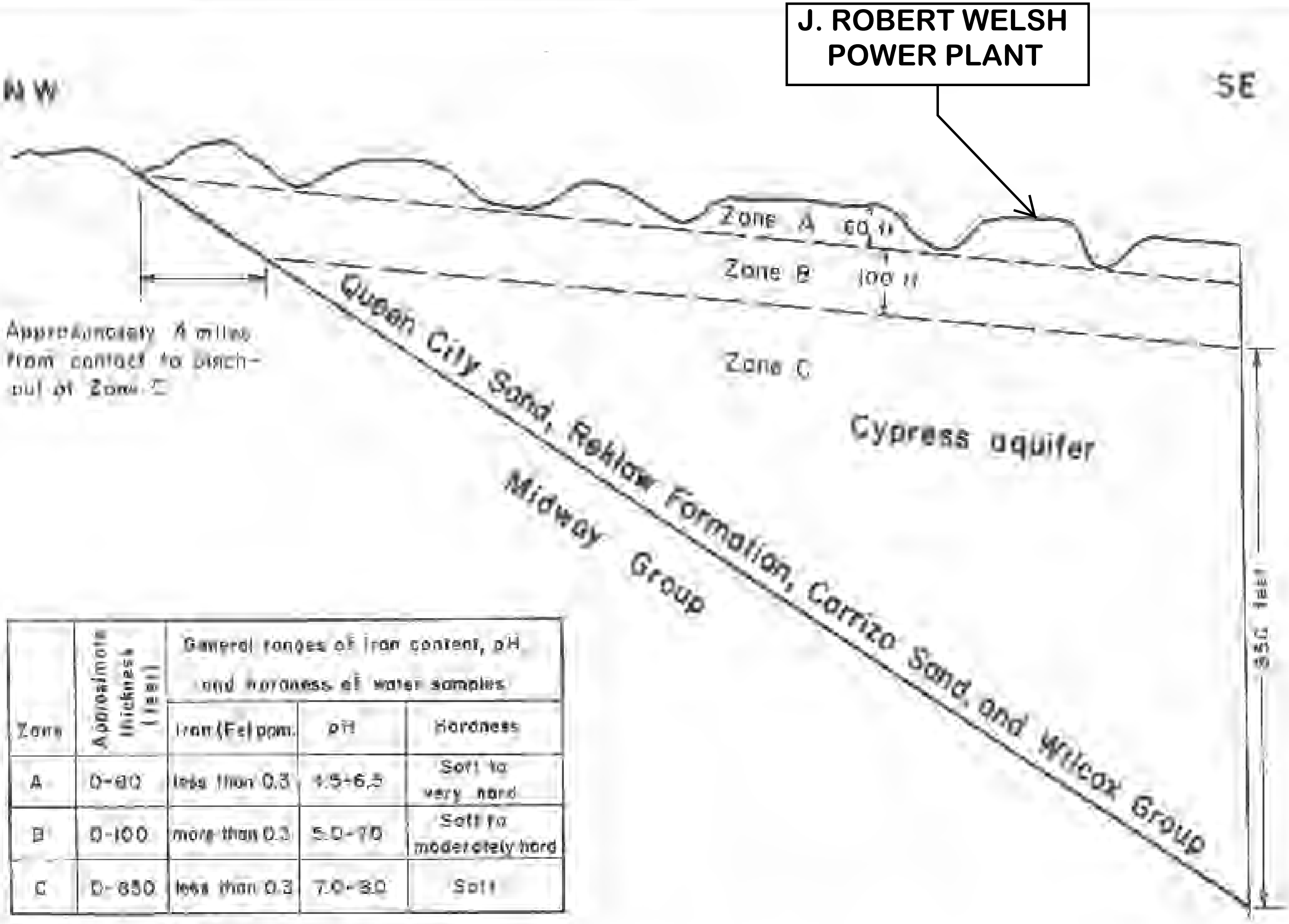
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
JUNE 19, 2019

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-10

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\September 2019\fig 2-10 - Potentiometric June2019.mxd



Zone	Approximate thickness (feet)	General ranges of iron content, pH and hardness of water samples		
		Iron (Fe) ppm.	pH	Hardness
A	0-60	less than 0.3	4.5-6.5	Soft to very hard
B	0-100	more than 0.3	5.0-7.0	Soft to moderately hard
C	0-850	less than 0.3	7.0-8.0	Soft

Figure 12

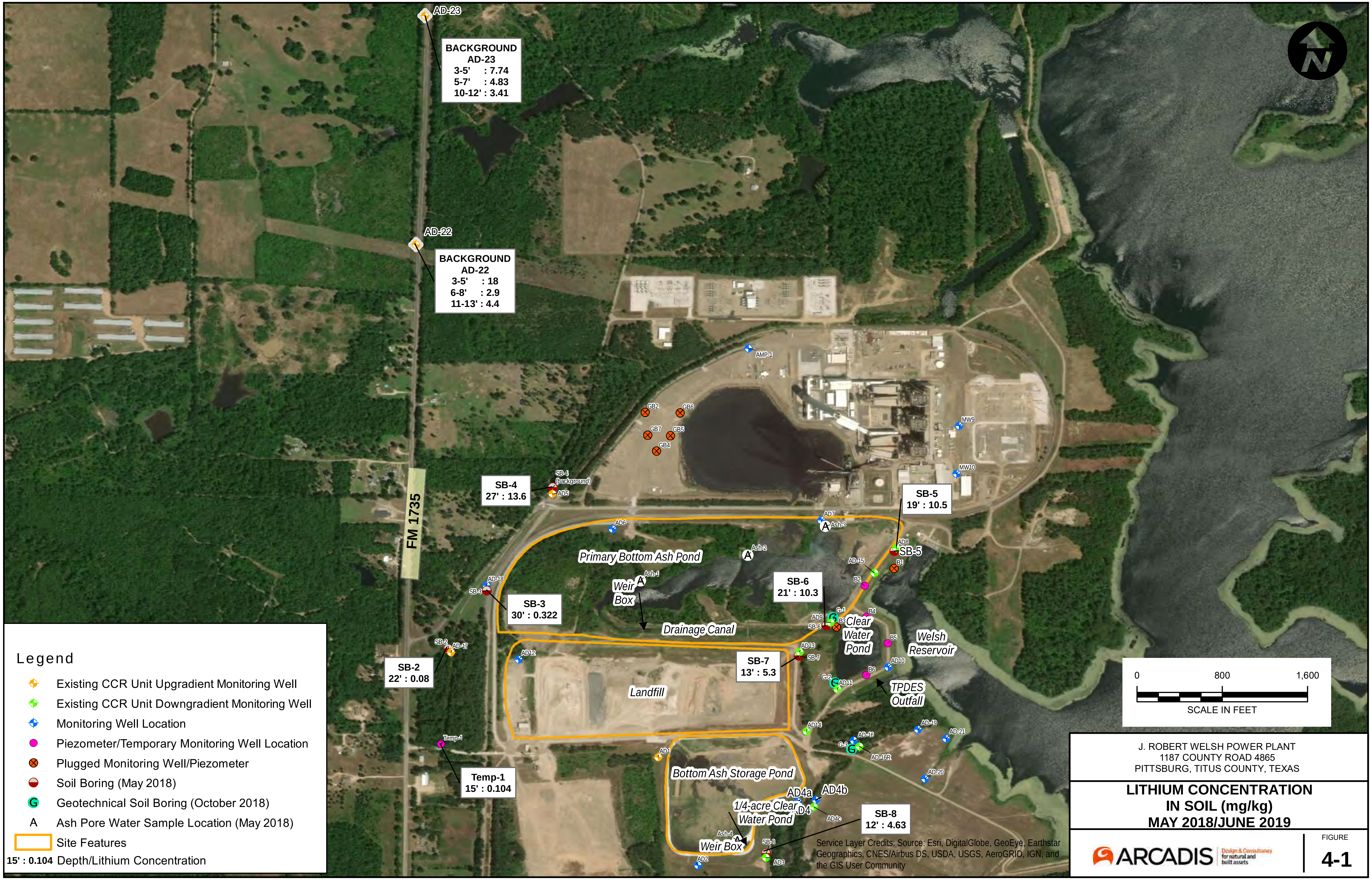
Diagrammatic Section Showing Zones A, B, and C in the Cypress Aquifer

U.S. Geological Survey in cooperation with the Texas Water Commission

(TWC BULLETIN 6517)

REGIONAL HYDROLOGIC CROSS SECTION

FIGURE 2-11



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

LITHIUM CONCENTRATION IN SOIL (mg/kg) MAY 2018/JUNE 2019

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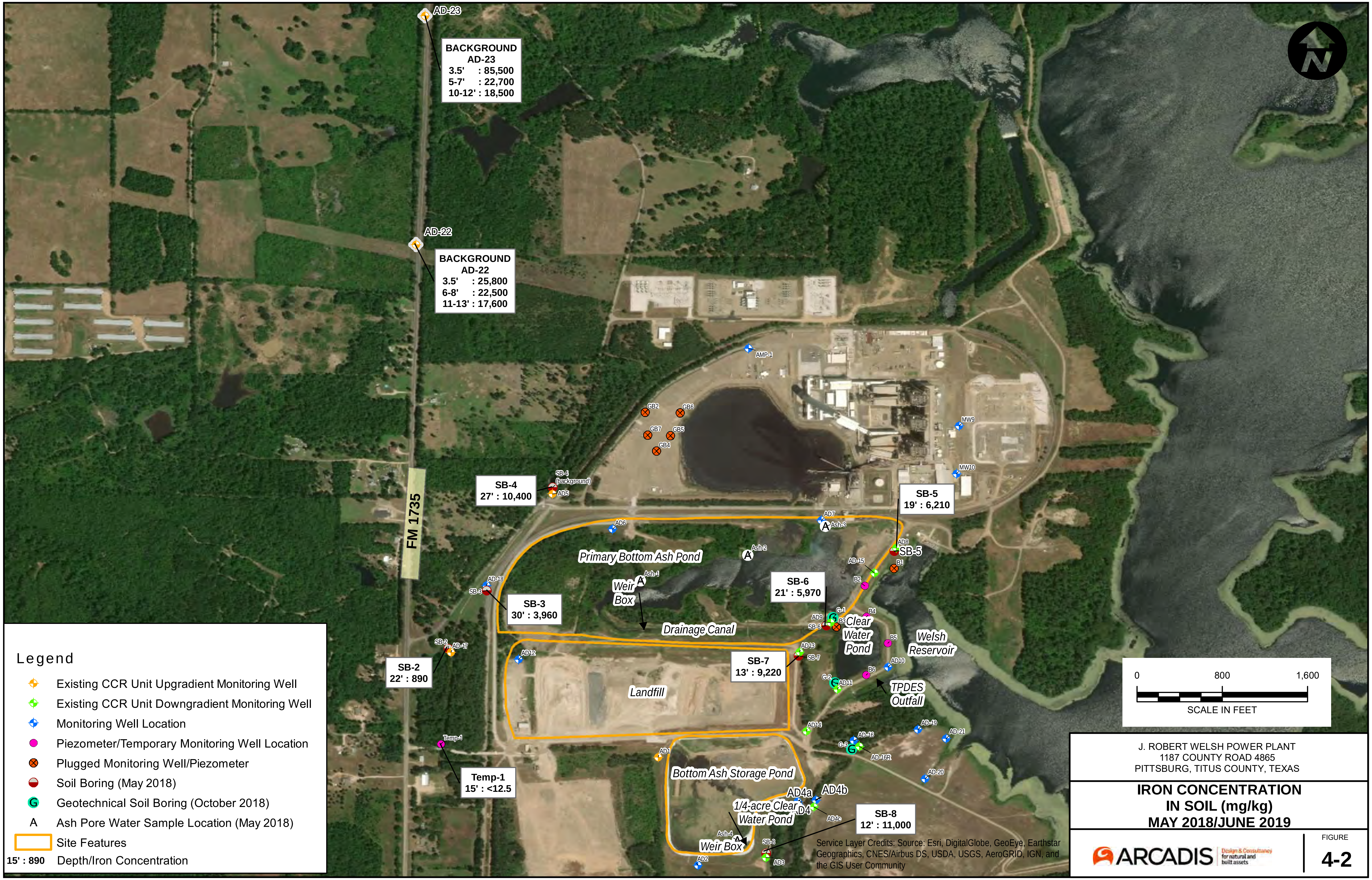
FIGURE
4-1

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\September 2019\Fig 4-1-SoilBoring_LithiumresultsMay2018-June2018.mxd



Legend

- 🟠 Existing CCR Unit Upgradient Monitoring Well
- 🟢 Existing CCR Unit Downgradient Monitoring Well
- 🔵 Monitoring Well Location
- ● Piezometer/Temporary Monitoring Well Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◓ Soil Boring (May 2018)
- G Geotechnical Soil Boring (October 2018)
- A Ash Pore Water Sample Location (May 2018)
- ▭ Site Features
- **15' : 890** Depth/Iron Concentration

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

IRON CONCENTRATION IN SOIL (mg/kg) MAY 2018/JUNE 2019

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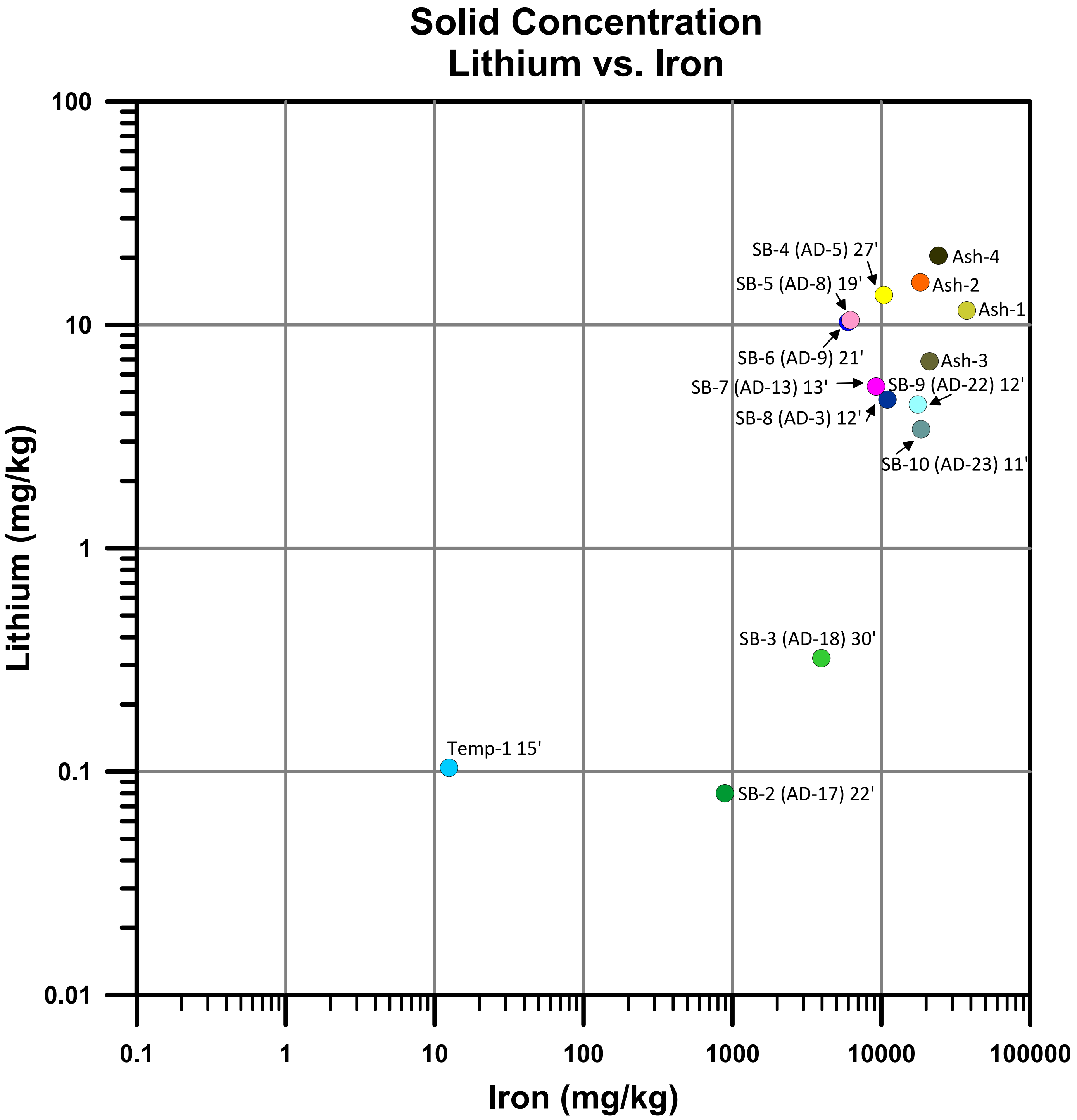
FIGURE
4-2

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\September 2019\Fig 4-2-SoilBoring_IronresultsMay2018-June2019.mxd



Native Soil

Upgradient

- ● SB-2 (AD-17) 22'
- ● SB-3 (AD-18) 30'
- ● SB-4 (AD-5) 27' Background
- ● SB-9 (AD-22) 12'
- ● SB-10 (AD-23) 11'

Downgradient

- ● SB-8 (AD-3) 12'
- ● SB-5 (AD-8) 19'
- ● SB-6 (AD-9) 21'
- ● SB-7 (AD-13) 13'

Supplemental Sidegradient

- ● Temp-1 15'

Coal Ash

- ● Ash-1
- ● Ash-2
- ● Ash-3
- ● Ash-4

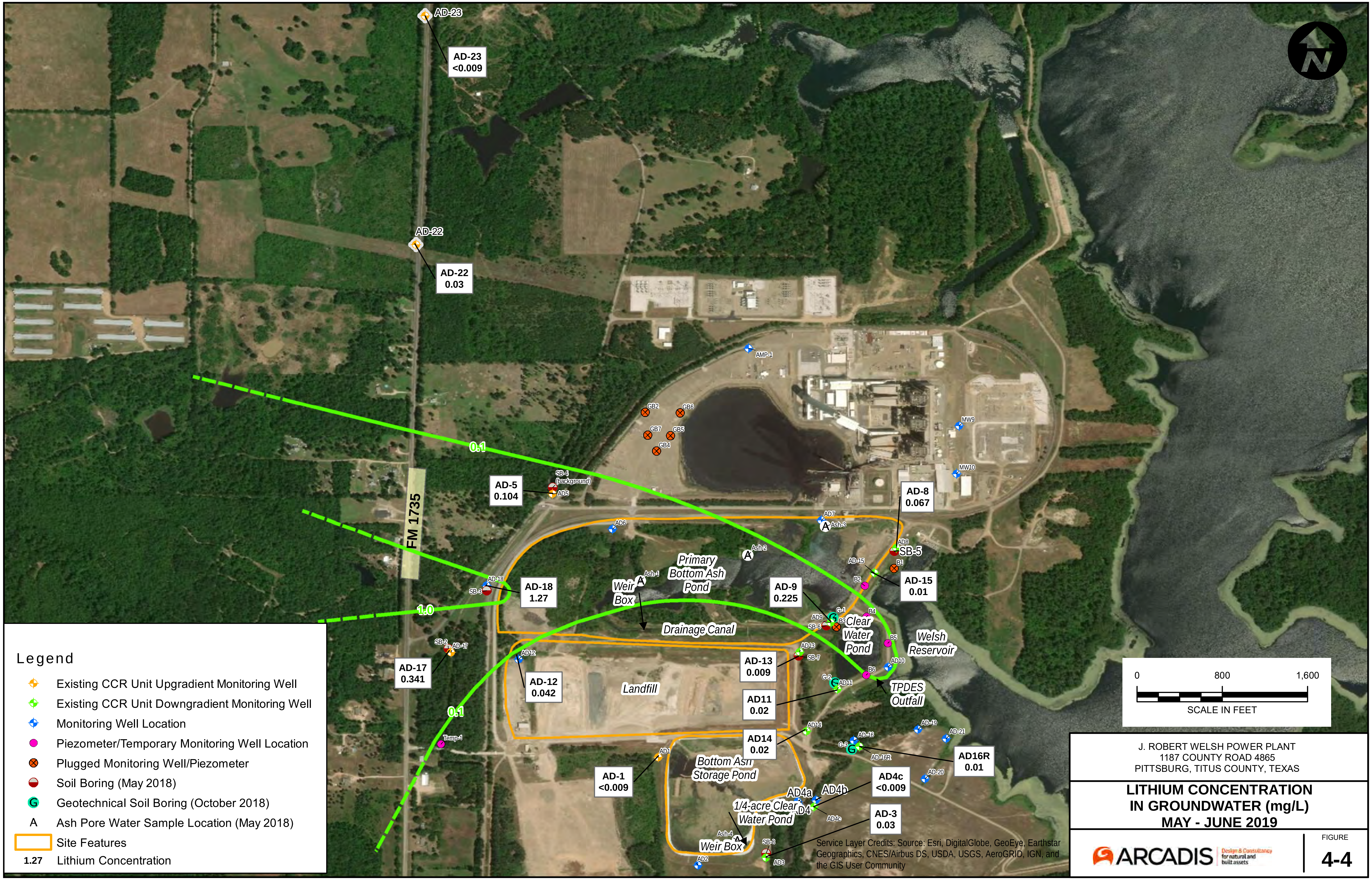
Notes:
mg/kg - milligrams per kilogram

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

LITHIUM VS. IRON SOLIDS CONCENTRATION PLOT

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-3



Legend

- ⯌ Existing CCR Unit Upgradient Monitoring Well
- ⯌ Existing CCR Unit Downgradient Monitoring Well
- ⯌ Monitoring Well Location
- ● Piezometer/Temporary Monitoring Well Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◒ Soil Boring (May 2018)
- G Geotechnical Soil Boring (October 2018)
- A Ash Pore Water Sample Location (May 2018)
- ▭ Site Features
- 1.27 Lithium Concentration

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

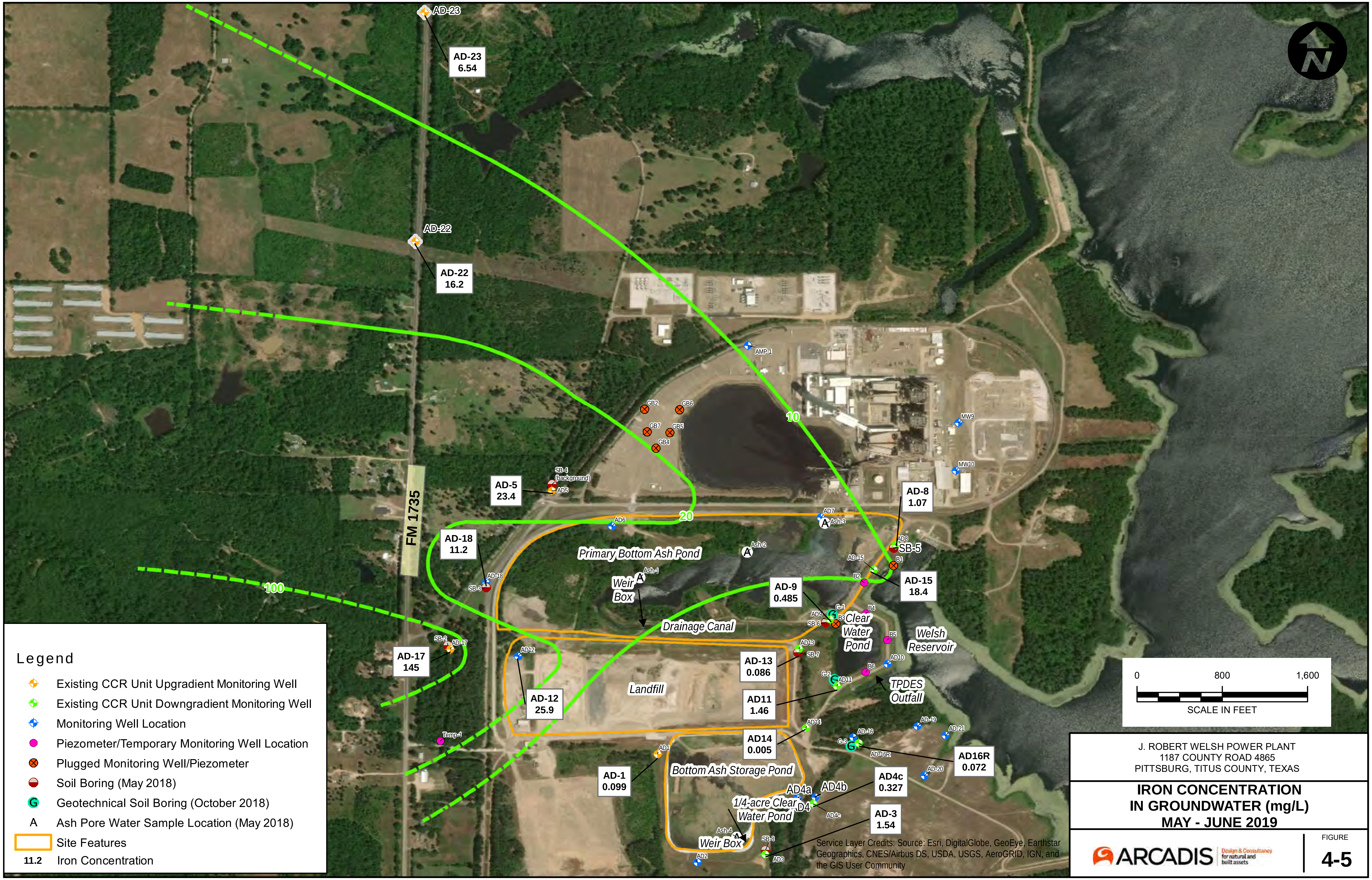
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

LITHIUM CONCENTRATION IN GROUNDWATER (mg/L) MAY - JUNE 2019

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-4

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\September 2019\Fig 4-4-SoilBoring_LithiumGWresultsMay2018-June2019.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

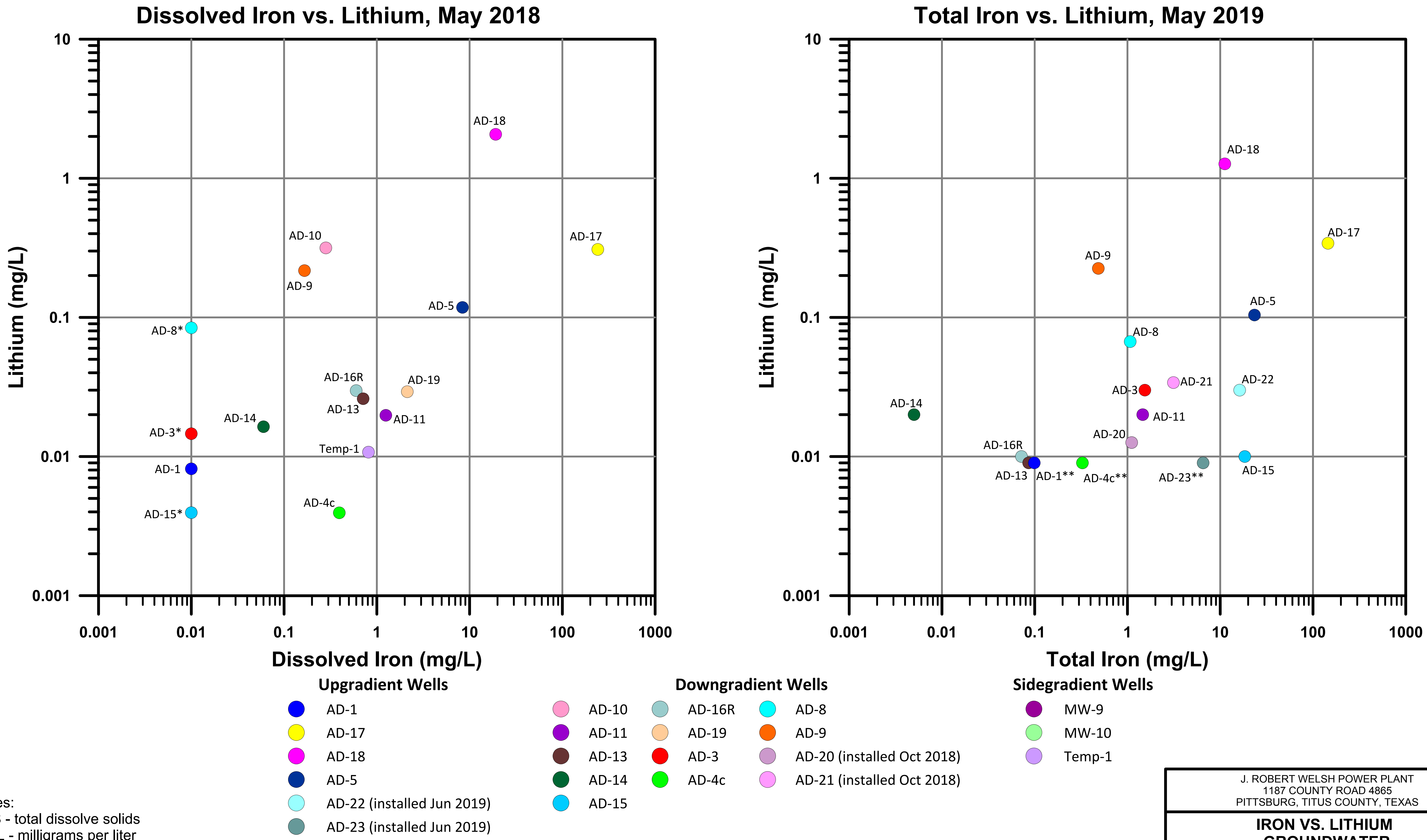
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

IRON CONCENTRATION IN GROUNDWATER (mg/L) MAY - JUNE 2019

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-5

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\September 2019\Fig 4-5-SoilBoring_IronGWresultsMay2018-June2019.mxd



Notes:
TDS - total dissolve solids
mg/L - milligrams per liter
Concentrations of iron and lithium in coal ash were below detection
Concentrations of lithium in coal ash porewater were less than 0.02 mg/L
AD-22 and AD-23 groundwater concentrations are total only
*Iron was not detected, result is plotted at the reporting limit
**Lithium was not detected, result is plotted at the reporting limit

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

**IRON VS. LITHIUM
GROUNDWATER
CONCENTRATION PLOT**

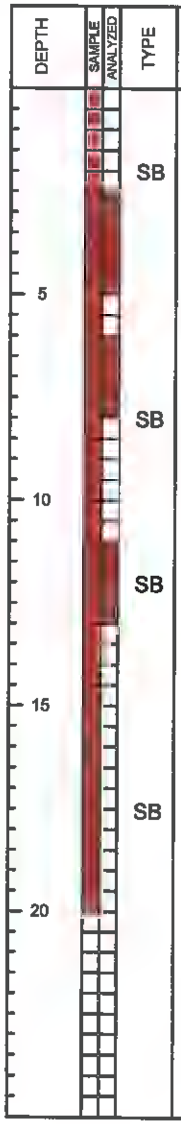
ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-6

APPENDIX A

Monitoring Well Completion Diagrams – 2019 Monitoring Wells

WELL LOG



SAMPLE DESCRIPTION

(0-2.5') SAND (SP), BROWN, FINE GRAINED.

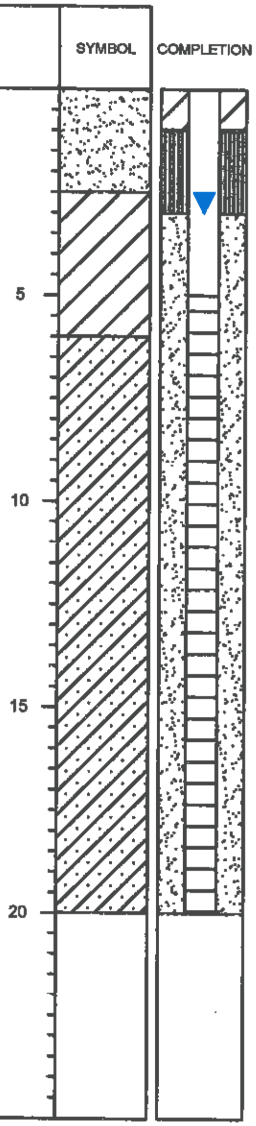
(2.5-6') SILTY CLAY (CL), GRAY WITH RED MOTTLING AND IRON NODULES.

(6-20') CLAYEY SAND (SC), GRAY WITH RED MOTTLING, FINE GRAINED, WET @ 9.5'.

Kenneth J. Brandner
Geology
1787

8-7-19

TOTAL DEPTH = 20 FEET BGS



WELL	AD-22
CLIENT	AEP
PROJECT	TX015976.0004
LOCATION	WELSH POWER PLANT
DATE	6/18/19
DRILLING METHOD	HSA
CASING	2" PVC, 0-5' BGS
SCREEN	5-20' BGS, 2" PVC MILL-SLOT
CEMENT	0-1' BGS
BENTONITE	1-3' BGS
SAND PACK	3-20' BGS
GROUND ELEV. / TOP OF CASING ELEV.	360.94' / 360.22'

CT - CUTTINGS
SB - SPLIT BARREL (5')
SS - SPLIT SPOON (2')

▽ HC LEVEL
▼ WATER LEVEL

▨ SAND	▨ FILL/CONCRETE
▥ SILT	▨ BENTONITE
▨ CLAY	▨ GRAVEL

PAGE 1 OF 1

711 N. CARANCAHUA, #1080
CORPUS CHRISTI, TEXAS 78401
TEL: (361) 883-1353 FAX: (361) 883-7565

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STATE OF TEXAS WELL REPORT for Tracking #515172

Owner:	**AEP**	Owner Well #:	**AD-22**
Address:	**1187 County Road 4865 Pittsburg, TX 75686**	Grid #:	**16-58-4**
Well Location:	**FM 1735 Pittsburg, TX 75686**	Latitude:	**33° 03' 35" N**
	In ROW along west side of FM 1735, WNW of the AEP - Welsh Plant	Longitude:	**094° 51' 09" W**
		Elevation:	**No Data**
Well County:	**Titus**		
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **6/18/2019** Drilling End Date: **6/18/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**7.25**	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**1**	**Concrete**
	1	**3**	**Bentonite**
	3	**20**	**Sand**

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**

	Strata Depth (ft.)	Water Type
Water Quality:	**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: **WEST Drilling**

101 Industrial Drive
Waxahachie, TX 75165

Driller Name: **Robert Williams**

License Number: **59501**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**2.5**	**brown sand**
2.5	**6**	**gray and red, mottled, silty clay with Fe nodules**
6	**20**	**gray, clayey sand**

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**	**20**

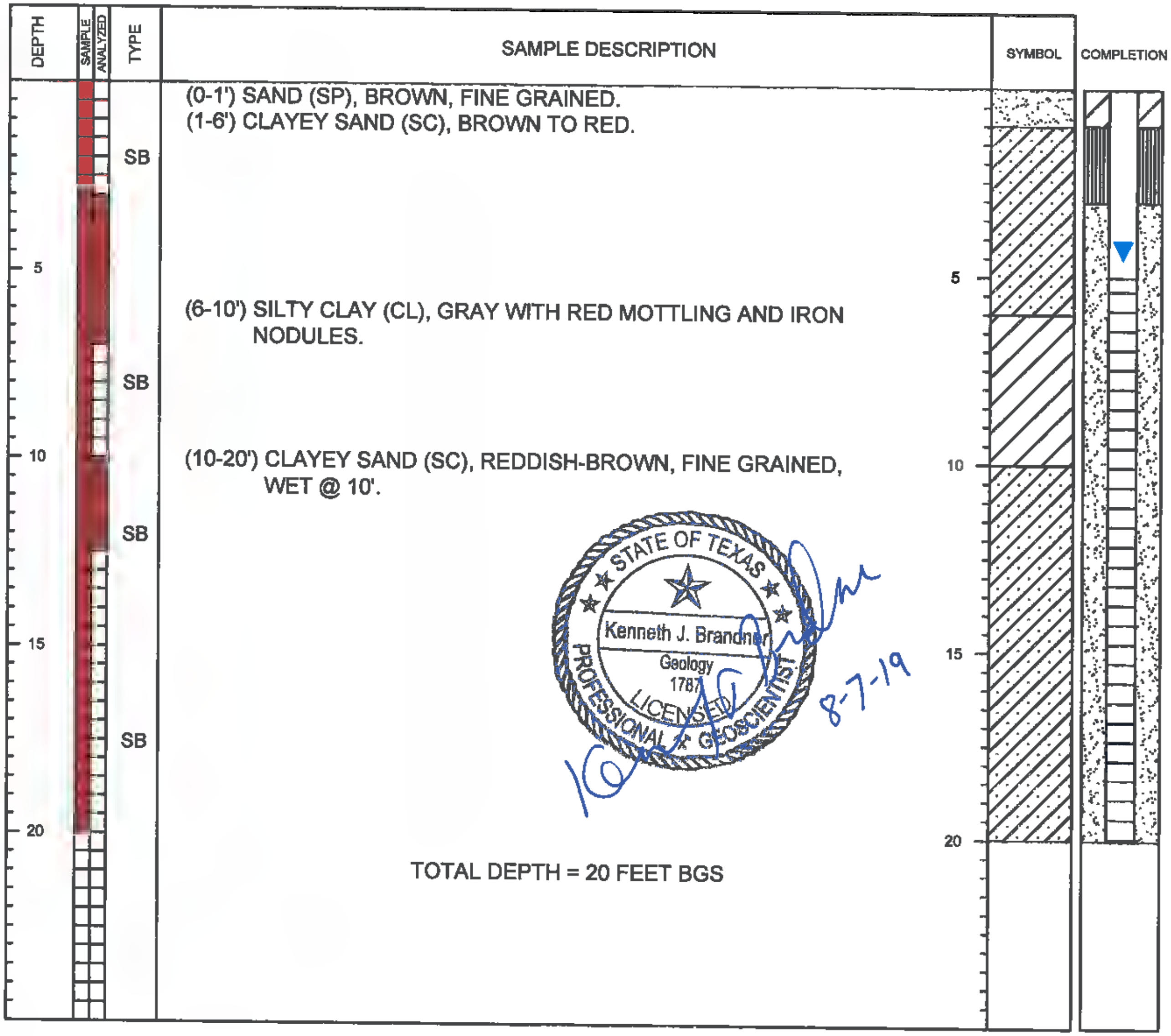
IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

WELL LOG



SAMPLE DESCRIPTION

(0-1') SAND (SP), BROWN, FINE GRAINED.
(1-6') CLAYEY SAND (SC), BROWN TO RED.

(6-10') SILTY CLAY (CL), GRAY WITH RED MOTTLING AND IRON NODULES.

(10-20') CLAYEY SAND (SC), REDDISH-BROWN, FINE GRAINED, WET @ 10'.

Kenneth J. Brandner
Geology
1787

8-7-19

TOTAL DEPTH = 20 FEET BGS

WELL: AD-23
CLIENT: AEP
PROJECT: TX015976.0004
LOCATION: WELSH POWER PLANT
DATE: 6/18/19
DRILLING METHOD: HSA
CASING: 2" PVC, 0-5' BGS
SCREEN: 5-20' BGS, 2" PVC MILL-SLOT
CEMENT: 0-1' BGS
BENTONITE: 1-3' BGS
SAND PACK: 3-20' BGS
GROUND ELEV. / TOP OF CASING ELEV.: 369.37' / 368.82'

CT - CUTTINGS
SB - SPLIT BARREL (5')
SS - SPLIT SPOON (2')

▽ HC LEVEL
▼ WATER LEVEL

⛆ SAND	⛆ FILL/CONCRETE
▥ SILT	▨ BENTONITE
▨ CLAY	⚬ GRAVEL

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CORPUS CHRISTI, TEXAS 78401
TEL: (361) 883-1353 FAX: (361) 883-7565
ARCADIS Design & Consultancy for natural and built assets

STATE OF TEXAS WELL REPORT for Tracking #515173

Owner:	**AEP**	Owner Well #:	**AD-23**
Address:	**1187 County Road 4865** **Pittsburg, TX 75686**	Grid #:	**16-58-4**
Well Location:	**FM 1735** **Pittsburg, TX 75686**	Latitude:	**33° 03' 56" N**
	In ROW along west side of FM 1735, **WNW of the AEP - Welsh Plant**	Longitude:	**094° 51' 08" W**
		Elevation:	**No Data**
Well County:	**Titus**		
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **6/18/2019** Drilling End Date: **6/18/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**7.25**	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**1**	**Concrete**
	1	**3**	**Bentonite**
	3	**20**	**Sand**

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**

	Strata Depth (ft.)	Water Type
Water Quality:	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: **WEST Drilling**

101 Industrial Drive
Waxahachie, TX 75165

Driller Name: **Robert Williams** License Number: **59501**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	1	brown sand
1	6	gray and red, clayey sand
6	10	gray and red, mottled, silty clay with Fe nodules
10	20	reddish brown, clayey sand

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	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.

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

APPENDIX B

Springs of Texas Reference

Springs of Texas

VOLUME I

Gunnar Brune

Manufactured in the United States of America

Second edition

The paper used in this book meets the minimum requirements of the American National Standard for Permanence of Paper for Printed Library Materials, Z39.48-1984. Binding materials have been chosen for durability.

∞

The publisher gratefully acknowledges those whose grants helped make this edition possible:

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College of Agriculture and Life Sciences,
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2002017373

INTRODUCTION TO THE SECOND EDITION

Helen C. Besse

When Gunnar Brune self-published *Springs of Texas, Volume I*, in 1981, most of the state water planning agencies and local environmental communities either did not recognize the importance of his work or were not aware of its existence. Brune had spent the previous decade conducting research and field studies, and then writing this book that describes the physical characteristics of springs, the archeology and history of springs' use, the ecological setting of springs, and the local use and lore surrounding springs for 183 out of 254 Texas counties. Gunnar Brune died before he could complete volume II.

Gunnar Brune described many of the large springs across the state as well as innumerable small springs present along river and stream courses that provide the base flow for waterways across the state. Brune repeatedly stated in the 1981 edition of this book that many of the springs he described had failed or were failing. With the pronounced influx of population in the last twenty years and the increased agricultural and industrial activities around the state, one can only wonder how many of the more than 2,000 springs have gone dry since he described them through the 1970s.

Nevertheless, this book is even more important today. Its value to water planners, elected officials, policy makers, municipal, county, and state administrators, wildlife stewards, environmentalists, and water lovers has not diminished. Springs are "the canary in the coal mine." The health of our springs reflects the health of our underground water resources and is seen in the state's surface resources as well.

In the section "The Prehistoric Setting of Springs," Brune provided a quote from another book on the beliefs that early Americans had about springs. It is appropriate to repeat those words here:

> Gods and heroes were born out of springs, and their [illegible] came and went between the above and below worlds through their pools. Every pueblo had sacred springs somewhere nearby. There was every reason to sanctify them – physical, as life depended upon water; spiritual, as they had natural mystery which suggested supernatural qualities; for how could it be that when water fell as rain, or as snow, and ran away, or dried up, there should be other water which continued came, secretly and sweetly, out of the ground and never failed (Horgan 1954).

F. Halley's farm. According to Dr. John Klein, a nearby resident and writer, the Klein settlement began here in 1848. The Sellars store was at the springs. They issued from Montgomery silt with many iron concretions at about 0.72 lps on April 11, 1978. The pools, containing duckweed, pennywort, and water primrose, were home to a family of ducks and ducklings. Probably the flow formerly continued down Spring Gully past Klein cemetery, 0.6 kilometer downstream, but on this date, even after rains, the channel here was dry except for some standing water. Many wells pump nearby.

Magnolia Garden Springs (15) are four kilometers northeast of Sheldon along the San Jacinto River. At Martha Dempsey's Good Times marina several very small springs trickle from Deweyville sand, including one which flows 0.15 lps from a pipe. Near the entrance to the nearby Magnolia Gardens marina, according to Jean Manson, springs flowed until about 1923. They are quite dry now. Very small springs are said to feed Simms Lake, across the river and 0.6 kilometer farther east. This formerly popular swimming hole is now closed to the public.

At Beaumont Place northeast of Houston, near the intersection of Highways 90 and 526, is another Spring Gully. The channel is now a drainage ditch into which very small springs and seeps (14) drain from Beaumont silt and sand.

Eight kilometers west of La Porte is Willow Springs Bayou, also called Willow Springs Gully or Ditch. **Willow Springs (8)** are chiefly between North L Street and Spencer Road. On April 9, 1978, the discharge of Willow Springs Bayou at North L Street was 0.18 lps, and at Spencer Road it was 0.70 lps. Many willows still fringe the channel, along with cattails.

A third Spring Gully is located eight kilometers southwest of La Porte. Springs (9) in Beaumont silt produced a discharge of about 0.18 lps in 1978 in the gully at the Red Bluff road crossing. Cottonmouths hide here among the willows and cattails.

HARRISON COUNTY

Harrison County is endowed with numerous springs of all types, some highly mineralized and valued for their healing properties. Most appear to be flowing as strongly as ever, because there has been little demand on the groundwater reservoirs. However, water levels in the artesian sands are declining as much as 4.6 meters per year in some areas. Most of the Caddo Indian villages were located at springs. Early French and Spanish explorers, some over 400 years ago, visited many of the same springs that can be seen today. The New Madrid earthquake of 1811 - 1812, which enlarged Caddo Lake, may have affected the flow of some springs. In general, however, the water-bearing formations were not greatly affected by the quake.

Most of the spring waters of the county issue from Eocene sands. They are usually fresh, soft, and acid, being of the sodium bicarbonate type. The iron content is often very high. Mineralized waters may also be high in aluminum and sulfate, may be slightly saline, and can be very hard. The analyses shown for 1942 in the table of Selected Chemical Analyses are probably too low in dissolved-solids content, perhaps because of high rainfall at the time the samples were collected. Most of the writer's field studies were made on January 23 - 28, 1976.

It was around **Locke Springs (1)** that the community of Marshall first appeared. In 1831 there were at least 20 springs flowing from the Reklaw sand near the intersection of Franklin and Houston Streets and up the hill toward the courthouse. In early times water was hauled from these springs in barrels to fill the cisterns on the town square. Most of the springs have now been paved over, but the remaining ones still flowed 1.4 liters per second in 1976.

Hynson Springs (10), also known as **Marshall**, **Noonday Camp**, and **Iron Springs**, are six kilometers north of Hallsville. They became very popular as a health resort about 1851. The waters are highly mineralized, containing much iron, sulfur, aluminum, and lithium. Originally there were said to be over 100 springs flowing from Queen City sand. Now not more than 20 can be found, possibly because the water table has fallen. During the Civil War the water from the springs was used in a leather-tanning factory. From 1891 to 1905 the large Hotel Randall accommodated thousands of visitors to the springs. Today there are an open-air auditorium and a number of cabins, but everything is in a sad state of disrepair. A historical marker is located at the springs. The discharge record, in liters per second, is as follows:

Jan. [illegible], 1942	[illegible]	
Jul. [illegible], 1964	[illegible]	
Jan. [illegible], 1976	[illegible] (one only)	1.4 (all springs)

Rock Springs (7) are just east of the Rock Springs church on Highway 449 about 13 kilometers west of Marshall. This and several other springs upstream flowed 2.3 lps from the Queen City sand in 1976. The Frenchman Henri Joutel of La Salle's party may have stopped here for refreshment in 1687.

Mulberry Springs (9), nine kilometers south-southwest of Harleton, are 100 meters north of the

APPENDIX IV

Notices of groundwater monitoring programs are included in this appendix.

NOTE:
Pulled from the OR because ASD was completed w/in 30 days of SSL negating the need for placing this notification into the OR.

Welsh Power Plant

Notice of Statistically Significant Levels (SSLs) above the Groundwater Protection Standard (GWPS)

CCR Unit – Primary Bottom Ash Pond

As required by 40 CFR 257.95(g), this is a notification that on January 8, 2019 lithium was detected at an SSL above the GWPS. This notification is being placed in the plant's operating record, as required by 40 CFR 257.105(h)(8).

SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

Welsh Power Plant

Notice of Statistically Significant Levels (SSLs) above the Groundwater Protection Standard (GWPS)

CCR Unit – Primary Bottom Ash Pond

As required by 40 CFR 257.95(g), this is a notification that on July 11, 2019 lithium was detected at an SSL above the GWPS. This notification is being placed in the plant's operating record, as required by 40 CFR 257.105(h)(8).

APPENDIX V- NA

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
J. Robert Welsh Power Plant

Bottom Ash Storage Pond CCR Management Unit

1187 Country Road 4865
Titus County
Pittsburg, Texas

January 2020

Prepared by:
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1 Riverside Plaza
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SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

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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), J. Robert Welsh 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:

- Semi-Annual groundwater samples were collected and analyzed for detection monitoring Appendix III constituents, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared in accordance with 40 CFR 257.93 and certified. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009);
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Statistically significant increases (SSI) were determined for Chloride and Sulfate in AD-4C and Chloride in AD-3.
- Successful alternate source demonstrations (ASDs) were conducted for the SSIs;
- This CCR Unit remained in Detection Monitoring during 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;
- Statistically reports are located in Appendix II;
- ASDs are located in Appendix III;

- 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 notification 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 program related notification 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.

Bottom Ash Storage Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-1	AD-3
AD-5	AD-4C
AD-17	AD-16R


AD5
Ash Pond Primary
AD-17
Landfill
Clear Water Pond
Welsh Reservoir
AD-16R
AD1
Bottom Ash Storage Pond
AD4c
AD3
AD2
0
450
900
SCALE IN FEET
Legend
Monitoring Well Location
Proposed Existing CCR Unit Downgradient Monitoring Well
Proposed Existing CCR Unit Upgradient Monitoring Well
Site Features
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS
MONITORING WELL NETWORK MAP - BOTTOM ASH STORAGE POND
ARCADIS
FIGURE
10

III. Monitoring Wells Installed or Decommissioned

During 2019, no monitoring wells were installed or decommissioned.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected under 40 CFR 257.90 through 257.98. 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.

V. Statistical Evaluations Completed in 2018 and 2019

A SSI were determined for:

- Chloride in AD-4C during the 1st semi-annual 2018 groundwater sampling event.
- Sulfate in AD-4C during the 2nd semi-annual 2018 groundwater sampling event.
- Chloride in AD-3 during the 1st semi-annual 2019 groundwater sampling event.

The statistical evaluation for the 2nd semi-annual 2019 groundwater sampling event demonstrated no SSIs.

Mann-Whitney tests were completed to evaluate whether data from the detection monitoring events could be added to the existing background dataset. Where appropriate, the background datasets were updated, and UPLs and LPLs were recalculated.

Statistical reports are found in Appendix II.

VI. Alternate Source Demonstrations Completed in 2019

Alternate source investigations were conducted for:

- Chloride in AD-4C during the 1st semi-annual 2018 groundwater sampling event.
- Sulfate in AD-4C during the 2nd semi-annual 2018 groundwater sampling event.
- Chloride in AD-3 during the 1st semi-annual 2019 groundwater sampling event.

Successful ASDs were completed for all SSIs.

Those demonstrations are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this annual groundwater report, the CCR Unit remains in detection monitoring.

VIII. Other Information Required

The sampling frequency of twice per year will be maintained for the current monitoring program.

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:

- Detection monitoring on a twice per year schedule;
- Evaluation of the detection monitoring results from a statistical analysis viewpoint, looking for any SSIs;
- 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 Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- ▭ CCR Units

Notes
- Monitoring well coordinates and water level data (collected on February 20-21, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

500 250 0 500
Feet

Groundwater Potentiometric Map
February 2019

AEP Welsh Power Plant
Cason, Texas

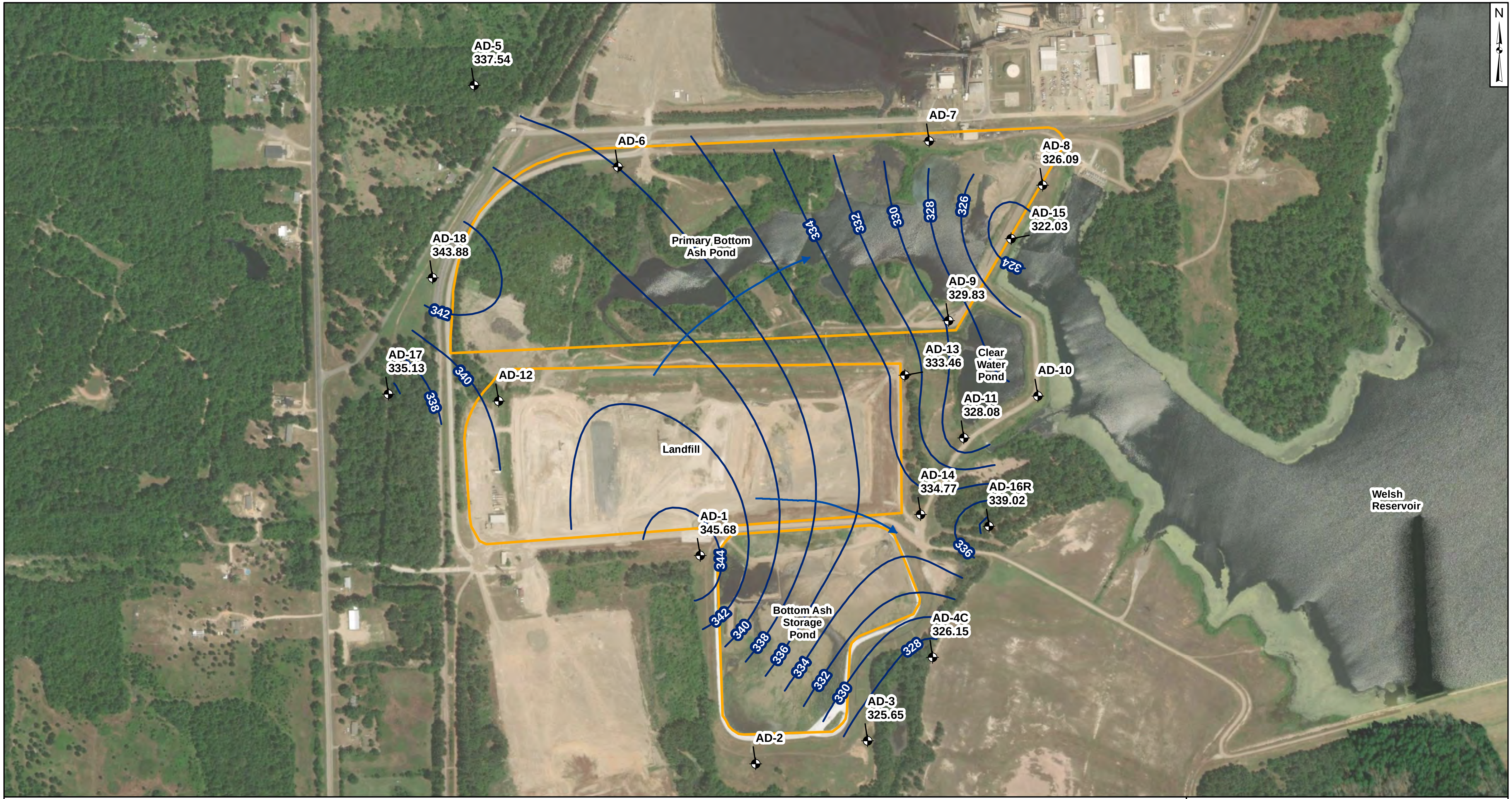
Geosyntec
consultants

Columbus, Ohio

2020/01/22

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2019\AEP-Welsh_GW_2019-20Feb.mxd. ARevezzo. 1/22/2020. CHA8423/14/08.



Legend

- ⊕ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- ▭ CCR Units

Notes

- Monitoring well coordinates and water level data (collected on May 29-30, 2019) provided by AEP.
- AD-10, AD-6, AD-7, AD-2, and AD-12 were not gauged during this event
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

750 375 0 750
Feet

Groundwater Potentiometric Map
May 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2019/12/12

Legend

- ⊕ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)
- ▭ CCR Units

Notes
- Monitoring well coordinates and water level data (collected on July 23-24, 2019) provided by AEP.
-AD-12 and AD-6 were not gauged during this event.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- Inferred groundwater contours were ectrapolated from topographic and hydrographic information as well as previous monitoring events.

750 375 0 750
Feet

Groundwater Potentiometric Map
July 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio | 2020/01/22

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2019\AEP-Welsh_GW_2019-07July.mxd. ARevezzo. 1/22/2020. CHA8423/14/08.

Table 1: Residence Time Calculation Summary
Welsh Bottom Ash Storage Pond

			2019-02		2019-04[3]		2019-05		2019-07	
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)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Bottom Ash Storage Pond	AD-1 [1]	2.0	2.7	22.4	NC	NC	5.3	11.5	4.1	14.9
	AD-3 [2]	2.0	4.9	12.4	0.5	127	5.7	10.7	5.1	11.9
	AD-4C [2]	2.0	4.0	15.3	0.5	127	5.2	11.6	4.2	14.4
	AD-5 [1]	2.0	1.5	40.2	NC	NC	2.4	25.4	2.1	29.2
	AD-16R [2]	2.0	3.7	16.3	3.7	16.4	6.5	9.4	4.6	13.3
	AD-17 [1]	2.0	8.9	6.9	NC	NC	4.7	13.0	3.5	17.5

Notes:

[1] - Upgradient Well

[2] - Downgradient Well

[3] - Upgradient wells were not gauged at the time of sampling, residence time estimates are based on available data.

NC - Not Calculated

Table 1 - Groundwater Data Summary: AD-1
Welsh - BASP
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
5/26/2016	Background	0.346	36.5	5	<0.083 U	5.9	252	42
7/29/2016	Background	0.35	39.6	4	<0.083 U	5.3	239	36
9/30/2016	Background	0.332	15	5	<0.083 U	5.4	173	35
10/21/2016	Background	0.398	19.1	4	<0.083 U	5.2	192	42
12/14/2016	Background	0.394	8.74	4	<0.083 U	5.2	200	40
1/20/2017	Background	0.656	129	4	<0.083 U	7.1	538	68
2/24/2017	Background	0.7	147	9	<0.083 U	6.9	612	68
6/8/2017	Background	0.449	15.1	4	<0.083 U	5.1	176	42
10/6/2017	Detection	0.453	14.3	4	<0.083 U	5.3	160	40
5/24/2018	Detection	0.345	10.2	5	<0.083 U	2.2	150	43
8/14/2018	Detection	0.443	5.95	5	<0.083 U	5.2	160	44
2/20/2019	Detection	0.504	142	2.82	0.240	7.3	522	49.2
5/30/2019	*	0.689	138	1.59	0.290	6.7	588	43.3
7/24/2019	Detection	0.644	62.7	2	0.106 J	6.0	180	58

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
* Sample is not associated with a specific monitoring program but was included in the updated background dataset.

Table 1 - Groundwater Data Summary: AD-1
Welsh - BASP
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
5/26/2016	Background	<0.93 U	1.39361 J	191	0.271453 J	0.213294 J	0.240267 J	1.15339 J	1.184	<0.083 U	<0.68 U	0.010	0.033	0.53149 J	1.74922 J	0.959865 J
7/29/2016	Background	<0.93 U	<1.05 U	191	0.315631 J	0.0940357 J	<0.23 U	0.615933 J	0.9952	<0.083 U	<0.68 U	0.019	0.00793 J	<0.29 U	1.81763 J	<0.86 U
9/30/2016	Background	<0.93 U	2.96797 J	141	0.382874 J	<0.07 U	5	0.850408 J	1.380	<0.083 U	3.38434 J	0.014	0.01773 J	<0.29 U	1.02629 J	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	114	0.311247 J	<0.07 U	0.412131 J	0.649606 J	1.141	<0.083 U	<0.68 U	0.008	0.00534 J	1.39872 J	2.03168 J	1.25062 J
12/14/2016	Background	<0.93 U	<1.05 U	72	0.34133 J	<0.07 U	<0.23 U	0.424105 J	0.7190	<0.083 U	<0.68 U	0.008	0.01521 J	<0.29 U	1.85825 J	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	410	0.0366913 J	<0.07 U	<0.23 U	0.480125 J	3.009	<0.083 U	<0.68 U	0.000275956 J	<0.005 U	<0.29 U	4.04737 J	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	488	<0.02 U	<0.07 U	<0.23 U	0.765099 J	4.309	<0.083 U	<0.68 U	0.001	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	1.14 J	93.46	0.37 J	<0.07 U	0.66 J	0.77 J	0.6760	<0.083 U	<0.68 U	0.00902	0.007 J	<0.29 U	2.1 J	<0.86 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-3
Welsh - BASP
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
5/31/2016	Background	0.02	1.41	9	<0.083 U	6.6	106	4
7/29/2016	Background	0.02	0.706	8	<0.083 U	6.7	118	5
9/30/2016	Background	0.02	< 0.5 U	9	<0.083 U	4.8	127	6
10/21/2016	Background	0.06	0.794	8	<0.083 U	3.7	112	9
12/14/2016	Background	0.02	1.05	8	<0.083 U	4.7	138	11
1/20/2017	Background	0.02	0.746	9	<0.083 U	4.6	76.0	4
2/24/2017	Background	0.02	0.573	9	<0.083 U	4.7	104	5
6/8/2017	Background	0.03326	0.543	9	0.2625 J	4.5	104	5
10/6/2017	Detection	0.02055	0.908	9	<0.083 U	5.2	114	7
5/24/2018	Detection	0.0069 J	0.545	8	<0.083 U	4.4	98.0	3
11/13/2018	Detection	0.009 J	0.684	8.0	<0.083 U	5.2	114	4.05
2/20/2019	Detection	0.01 J	0.817	9.40	0.13	4.8	110	1.9
4/30/2019	Detection	0.007	- -	9.34	- -	4.1	- -	- -
5/30/2019	*	<0.02 U	3.02	9.03	0.18	4.3	110	2.3
7/24/2019	Detection	<0.02 U	1.35	7	0.09 J	4.6	116	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
* Sample is not associated with a specific monitoring program but was included in the updated background dataset.

Table 1 - Groundwater Data Summary: AD-3
Welsh - BASP
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
5/31/2016	Background	<0.93 U	1.56793 J	53	0.286352 J	<0.07 U	0.464721 J	1.49214 J	1.018	<0.083 U	<0.68 U	0.01	0.85	<0.29 U	0.995807 J	1.31537 J
7/29/2016	Background	3.21106 J	<1.05 U	36	0.349485 J	<0.07 U	0.515023 J	1.19046 J	0.183	<0.083 U	<0.68 U	0.024	0.589	1.43134 J	2.40188 J	<0.86 U
9/30/2016	Background	2.70729 J	2.61987 J	43	0.188596 J	0.0802799 J	0.659763 J	1.44845 J	0.552	<0.083 U	<0.68 U	0.019	0.39	<0.29 U	1.79734 J	<0.86 U
10/21/2016	Background	2.47184 J	1.97572 J	41	0.451723 J	0.277085 J	0.818782 J	1.53187 J	1.589	<0.083 U	<0.68 U	0.018	0.351	6	<0.99 U	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	45	0.262387 J	<0.07 U	0.627352 J	1.34901 J	0.546	<0.083 U	<0.68 U	0.017	0.321	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	2.13113 J	41	0.235263 J	<0.07 U	0.647294 J	1.6345 J	0.350	<0.083 U	<0.68 U	0.014	0.504	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	37	0.209151 J	<0.07 U	<0.23 U	1.1537 J	0.4592	<0.083 U	<0.68 U	0.014	0.501	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	1.91 J	38	0.24 J	0.08 J	0.75 J	1.28 J	0.459	0.2625 J	<0.68 U	0.01503	0.365	<0.29 U	<0.99 U	<0.86 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-4C
Welsh - BASP
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
5/31/2016	Background	0.05	0.798	10	<0.083 U	5.4	204	32
7/29/2016	Background	0.03	0.666	12	<0.083 U	5.5	208	35
9/30/2016	Background	0.02	<0.5 U	11	<0.083 U	5.0	212	45
10/21/2016	Background	0.04	0.578	10	<0.083 U	4.3	212	35
12/14/2016	Background	0.02	0.341	11	<0.083 U	4.6	252	36
1/20/2017	Background	0.02	0.761	10	<0.083 U	4.7	184	43
2/24/2017	Background	0.02	0.467	9	<0.083 U	5.1	196	40
6/8/2017	Background	0.03331	0.573	10	<0.083 U	4.9	228	39
10/6/2017	Detection	0.02565	0.654	11	<0.083 U	5.4	226	44
5/24/2018	Detection	0.02505	0.434	14	<0.083 U	5.2	224	42
8/14/2018	Detection	- -	- -	15	- -	5.0	- -	- -
11/13/2018	Detection	0.01 J	0.609	7.5	<0.083 U	5.8	220	56
12/18/2018	Detection	- -	- -	- -	- -	4.9	- -	58
2/20/2019	Detection	0.01 J	0.931	9.18	0.1 J	5.2	242	60.1
4/30/2019	Detection	0.014	- -	- -	- -	4.8	- -	56.2
5/30/2019	*	<0.02 U	0.564	14.8	0.16	4.6	208	52.8
7/24/2019	Detection	<0.02 U	0.586	13	<0.083 U	3.9	284	52

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
* Sample is not associated with a specific monitoring program but was included in the updated background dataset.

Table 1 - Groundwater Data Summary: AD-4C
Welsh - BASP
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
5/31/2016	Background	<0.93 U	<1.05 U	88	0.407928 J	<0.07 U	9	1.19093 J	1.289	<0.083 U	<0.68 U	0.004	0.191	<0.29 U	1.12526 J	<0.86 U
7/29/2016	Background	<0.93 U	<1.05 U	59	0.335947 J	<0.07 U	4	0.852951 J	0.571	<0.083 U	<0.68 U	0.015	0.185	1.09296 J	2.52271 J	<0.86 U
9/30/2016	Background	<0.93 U	1.51249 J	74	0.274296 J	<0.07 U	8	0.986752 J	2.572	<0.083 U	<0.68 U	0.006	0.16	<0.29 U	1.95938 J	<0.86 U
10/21/2016	Background	<0.93 U	1.74748 J	69	0.347477 J	0.0809157 J	9	1.08565 J	1.657	<0.083 U	<0.68 U	0.006	0.141	3.20217 J	1.18291 J	<0.86 U
12/14/2016	Background	<0.93 U	2.24683 J	21	0.133622 J	<0.07 U	0.944028 J	0.305391 J	0.685	<0.083 U	<0.68 U	0.004	0.143	<0.29 U	1.27423 J	<0.86 U
1/20/2017	Background	<0.93 U	1.85604 J	75	0.221609 J	<0.07 U	4	1.02773 J	2.045	<0.083 U	<0.68 U	0.005	0.125	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	30	0.102645 J	<0.07 U	0.421354 J	0.364739 J	0.517	<0.083 U	<0.68 U	0.004	0.098	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	1.19 J	51.42	0.19 J	0.08 J	4.03	0.75 J	0.953	<0.083 U	<0.68 U	0.00482	0.147	<0.29 U	<0.99 U	<0.86 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-5
Welsh - BASP
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
5/31/2016	Background	0.03	36.9	15	0.3469 J	6.4	337	123
7/29/2016	Background	0.04	44.7	16	<0.083 U	5.4	360	163
9/30/2016	Background	0.04	46.3	15	0.2436 J	5.3	416	190
10/21/2016	Background	0.05	50.7	14	<0.083 U	5.9	448	267
12/14/2016	Background	0.05	49.6	13	<0.083 U	6.2	484	233
1/20/2017	Background	0.04	49.8	14	<0.083 U	6.3	438	234
2/24/2017	Background	0.04	33	15	<0.083 U	5.5	286	127
6/8/2017	Background	0.05281	49.7	14	<0.083 U	6.0	300	82
10/6/2017	Detection	0.04322	33.1	16	<0.083 U	5.6	258	82
5/24/2018	Detection	0.05007	28.1	22	<0.083 U	6.2	242	60
8/15/2018	Detection	0.050	40.5	19	<0.083 U	6.2	428	240
2/21/2019	Detection	0.033	33.9	24.7	0.210	5.4	220	46.5
5/30/2019	*	0.03 J	30.0	22.3	0.290	6.3	238	51.3
7/24/2019	Detection	0.04 J	41.1	18	0.112 J	6.3	354	90

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
* Sample is not associated with a specific monitoring program but was included in the updated background dataset.

Table 1 - Groundwater Data Summary: AD-5
Welsh - BASP
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
5/31/2016	Background	<0.93 U	<1.05 U	57	0.149801 J	0.0765156 J	0.555038 J	14	1.634	0.3469 J	<0.68 U	0.135	0.01135 J	<0.29 U	<0.99 U	<0.86 U
7/29/2016	Background	2.05116 J	2.90819 J	93	0.518653 J	0.502155 J	0.411466 J	15	4.750	<0.083 U	<0.68 U	0.191	0.01516 J	<0.29 U	1.08901 J	<0.86 U
9/30/2016	Background	<0.93 U	4.7609 J	87	0.251584 J	<0.07 U	0.90676 J	14	3.330	0.2436 J	<0.68 U	0.186	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	70	0.08781 J	0.107488 J	0.248085 J	9	2.319	<0.083 U	<0.68 U	0.225	<0.005 U	1.36984 J	<0.99 U	<0.86 U
12/14/2016	Background	<0.93 U	1.15381 J	53	0.164529 J	0.203546 J	0.747921 J	13	2.182	<0.083 U	<0.68 U	0.199	0.00802 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	47	0.0574718 J	0.180502 J	<0.23 U	12	1.023	<0.083 U	<0.68 U	0.239	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	42	0.0306858 J	<0.07 U	<0.23 U	13	1.788	<0.083 U	<0.68 U	0.166	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	3.85 J	87.7	0.08 J	0.39 J	0.28 J	11.93	2.320	<0.083 U	<0.68 U	0.124	<0.005 U	<0.29 U	<0.99 U	<0.86 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-16R
Welsh - BASP
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
6/8/2017	Background	0.04198	2.75	7	0.3438 J	3.7	204	54
6/28/2017	Background	0.06398	1.24	6	0.2512 J	3.9	200	55
7/7/2017	Background	0.02699	2.07	36	<0.083 U	3.4	184	52
7/14/2017	Background	0.04415	2.39	6	0.2516 J	3.5	160	44
7/24/2017	Background	0.03237	2.5	7	0.2615 J	3.5	180	54
8/1/2017	Background	0.02841	1.92	7	<0.083 U	2.8	162	48
8/2/2017	Background	0.03177	1.86	7	<0.083 U	3.0	174	49
8/11/2017	Background	0.06192	1.83	8	<0.083 U	4.1	164	44
8/18/2017	Background	0.0304	1.44	7	<0.083 U	3.4	160	46
9/1/2017	Background	0.02841	1.33	7	<0.083 U	3.9	152	63
10/6/2017	Detection	0.04672	0.896	7	<0.083 U	3.3	152	82
1/18/2018	Detection	- -	- -	- -	- -	4.0	- -	58.6
5/23/2018	Detection	0.03202	2.53	6	<0.083 U	3.8	204	67
8/14/2018	Detection	- -	- -	- -	- -	3.9	- -	44
11/13/2018	Detection	0.02 J	0.467	6.5	<0.083 U	5.6	186	54
2/20/2019	Detection	0.03 J	2.00	6.78	0.20	4.7	200	52.8
4/30/2019	Detection	0.015	- -	- -	- -	3.9	- -	- -
5/30/2019	*	<0.02 U	1.36	5.43	0.19	3.9	80	41.6
7/24/2019	Detection	0.03 J	1.50	7	0.13 J	3.6	250	70

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
* Sample is not associated with a specific monitoring program but was included in the updated background dataset.

Table 1 - Groundwater Data Summary: AD-16R
Welsh - BASP
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
6/8/2017	Background	<0.93 U	7.07	46.4	2.21	1.03	1.76	41.74	6.66	0.3438 J	<0.68 U	0.0293	<0.005 U	<0.29 U	1.98 J	<0.86 U
6/28/2017	Background	<0.93 U	5.28	41.43	2.16	0.92 J	0.95 J	40.87	12.11	0.2512 J	<0.68 U	0.02932	<0.005 U	<0.29 U	<0.99 U	<0.86 U
7/7/2017	Background	<0.93 U	4.13 J	44.56	2.08	0.97 J	1.44	41.75	25.16	<0.083 U	<0.68 U	0.02846	<0.005 U	<0.29 U	2.09 J	1.2 J
7/14/2017	Background	<0.93 U	6.31	54.35	2.01	1.09	0.84 J	37.88	9.12	0.2516 J	<0.68 U	0.02391	0.009 J	<0.29 U	<0.99 U	<0.86 U
7/24/2017	Background	<0.93 U	3.88 J	51.06	2.09	1.02	1.43	40.86	9.81	0.2615 J	<0.68 U	0.02653	<0.005 U	<0.29 U	1 J	<0.86 U
7/28/2017	Background	- -	- -	- -	- -	- -	- -	- -	8.52		- -	- -	- -	- -	- -	- -
8/1/2017	Background	<0.93 U	3.7	48.51	2.17	1.28	1.07	45.33	- -	<0.083 U	<0.68 U	0.02617	0.006 J	<0.29 U	1.27 J	1.43 J
8/2/2017	Background	<0.93 U	4.46 J	49.61	2.06	1.22	0.95 J	43.11	5.45	<0.083 U	<0.68 U	0.02498	<0.005 U	<0.29 U	1.74	2.02
8/11/2017	Background	<0.93 U	4.93 J	47.52	1.89	1.13	0.96 J	40.37	5.78	<0.083 U	<0.68 U	0.02347	0.008 J	<0.29 U	1.36 J	<0.86 U
8/18/2017	Background	<0.93 U	2.35 J	43.85	1.91	1.08	0.8 J	40.05	5.56	<0.083 U	<0.68 U	0.02466	0.009 J	<0.29 U	<0.99 U	0.92 J
9/1/2017	Background	<0.93 U	2.12 J	44.14	1.75	1.04	1.18	37.56	6.68	<0.083 U	<0.68 U	0.02429	0.006 J	<0.29 U	<0.99 U	<0.86 U
5/30/2019	Detection	0.02 J	1.76	72.4	0.424	0.08	0.334	4.38	4.41	<0.083 U	0.06 J	0.01 J	- -	<0.4 U	0.6	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-17
Welsh - BASP
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
5/26/2016	Background	0.121	200	43	0.4023 J	7.2	1810	1166
7/29/2016	Background	0.119	195	32	0.4135 J	5.7	1576	1005
9/30/2016	Background	0.111	191	36	0.3055 J	6.2	1663	1055
10/21/2016	Background	0.124	194	32	0.583 J	6.1	1612	1163
12/14/2016	Background	0.135	196	31	0.5399 J	6.0	1560	1096
1/20/2017	Background	0.101	196	33	<0.083 U	5.9	1686	1445
2/24/2017	Background	0.135	189	30	<0.083 U	5.7	1628	1055
6/8/2017	Background	0.121	188	30	<0.083 U	5.8	1578	1105
10/6/2017	Detection	0.183	183	31	<0.083 U	5.9	1548	1090
5/24/2018	Detection	0.239	193	39	<0.083 U	6.3	1836	1067
8/15/2018	Detection	0.118	187	40	<0.083 U	5.6	1748	1168
2/21/2019	Detection	0.151	207	43.2	0.18	6.9	1722	1060
5/30/2019	*	0.158	202	41.7	<0.04 U	6.1	1546	1120
7/24/2019	Detection	0.113	216	37	0.085 J	6.0	1864	1127

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
* Sample is not associated with a specific monitoring program but was included in the updated background dataset.

Table 1 - Groundwater Data Summary: AD-17
Welsh - BASP
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
5/26/2016	Background	<0.93 U	1.37501 J	21	0.173275 J	2	1	63	1.525	0.4023 J	<0.68 U	0.37	0.032	<0.29 U	<0.99 U	<0.86 U
7/29/2016	Background	1.13716 J	<1.05 U	20	0.307264 J	4	1	68	2.78	0.4135 J	<0.68 U	0.374	0.02133 J	1.04115 J	4.56733 J	<0.86 U
9/30/2016	Background	<0.93 U	<1.05 U	31	0.175474 J	0.848199 J	3	58	2.358	0.3055 J	<0.68 U	0.354	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	34	0.200656 J	2	4	65	2.224	0.583 J	<0.68 U	0.394	<0.005 U	0.322249 J	3.34422 J	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	17	0.0498325 J	3	0.816224 J	68	2.384	0.5399 J	<0.68 U	0.323	0.01485 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	14	0.0319852 J	3	68	68	2.436	<0.083 U	<0.68 U	0.341	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	20	0.0665729 J	2	1	73	2.288	<0.083 U	<0.68 U	0.331	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	<1.05 U	10.3	<0.02 U	6.06	<0.23 U	74.8	1.598	<0.083 U	<0.68 U	0.329	0.013 J	<0.29 U	<0.99 U	<0.86 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.

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Memorandum

Date: January 11, 2019

To: David Miller (AEP)

Copies to: Jill Parker-Witt (AEP)

From: Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at Welsh Plant's Bottom Ash Storage Pond (BASP)

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"), the first semi-annual detection monitoring event detection at the Bottom Ash Storage Pond (BASP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas, was completed on May 24, 2018. Based on the results, a two-of-two verification sampling was completed on August 14, 2018.

Eight background monitoring events were conducted at the Welsh BASP prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 15, 2018. An alternative source demonstration (ASD) was certified on April 14, 2018 which resulted in a revision to the calculated prediction limits.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1 and noted exceedances are described in the list below.

- Chloride concentrations exceeded the intrawell UPL of 12.6 mg/L in both the initial (14 mg/L) and second (15 mg/L) samples collected at AD-4C. Therefore, an SSI over background is concluded for chloride at AD-4C.

No other exceedances of UPLs were observed during these detection monitoring events.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). Within 90 days of identification of the above-listed SSIs, a written demonstration that a source other than the Welsh BASP caused the increases was completed in accordance with 40 CFR 257.94(e)(2). Thus, the Welsh BASP will remain in detection monitoring.

A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Evaluation
Welsh Plant - Bottom Ash Storage Pond

Parameter	**Units**	**Description**	AD-3	AD-4C		AD-16R	
			5/24/2018	5/24/2018	8/14/2018	5/23/2018	8/14/2018
Boron	mg/L	Intrawell Background Value (UPL)	0.0333	0.0571		0.0700	
		Detection Monitoring Data	0.0069 J	0.0251	--	0.0320	--
Calcium	mg/L	Intrawell Background Value (UPL)	1.541	0.962		3.069	
		Detection Monitoring Data	0.545	0.434	--	2.53	--
Chloride	mg/L	Intrawell Background Value (UPL)	9	12.6		8.3	
		Detection Monitoring Data	8	**14**	**15**	6	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1	1		1	
		Detection Monitoring Data	<0.083	<0.083	--	<0.083	--
pH	SU	Intrawell Background Value (UPL)	7.63	5.91		4.4	
		Intrawell Background Value (LPL)	2.43	3.95		2.61	
		Detection Monitoring Data	4.38	5.17	--	3.79	--
Sulfate	mg/L	Intrawell Background Value (UPL)	12.4	49.0		64.1	
		Detection Monitoring Data	3	42	--	**67**	44
TDS	mg/L	Intrawell Background Value (UPL)	156	263		214	
		Detection Monitoring Data	98	224	--	204	--

Notes

UPL: Upper prediction limit
LPL: Lower prediction limit
TDS: Total dissolved solids
J: Estimated value
<: Indicates the parameter was not detected
Bold values exceed the background value.
Background values are shaded gray.
--: sample was not collected

ATTACHMENT A

Certification by Qualified Professional Engineer

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 15, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Welsh BASP 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

DAVID ANTHONY MILLER
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Memorandum

Date:	February 16, 2019
To:	David Miller (AEP)
Copies to:	Jill Parker-Witt (AEP)
From:	Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)
Subject:	Evaluation of Detection Monitoring Data at Welsh Plant's Bottom Ash Storage Pond (BASP)

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 Subpart D, "CCR rule"), the second semi-annual detection monitoring event detection at the Bottom Ash Storage Pond (BASP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas, was completed on November 13, 2018. Based on the results, a two-of-two verification sampling was completed on December 18, 2018 and January 11, 2019.

Eight to ten background monitoring events were conducted at the Welsh BASP prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 15, 2018. An alternative source demonstration (ASD) was certified on April 14, 2018 which resulted in a revision to the calculated prediction limits.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1 and noted exceedances are described in the list below.

- Sulfate concentrations exceeded the intrawell UPL of 49 mg/L in both the initial (56 mg/L) and second (58 mg/L) samples collected at AD-4C. Therefore, an SSI over background is concluded for Sulfate at AD-4C.

No other exceedances of UPLs were observed during these detection monitoring events.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). Within 90 days of identification of the above-listed SSIs, a written demonstration that a source other than the Welsh BASP caused the increases will be completed in accordance with 40 CFR 257.94(e)(2). If the ASD is successful, the Welsh BASP will remain in detection monitoring.

A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Evaluation
Welsh Plant - Bottom Ash Storage Pond

Parameter	Units	Description	AD-3		AD-4C		AD-16R	
			11/13/2018	12/18/2018	11/13/2018	12/18/2018	11/13/2018	1/11/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.033		0.057		0.070	
		Detection Monitoring Result	0.009	-	0.010	-	0.020	-
Calcium	mg/L	Intrawell Background Value (UPL)	1.54		0.962		3.07	
		Detection Monitoring Result	0.684	-	0.609	-	0.467	-
Chloride	mg/L	Intrawell Background Value (UPL)	9.0		12.6		8.3	
		Detection Monitoring Result	8.0	-	7.5	-	6.5	-
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00		1.00		1.00	
		Detection Monitoring Result	<0.083	-	<0.083	-	<0.083	-
pH	SU	Intrawell Background Value (UPL)	7.63		5.91		4.40	
		Intrawell Background Value (LPL)	2.43		3.95		2.61	
		Detection Monitoring Result	5.19	-	5.79	-	**5.57**	2.66
Sulfate	mg/L	Intrawell Background Value (UPL)	12.4		49		64	
		Detection Monitoring Result	4.05	-	**56**	**58**	54	-
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	156		263		214	
		Detection Monitoring Result	114	-	220	-	186	-

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

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 calculated background

ATTACHMENT A

Certification by Qualified Professional Engineer

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 15, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Welsh BASP 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

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Memorandum

Date: June 26, 2019

To: David Miller (AEP)

Copies to: Jill Parker-Witt (AEP)

From: Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at
Welsh Plant's Bottom Ash Storage Pond (BASP)

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 Subpart D, "CCR rule"), the first semi-annual detection monitoring event at the Bottom Ash Storage Pond (BASP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas, was completed on February 20, 2019. Based on the results, a two-of-two verification sampling was completed on April 30, 2019.

Eight to ten background monitoring events were conducted at the Welsh BASP prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 15, 2018. An alternative source demonstration (ASD) was certified on April 14, 2018 which resulted in a revision to the calculated prediction limits. The calculated prediction limit for sulfate at AD-4C was also revised during a subsequent ASD which was certified on May 17, 2019. While another ASD was certified on January 7, 2019, the calculated prediction limits were not revised as part of that demonstration.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL (or are below the LPL for pH). In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1 and noted exceedances are described in the list below.

- Chloride concentrations exceeded the intrawell UPL of 9.00 mg/L in both the initial (9.40 mg/L) and second (9.34 mg/L) samples collected at AD-3. Therefore, an SSI over background is concluded for chloride at AD-3.

No other exceedances of UPLs were observed during these detection monitoring events.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). Within 90 days of identification of the above-listed SSIs, a written demonstration that a source other than the Welsh BASP caused the increases will be completed in accordance with 40 CFR 257.94(e)(2). If the ASD is successful, the Welsh BASP will remain in detection monitoring.

A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Evaluation
Welsh Plant - Bottom Ash Storage Pond

Parameter	Units	Description	AD-3		AD-4C		AD-16R	
			2/20/2019	4/30/2019	2/20/2019	4/30/2019	2/20/2019	4/30/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.0333		0.0571		0.0700	
		Detection Monitoring Data	0.01 J	0.0070	0.01 J	0.0140	0.03 J	**0.0150**
Calcium	mg/L	Intrawell Background Value (UPL)	1.54		0.962		3.07	
		Detection Monitoring Data	0.817	--	0.931	--	2.00	-
Chloride	mg/L	Intrawell Background Value (UPL)	9.00		12.6		8.30	
		Detection Monitoring Data	**9.40**	**9.34**	9.18	--	6.78	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1.0		1.0		1.0	
		Detection Monitoring Data	0.13	--	0.10	--	0.20	--
pH	SU	Intrawell Background Value (UPL)	7.6		5.9		4.4	
		Intrawell Background Value (LPL)	2.4		3.9		2.6	
		Detection Monitoring Data	4.8	4.1	5.2	4.8	**4.7**	3.9
Sulfate	mg/L	Intrawell Background Value (UPL)	12.4		59.1		64.1	
		Detection Monitoring Data	1.90	--	**60.1**	56.2	52.8	--
TDS	mg/L	Intrawell Background Value (UPL)	156		263		214	
		Detection Monitoring Data	110	--	242	--	200	--

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 statistical method, described above and in the January 15, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Welsh BASP 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
License Number

TEXAS
Licensing State

06.26.19
Date

DAVID ANTHONY MILLER
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Geosyntec consultants

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Memorandum

Date: December 23, 2019

To: David Miller (AEP)

Copies to: Jill Parker-Witt (AEP)

From: Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at Welsh Plant's Bottom Ash Storage Pond (BASP)

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 Subpart D, "CCR rule"), the second semi-annual detection monitoring event at the Bottom Ash Storage Pond (BASP), an existing CCR unit at the Welsh Power Plant located in Pittsburg, Texas, was completed on July 24, 2019. Based on the results, a two-of-two verification sampling was completed on November 25, 2019 and on December 19, 2019.

Background values for the BASP were previously calculated in January 2018. After a minimum of four detection monitoring events, the results of those events were compared to the existing background and the dataset was updated as appropriate. Revised and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these revised background values are described in Geosyntec's *Statistical Analysis Summary* report, dated December 10, 2019.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL (or are below the LPL for pH). In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1. No SSIs were observed at the Welsh BASP CCR unit, and as a result the Welsh BASP will remain in detection monitoring.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Evalation
Welsh Plant - Bottom Ash Storage Pond

Parameter	Unit	Description	AD-16R		AD-3		AD-4C	
			7/24/2019	12/19/2019	7/24/2019	11/25/2019	7/24/2019	12/19/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.0638		0.0580		0.0529	
		Detection Monitoring Result	0.0300	-	0.0200	-	0.0200	-
Calcium	mg/L	Intrawell Background Value (UPL)	3.15		1.32		0.961	
		Detection Monitoring Result	1.50	-	**1.35**	0.734	0.586	-
Chloride	mg/L	Intrawell Background Value (UPL)	8.02		9.40		15.6	
		Detection Monitoring Result	7.00	-	7.00	-	13.0	-
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00		1.000		1.000	
		Detection Monitoring Result	0.130	-	0.0900	-	0.0830	-
pH	SU	Intrawell Background Value (UPL)	5.0		6.6		5.8	
		Intrawell Background Value (LPL)	2.6		3.1		4.2	
		Detection Monitoring Result	3.6	-	4.6	-	**3.9**	4.7 on 11/25/19
Sulfate	mg/L	Intrawell Background Value (UPL)	73.2		10.6		63.7	
		Detection Monitoring Result	70.0	-	6.00	-	52.0	-
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	221		140		255	
		Detection Monitoring Result	**250**	134	116	-	**284**	226

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 statistical method, described above and in the January 15, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Welsh BASP 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
112498

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

01.21.2020
Date

STATISTICAL ANALYSIS SUMMARY-
Background Update Calculations
Bottom Ash Storage Pond –
J. Robert Welsh Plant
Pittsburg, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
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Columbus, Ohio 43221

December 10, 2019

CHA847

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
ASD	Alternative Source Demonstration
BASP	Bottom Ash Storage Ponds
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

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 Bottom Ash Storage Ponds (BASP), an existing CCR unit at the J. Robert Welsh Power Plant located in Pittsburg, Texas.

A minimum of eight monitoring events were completed prior to October 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. Four semiannual detection monitoring events were conducted between October 2017 and May 2019. Data from these four events, including both initial and verification results, and an additional event conducted in May 2019 were evaluated for inclusion in the background dataset. 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 detection monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The compliance data were reviewed for outliers, with no values removed prior to updating upper prediction limits (UPLs) for each Appendix III parameter to represent background values. Oversight on the use of statistical calculations was provided by Dr. Jim Loftis, Professor Emeritus of Civil & Environmental Engineering at Colorado State University and Senior Advisor to Groundwater Stats Consulting.

SECTION 2

BOTTOM ASH STORAGE POND EVALUATION

2.1 Previous Background Calculations

Eight to ten background monitoring events were completed from May 2016 through September 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. The data were reviewed for outliers and trends prior to calculating upper prediction limits (UPLs) for each Appendix III parameter. Lower prediction limits (LPLs) were also established for pH. Interwell prediction limits were selected for all parameters with a one-of-two resampling plan. Tests for pH were revised to intrawell prediction limits based on an alternative source demonstration (ASD) certified on April 13, 2018 (Geosyntec, 2018a). The statistical analyses to establish background levels were previously documented in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018b).

2.2 Data Validation & QA/QC

Since October 2017, four semiannual detection monitoring events have been conducted at the BASP. If the initial results for each detection monitoring event identified possible exceedances, verification sampling was completed on an individual well/parameter basis. Thus, a minimum of four samples were collected from each compliance well. A summary of data collected during these detection monitoring events may be found in Table 1. Results for an additional event conducted in May 2019, which was also included in the update to background levels, is also provided 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 was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.3 Statistical Analysis

The data used to conduct the statistical analyses described below are summarized in Table 1. Statistical analyses for the BASP were conducted in accordance with the January 2017 *Statistical*

Analysis Plan (AEP, 2017), except where noted below. The complete statistical analysis results are included in Attachment A.

Time series plots of Appendix III parameters are included in Attachment A and were used to evaluate concentrations over time and to provide an initial screening of suspected outliers and trends. Box plots were also compiled to provide visual representation of variations between wells and within individual wells (Attachment A).

2.3.1 Outlier Evaluation

Potential outliers were evaluated using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

No potential outliers were identified in the data collected for the four most recent detection monitoring events.

2.3.2 Establishment of Updated Background Levels

Analysis of variance (ANOVA) was conducted during the initial background screening to assist in identifying if intrawell tests are the most appropriate statistical approach for assessing Appendix III parameters. Intrawell tests compare compliance data from a single well to background data within the same well and are most appropriate when 1) upgradient wells exhibit spatial variation; 2) when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; or 3) when downgradient water quality is not impacted compared to upgradient water quality for the same parameter. Periodic updating of background statistical limits is necessary as natural systems continuously change due to physical changes to the environment. For intrawell analyses, data for all wells and constituents are re-evaluated when a minimum of four new data points are available. These four (or more) new data points are used to determine if earlier concentrations are representative of present-day groundwater quality.

Mann-Whitney (Wilcoxon rank-sum) tests were used to compare the medians of historical data (May 2016 - September 2017) to the new compliance samples (October 2017 – May 2019).

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 Appendix B. Significant differences were found between the two groups for chloride in upgradient well AD-5. However, because AD-5 is an upgradient monitoring well and more recent data are similar to background and better represent the groundwater quality upgradient of the facility, the background dataset was updated to include the compliance data for chloride at AD-5.

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 A.

2.3.3 Updated Prediction Limits

Intrawell UPLs were updated using all the historical data through May 2019 to represent background values. Intrawell LPLs were also generated for pH. The updated prediction limits are summarized in Table 2.

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.

2.4 Conclusions

Four detection monitoring events were completed in accordance with the CCR Rule. An additional event completed in May 2019 was also included in the new dataset. The laboratory and field data from these events were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. Mann-Whitney tests were completed to evaluate whether data from the detection monitoring events could be added to the existing background dataset. Where appropriate, the background datasets were updated, and UPLs and LPLs were recalculated. Intrawell tests using a one-of-two retesting procedure were selected and updated for all Appendix III parameters

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – J. Robert Welsh Plant. January 2017.

Geosyntec Consultants, 2018a. Alternative Source Demonstration Report – Federal CCR Rule. J. Robert Welsh Plant. April 2018.

Geosyntec Consultants, 2018b. Statistical Analysis Summary. Bottom Ash Storage Pond – J. Robert Welsh Plant. January 2018.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March

TABLES

Table 1: Groundwater Data Summary
Welsh - Bottom Ash Storage Pond

Parameter	**Unit**	**AD-1**					**AD-3**					
		10/6/2017	5/24/2018	8/14/2018	2/20/2019	5/30/2019	10/6/2017	5/24/2018	11/13/2018	2/20/2019	4/30/2019	5/30/2019
		2017-D1	2018-D1	2018-D1-R1	2019-D1	*	2017-D1	2018-D1	2018-D2	2019-D1	2019-D1-R1	*
Boron	mg/L	0.453	0.345	0.443	0.504	0.689	0.021	0.007 J	0.009 J	0.010 J	0.007	0.100 U
Calcium	mg/L	14.3	10.2	5.95	142	138	0.908	0.545	0.684	0.817		3.02
Chloride	mg/L	4.00	4.00	5.00	2.82	1.59	9.00	8.00	8.00	9.40	9.34	9.03
Fluoride	mg/L	1.00 U	1.00 U	1.00 U	0.240	0.290	1.00 U	1.00 U	1.00 U	0.130	-	0.180
Total Dissolved Solids	mg/L	160	150	160	522	588	114	98.0	114	110	-	110
Sulfate	mg/L	40.0	43.0	44.0	49.2	43.3	7.00	3.00	4.05	1.90	-	2.30
pH	SU	5.3	2.2	5.2	7.3	6.7	5.2	4.4	5.2	4.8	4.1	4.3

Parameter	**Unit**	**AD-4C**							
		10/6/2017	5/24/2018	8/14/2018	11/13/2018	12/18/2018	2/20/2019	4/30/2019	5/29/2019
		2017-D1	2018-D1	2018-D1-R1	2018-D2	2018-D2-R1	2019-D1	2019-D1-R1	*
Boron	mg/L	0.026	0.025	-	0.010 J	-	0.010 J	0.014	0.100 U
Calcium	mg/L	0.654	0.434	-	0.609	-	0.931	-	0.564
Chloride	mg/L	11.0	14.0	15.0	7.50	-	9.18	-	14.8
Fluoride	mg/L	1.00 U	1.00 U	-	1.00 U	-	0.100 J	-	0.160
Total Dissolved Solids	mg/L	226	224	-	220	-	242	-	208
Sulfate	mg/L	44.0	42.0	-	56.0	58.0	60.1	56.2	52.8
pH	SU	5.4	5.2	5.0	5.8	4.9	5.2	4.8	4.6

Notes:
mg/L: milligrams 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
-: Not Measured
D1: First semi-annual detection monitoring event of the year
D2: Second semi-annual detection monitoring event of the year
R1: First verification event associated with detection monitoring round
*May 2019 data are not associated with any semiannual detection monitoring events but were included in the background update.

Table 1: Groundwater Data Summary
Welsh - Bottom Ash Storage Pond

Parameter	Unit	AD-5					AD-16R						
		10/6/2017	5/24/2018	8/15/2018	2/21/2019	5/30/2019	10/6/2017	5/23/2018	8/14/2018	11/13/2018	2/20/2019	4/30/2019	5/30/2019
		2017-D1	2018-D1	2018-D1-R1	2019-D1	*	2017-D1	2018-D1	2018-D1-R1	2018-D2	2019-D1	2019-D1-R1	*
Boron	mg/L	0.043	0.050	0.050	0.033	0.030 J	0.047	0.032	-	0.020 J	0.030 J	0.015	0.100 U
Calcium	mg/L	33.1	28.1	40.5	33.9	30.0	0.896	2.53	-	0.467	2.00	-	1.36
Chloride	mg/L	16.0	22.0	19.0	24.7	22.3	7.00	6.00	-	6.50	6.78	-	5.43
Fluoride	mg/L	1.00 U	1.00 U	1.00 U	0.210	0.290	1.00 U	1.00 U	-	1.00 U	0.2	-	0.190
Total Dissolved Solids	mg/L	258	242	428	220	238	152	204	-	186	200	-	80.0
Sulfate	mg/L	82.0	60.0	240	46.5	51.3	82.0	67.0	44.0	54.0	52.8	-	41.6
pH	SU	5.6	6.2	6.2	5.4	6.3	3.3	3.8	3.9	5.6	4.7	3.9	3.9

Parameter	Unit	AD-17				
		10/6/2017	5/24/2018	8/15/2018	2/21/2019	5/30/2019
		2017-D1	2018-D1	2018-D1-R1	2019-D1	*
Boron	mg/L	0.183	0.239	0.118	0.151	0.158
Calcium	mg/L	183	193	187	207	202
Chloride	mg/L	31.0	39.0	-	43.2	41.7
Fluoride	mg/L	1.00 U	1.00 U	-	0.180	0.200 U
Total Dissolved Solids	mg/L	1550	1840	-	1720	1550
Sulfate	mg/L	1090	1070	-	1060	1120
pH	SU	5.9	6.3	5.6	6.9	6.1

Notes:
mg/L: milligrams 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
-: Not Measured
D1: First semi-annual detection monitoring event of the year
D2: Second semi-annual detection monitoring event of the year
R1: First verification event associated with detection monitoring round
*May 2019 data are not associated with any semiannual detection monitoring events but were included in the background update.

Table 2: Background Level Summary
Welsh Plant - Bottom Ash Storage Pond

Parameter	Unit	Description	AD-16R	AD-3	AD-4C
Boron	mg/L	Intrawell Background Value (UPL)	0.0638	0.0580	0.0529
Calcium	mg/L	Intrawell Background Value (UPL)	3.15	1.32	0.961
Chloride	mg/L	Intrawell Background Value (UPL)	8.02	9.40	15.6
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00	1.00	1.00
pH	SU	Intrawell Background Value (UPL)	5.0	6.6	5.8
		Intrawell Background Value (LPL)	2.6	3.1	4.2
Sulfate	mg/L	Intrawell Background Value (UPL)	73.2	10.6	63.7
Solids	mg/L	Intrawell Background Value (UPL)	221	140	255

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

ATTACHMENT A
Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

November 12, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Welsh BASP
Background Update - 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's Welsh BASP. 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 Welsh BASP for the CCR program in 2016, and at least 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-1, AD-5, and AD-17; and
- **Downgradient wells:** AD-3, AD-4C, and AD-16R.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was prepared according to the background screening conducted in December 2017 that was approved 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 reviewed by Dr. Jim Loftis, Civil & Environmental Engineering professor emeritus at Colorado State University and Senior Advisor to Groundwater Stats Consulting.

The following CCR Detection Monitoring constituents were evaluated:

- **Appendix III Parameters**: boron, calcium, chloride, fluoride, pH, sulfate, and TDS

Time series plots for these parameters are provided for all wells and constituents; and are used to evaluate concentrations over time as well as for the purpose of updating statistical limits (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). Values in background which have been flagged as outliers may be seen in a lighter font and as a disconnected symbol on the graph. A summary of these values follows this letter (Figure C). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

During the background screening conducted in December 2017 data at all wells were evaluated 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. Power curves were provided 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 boron, calcium, chloride, fluoride, pH, 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. While the false positive rate associated with the parametric limits is based on an annual 10% as recommended by the EPA Unified Guidance (2009), the false positive rate associated with the nonparametric limits is dependent upon the available background sample size, number of future comparisons, and verification resample plan. 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 is 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.

Historical Summary of Background Screening – 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.

Tukey's outlier test noted a high value for chloride in well AD-16R, and this value was flagged in the database. A substitution of the most recent reporting limit was applied when varying detection limits existed in data. The results were submitted with the previous background screening report.

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. It was noted that for each constituent evaluated, the highest concentrations are reported in the upgradient wells.

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 showed concentrations were stable over time with no statistically significant increasing or decreasing trends, except for one decreasing trend for TDS in well AD-16R as may be seen on the Trend Test Summary table. This trend was relatively low in magnitude when compared to average concentrations; therefore, no adjustments were required.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) is typically used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach. The ANOVA identified variation for all Appendix III parameters except for pH. 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 and when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective.

All available data through September 2017 at each well were used to establish intrawell background limits for the parameters identified above based on a 1-of-2 resample plan that will be used for future comparisons. Future compliance 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 intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points 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. A summary table of the background prediction limits follows the previous letter.

Background Update - September 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 on all historical data through May 2019. Tukey's outlier test noted high values for chloride in wells AD-1 and AD-16R; and for sulfate in well AD-17 that were flagged in the database, and may be seen on the Outlier Summary Table and accompanying graphs. A low value was flagged for chloride in well AD-1, but when Tukey's outlier test detects an outlier for the most recent sample, it will not be flagged in the event that the data precede a trend that is more representative of current concentrations. 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.

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through September 2017 to the new compliance samples at each well through May 2019 to evaluate whether the groups are significantly different at the 99% confidence level. When no differences are identified, the background data may be updated with compliance data (Figure D). The only exception to this is sulfate in well AD-4C, which uses historical data through December 2018.

Statistically significant differences were found between the two groups for chloride in upgradient well AD-5. 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. However, because the differences for chloride in well AD-5 occurred in an upgradient well and more recent data are fairly similar to background and better represent the groundwater quality upgradient of the facility, the background data set was updated. 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, a summary of well/constituent pairs using a truncated portion of their records follows this letter (Figure E).

Intrawell prediction limits using all historical data through May 2019, combined with a 1-of-2 resample plan, were constructed and a summary of the updated limits follows this letter (Figure F).

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Welsh BASP. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

ACollins

Andrew T. Collins
Groundwater Analyst

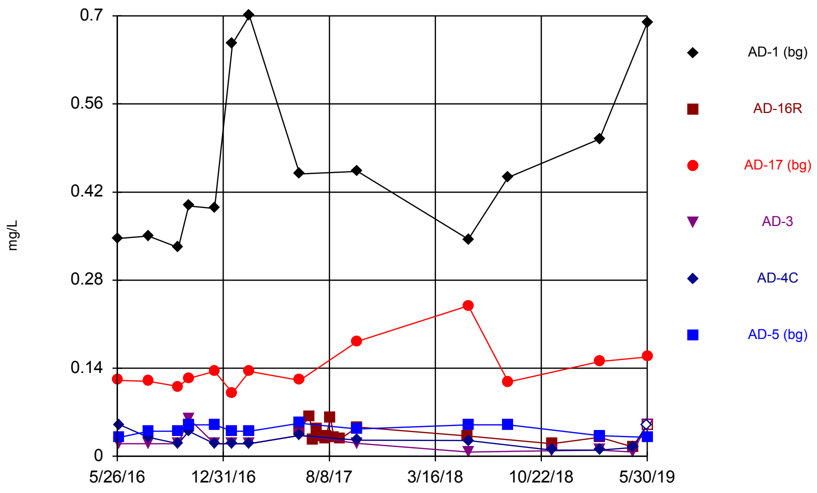
Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Figure A. Time Series

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

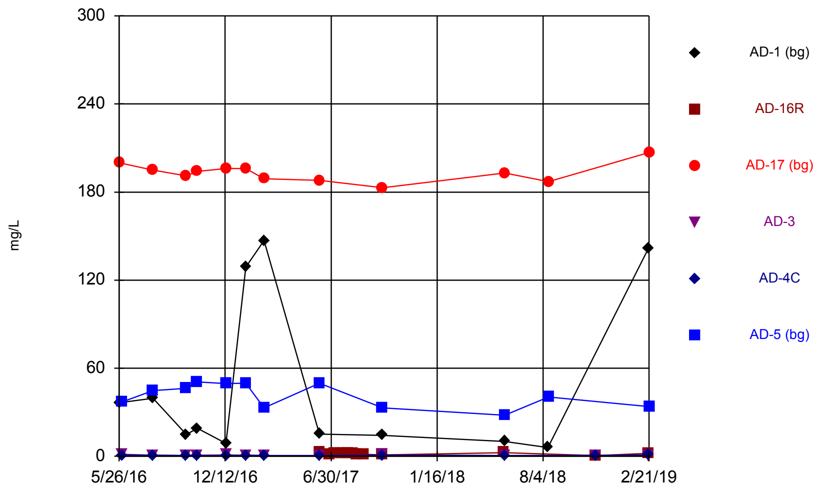
Time Series



Constituent: Boron Analysis Run 11/7/2019 10:05 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

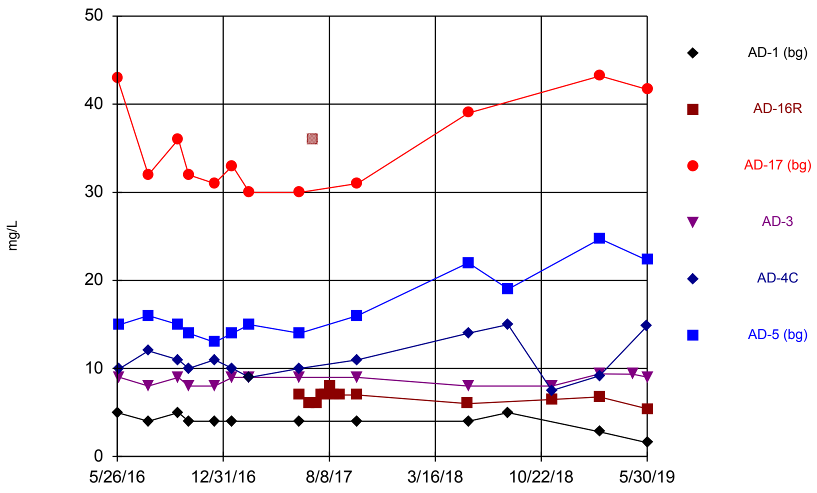
Time Series



Constituent: Calcium Analysis Run 11/7/2019 10:05 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

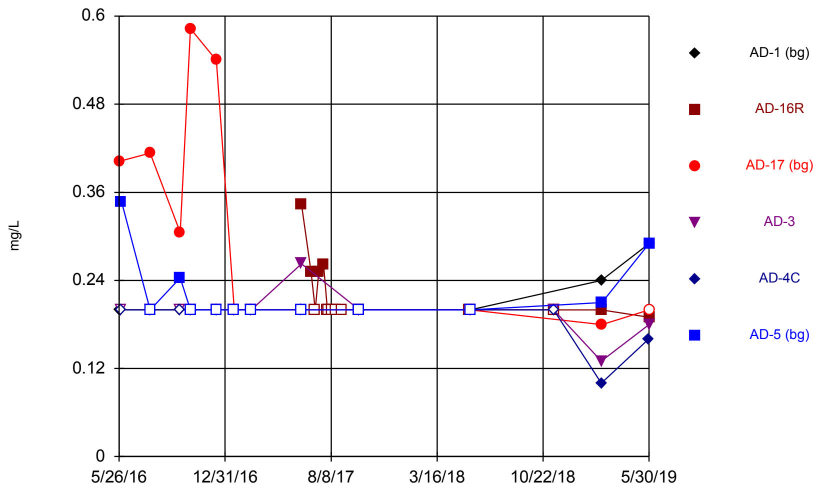
Time Series



Constituent: Chloride Analysis Run 11/7/2019 10:05 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

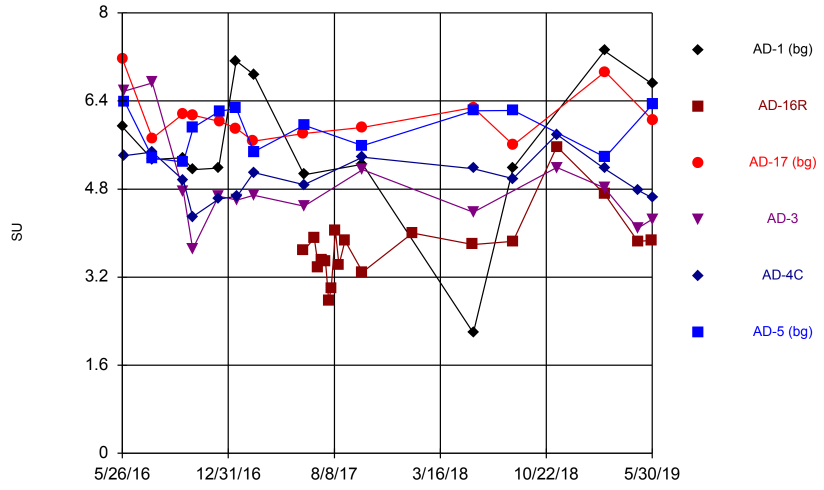
Time Series



Constituent: Fluoride Analysis Run 11/7/2019 10:06 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series

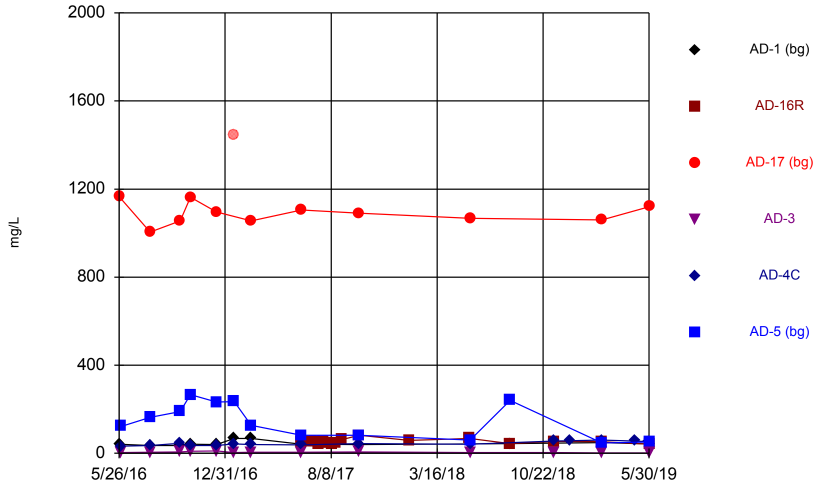


Constituent: pH, field Analysis Run 11/7/2019 10:06 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series

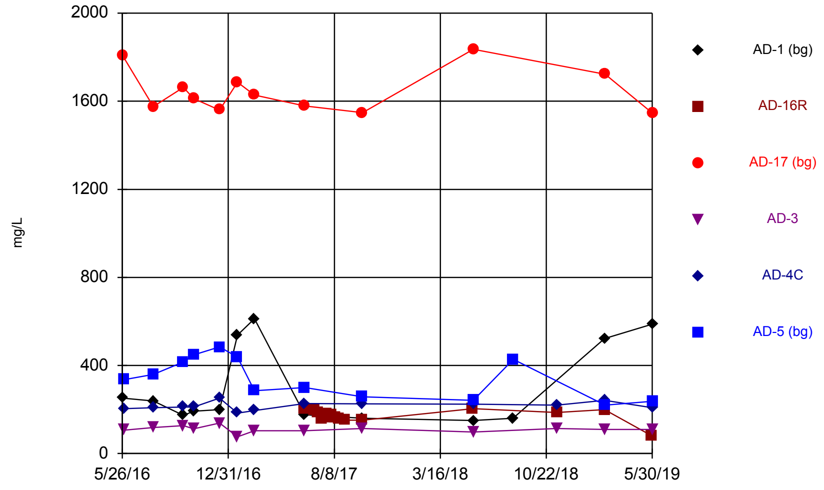


Constituent: Sulfate Analysis Run 11/7/2019 10:06 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series

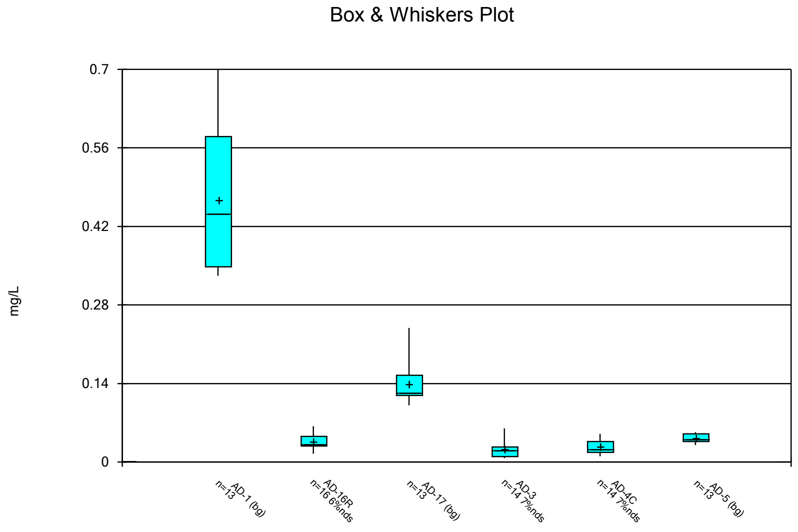


Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:06 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Figure B. Box Plots

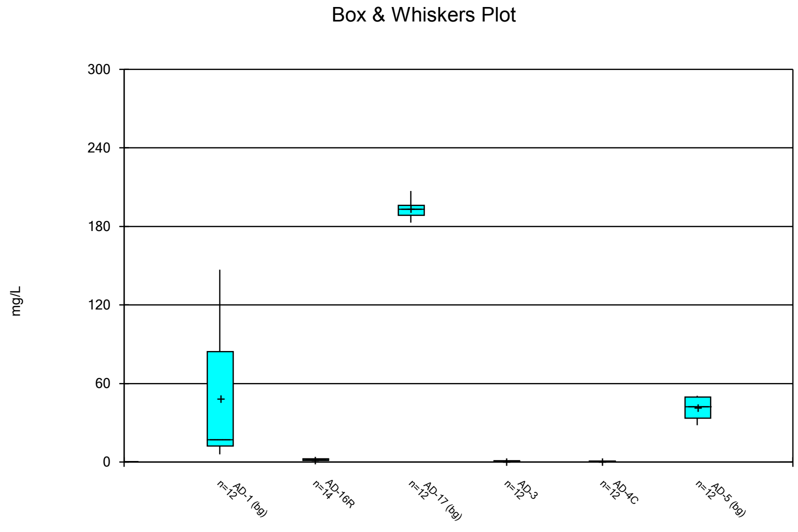
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Boron   Analysis Run 11/7/2019 10:06 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

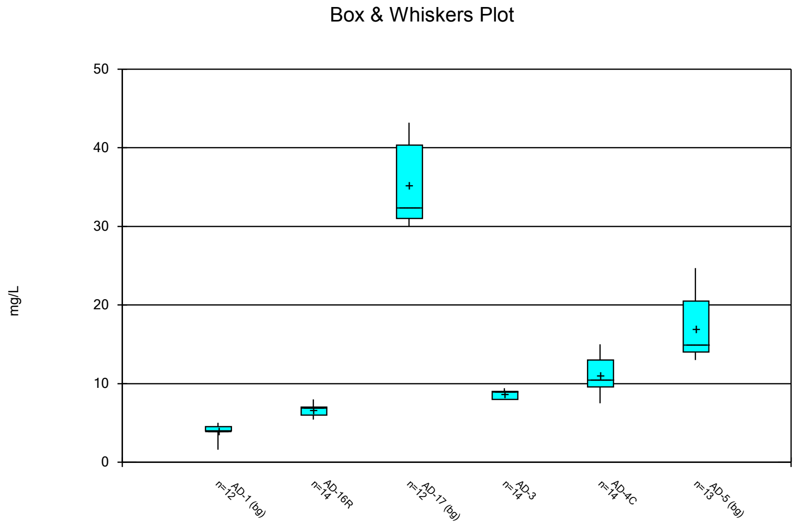
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Calcium   Analysis Run 11/7/2019 10:06 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

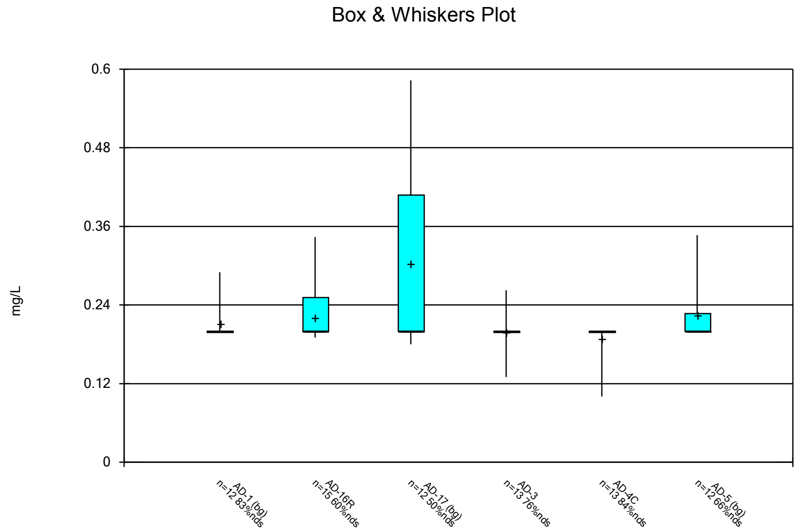
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Chloride   Analysis Run 11/7/2019 10:06 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

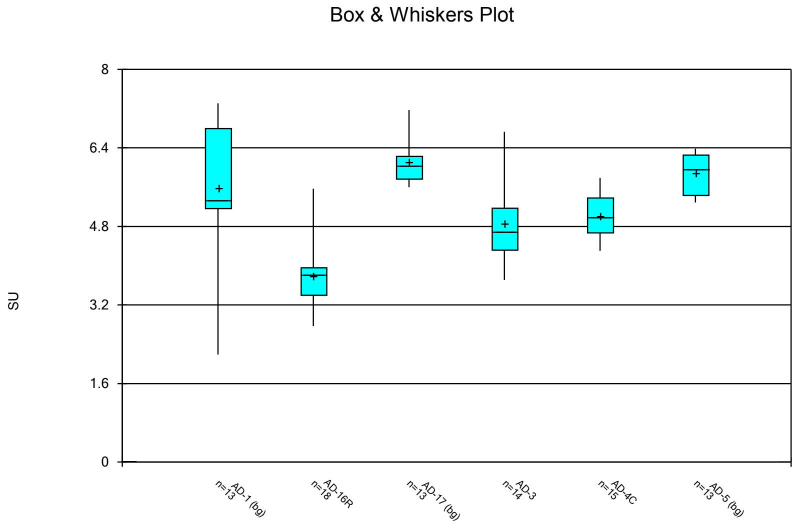
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Fluoride   Analysis Run 11/7/2019 10:06 AM

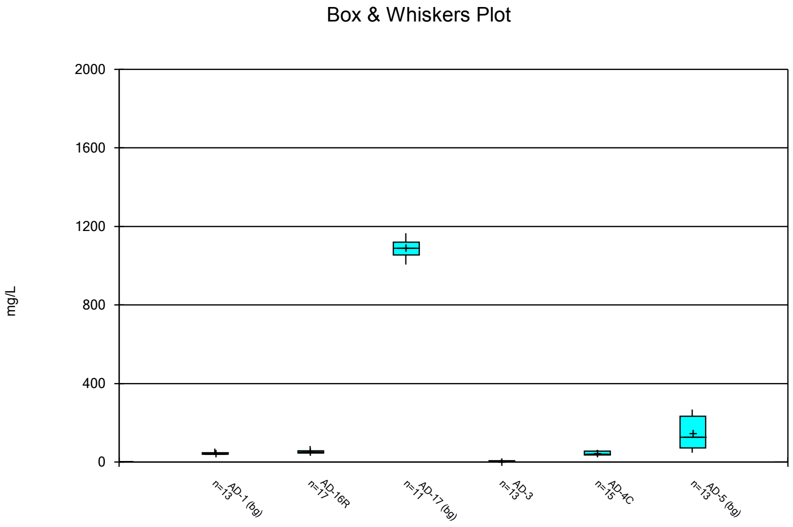
Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



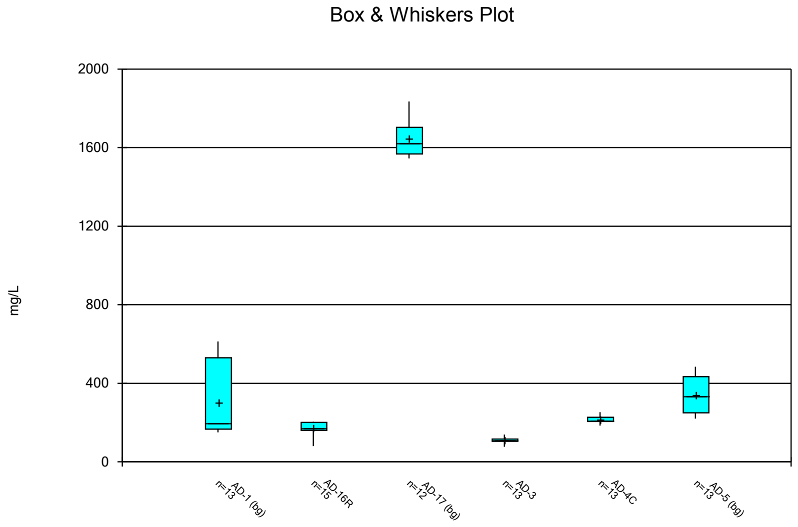
Constituent: pH, field Analysis Run 11/7/2019 10:06 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Sulfate Analysis Run 11/7/2019 10:06 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:06 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Figure C. Outlier Summary

Welsh BASP   Client: Geosyntec   Data: Welsh BASP   Printed 11/7/2019, 10:05 AM

	AD-1 Chloride (mg/L)	AD-16R Chloride (mg/L)	AD-17 Sulfate (mg/L)
1/20/2017			1445 (o)
2/24/2017	9 (o)		
7/7/2017		36 (o)	

Figure D. Welch's t-test/Mann-Whitney - Significant Results

Welsh BASP   Client: Geosyntec   Data: Welsh BASP   Printed 11/7/2019, 10:37 AM

Constituent	Well	Calc.	0.01	Method
Chloride (mg/L)	**AD-5 (bg)**	**2.816**	**Yes**	**Mann-W**

Figure D. Welch's t-test/Mann-Whitney - All Results

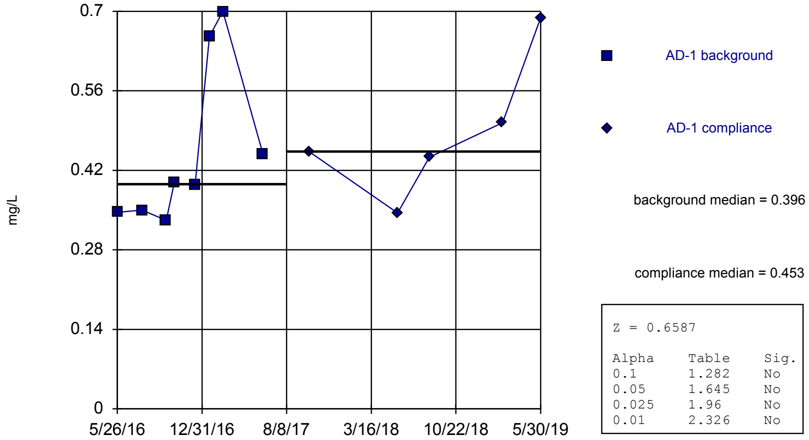
Welsh BASP   Client: Geosyntec   Data: Welsh BASP   Printed 11/7/2019, 10:37 AM

Constituent	Well	Calc.	0.01	Method
Boron (mg/L)	AD-1 (bg)	0.6587	No	Mann-W
Boron (mg/L)	AD-16R	-0.7055	No	Mann-W
Boron (mg/L)	AD-17 (bg)	1.982	No	Mann-W
Boron (mg/L)	AD-3	-1.545	No	Mann-W
Boron (mg/L)	AD-4C	-1.111	No	Mann-W
Boron (mg/L)	AD-5 (bg)	-0.1495	No	Mann-W
Calcium (mg/L)	AD-1 (bg)	-1.274	No	Mann-W
Calcium (mg/L)	AD-16R	-0.7778	No	Mann-W
Calcium (mg/L)	AD-17 (bg)	-0.9358	No	Mann-W
Calcium (mg/L)	AD-3	0.08492	No	Mann-W
Calcium (mg/L)	AD-4C	0.4246	No	Mann-W
Calcium (mg/L)	AD-5 (bg)	-2.123	No	Mann-W
Chloride (mg/L)	AD-1 (bg)	-1.279	No	Mann-W
Chloride (mg/L)	AD-16R	-1.86	No	Mann-W
Chloride (mg/L)	AD-17 (bg)	1.366	No	Mann-W
Chloride (mg/L)	AD-3	1.102	No	Mann-W
Chloride (mg/L)	AD-4C	0.8524	No	Mann-W
Chloride (mg/L)	**AD-5 (bg)**	**2.816**	**Yes**	**Mann-W**
Fluoride (mg/L)	AD-1 (bg)	-2.219	No	Mann-W
Fluoride (mg/L)	AD-16R	-0.6218	No	Mann-W
Fluoride (mg/L)	AD-17 (bg)	-2.176	No	Mann-W
Fluoride (mg/L)	AD-3	-1.386	No	Mann-W
Fluoride (mg/L)	AD-4C	-1.978	No	Mann-W
Fluoride (mg/L)	AD-5 (bg)	-1.112	No	Mann-W
pH, field (SU)	AD-1 (bg)	-0.1466	No	Mann-W
pH, field (SU)	AD-16R	1.734	No	Mann-W
pH, field (SU)	AD-17 (bg)	0.366	No	Mann-W
pH, field (SU)	AD-3	-0.4518	No	Mann-W
pH, field (SU)	AD-4C	0.8687	No	Mann-W
pH, field (SU)	AD-5 (bg)	0.5123	No	Mann-W
Sulfate (mg/L)	AD-1 (bg)	0.8856	No	Mann-W
Sulfate (mg/L)	AD-16R	0.7355	No	Mann-W
Sulfate (mg/L)	AD-17 (bg)	-0.09471	No	Mann-W
Sulfate (mg/L)	AD-3	-1.843	No	Mann-W
Sulfate (mg/L)	AD-4C	2.095	No	Mann-W
Sulfate (mg/L)	AD-5 (bg)	-1.906	No	Mann-W
Total Dissolved Solids (mg/L)	AD-1 (bg)	-1.099	No	Mann-W
Total Dissolved Solids (mg/L)	AD-16R	0.1229	No	Mann-W
Total Dissolved Solids (mg/L)	AD-17 (bg)	-0.2548	No	Mann-W
Total Dissolved Solids (mg/L)	AD-3	-0.2205	No	Mann-W
Total Dissolved Solids (mg/L)	AD-4C	1.174	No	Mann-W
Total Dissolved Solids (mg/L)	AD-5 (bg)	-2.269	No	Mann-W

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-1 (bg)



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compliance median = 0.453

Z = 0.6587

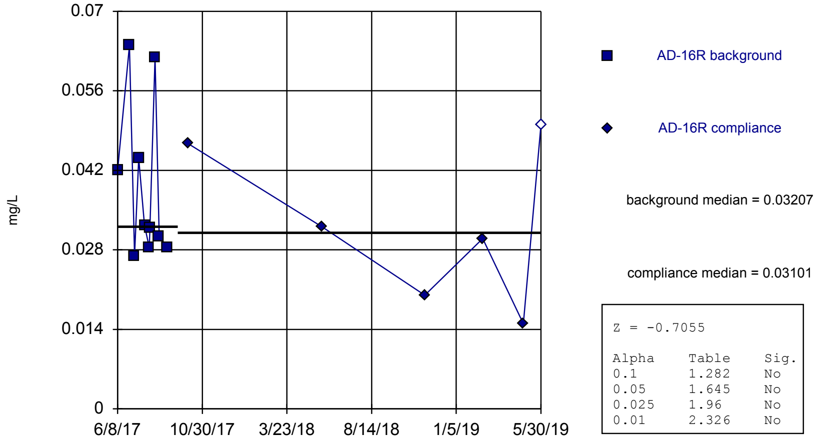
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Boron Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-16R



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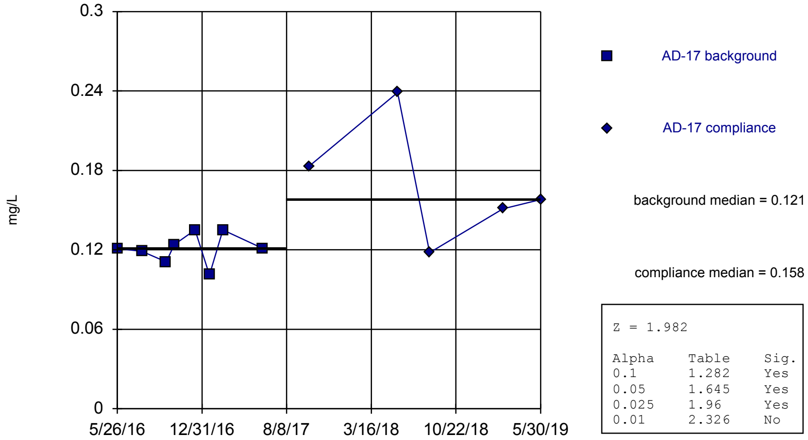
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Boron Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17 (bg)



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compliance median = 0.158

Z = 1.982

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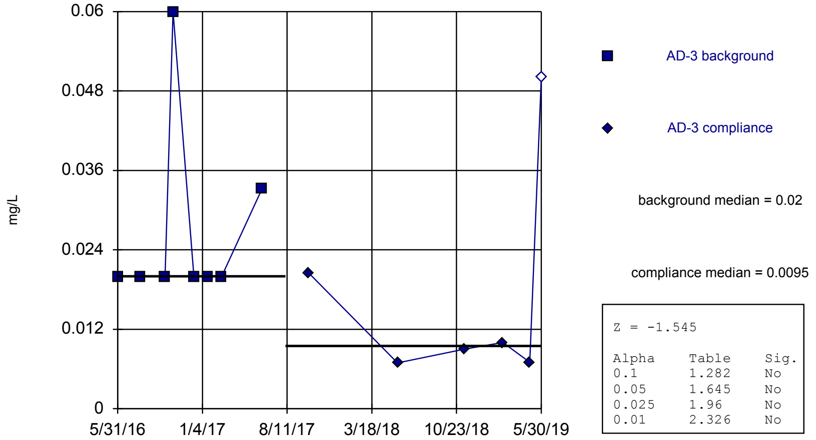
0.05	1.645	Yes
0.025	1.96	Yes
0.01	2.326	No

Constituent: Boron Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-3



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compliance median = 0.0095

Z = -1.545

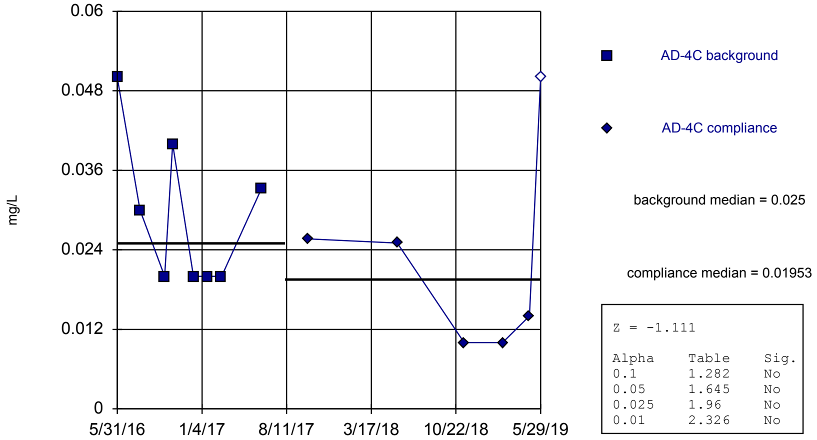
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Boron Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-4C



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compliance median = 0.01953

Z = -1.111

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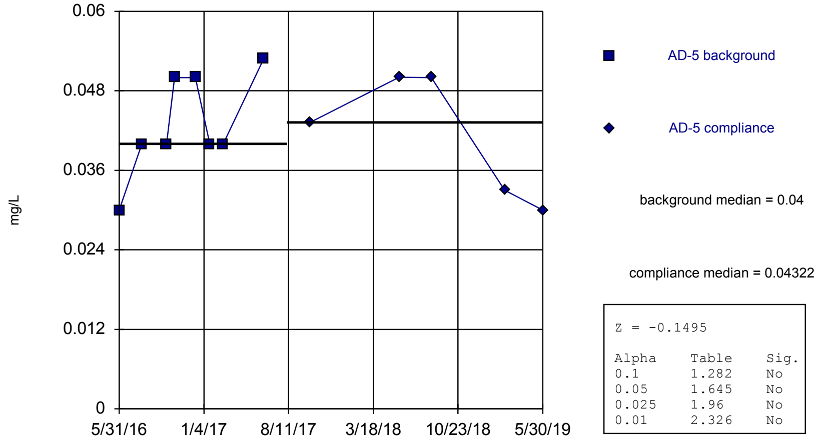
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Boron Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-5 (bg)



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Z = -0.1495

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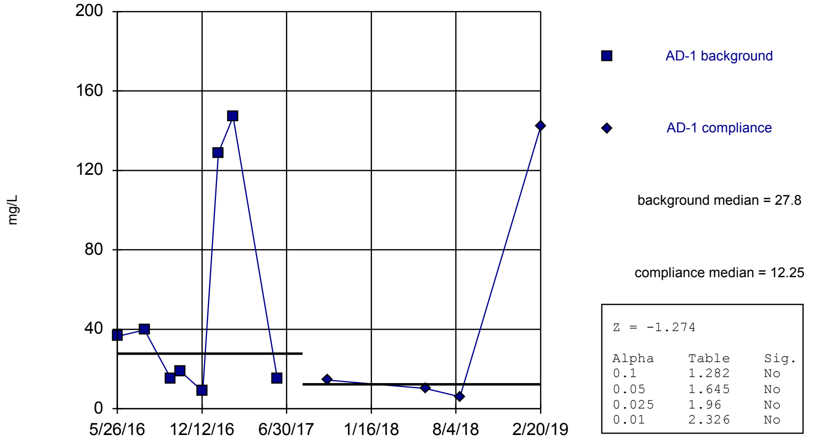
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Boron Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-1 (bg)



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compliance median = 12.25

Z = -1.274

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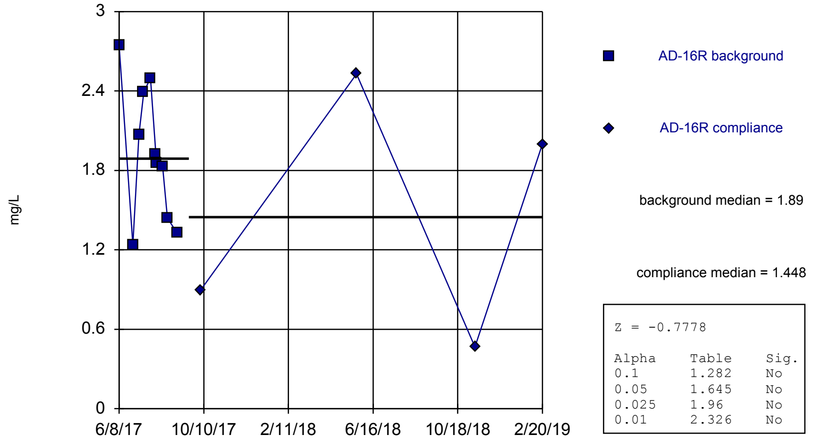
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Calcium Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16R



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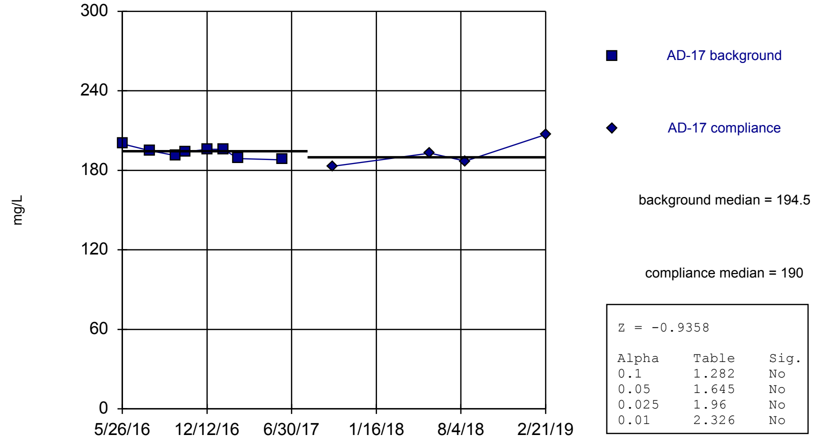
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Calcium Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Mann-Whitney (Wilcoxon Rank Sum)

AD-17 (bg)



background median = 194.5

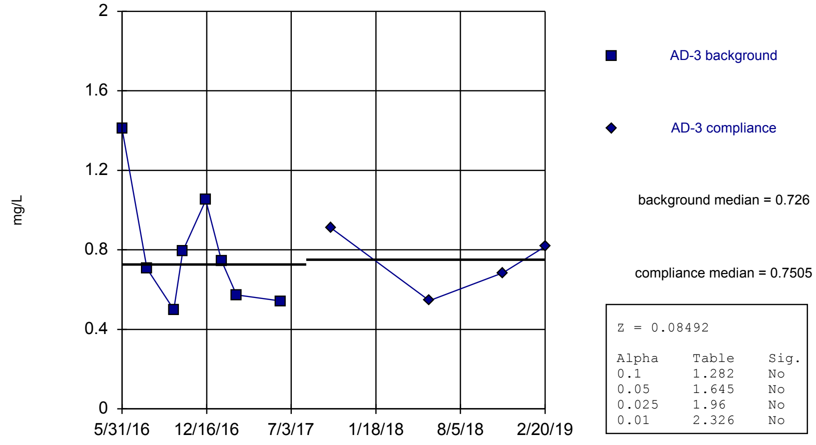
compliance median = 190

```
Z = -0.9358

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Calcium Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Mann-Whitney (Wilcoxon Rank Sum)

AD-3



background median = 0.726

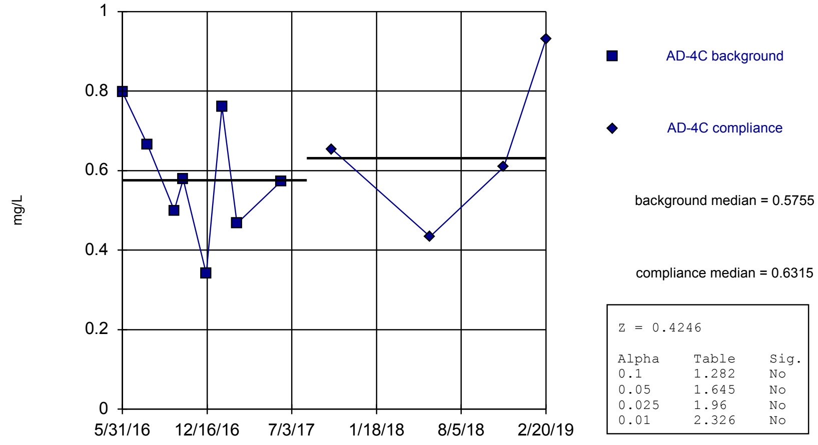
compliance median = 0.7505

```
Z = 0.08492

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Calcium Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Mann-Whitney (Wilcoxon Rank Sum)

AD-4C



background median = 0.5755

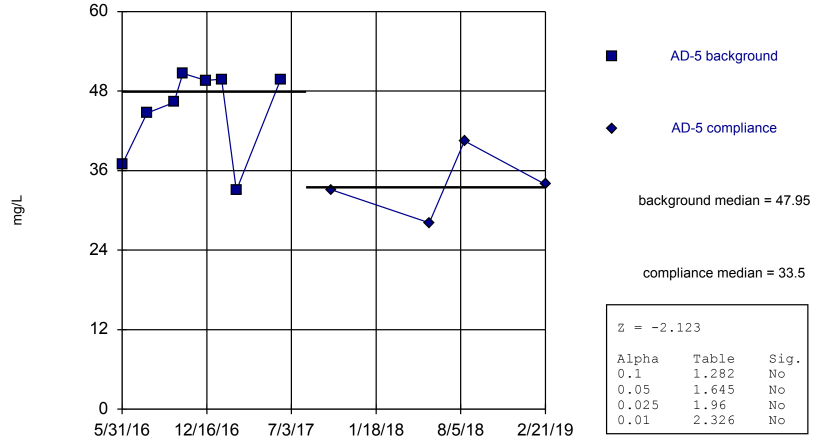
compliance median = 0.6315

```
Z = 0.4246

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Calcium Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Mann-Whitney (Wilcoxon Rank Sum)

AD-5 (bg)



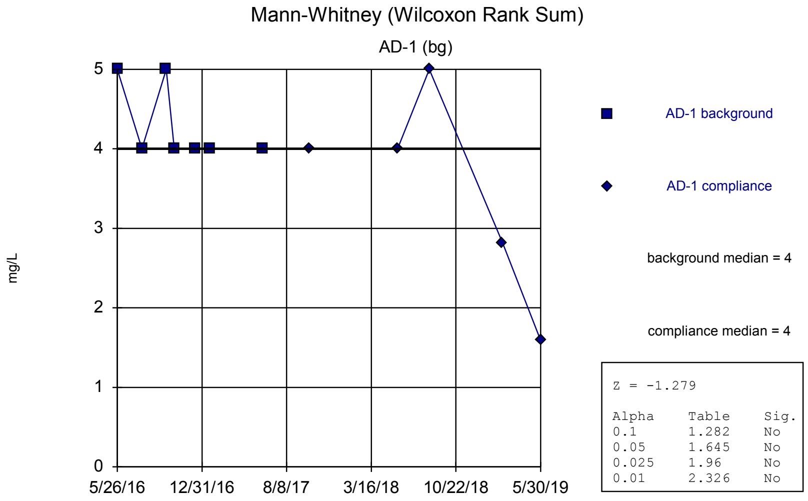
background median = 47.95

compliance median = 33.5

```
Z = -2.123

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Calcium Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

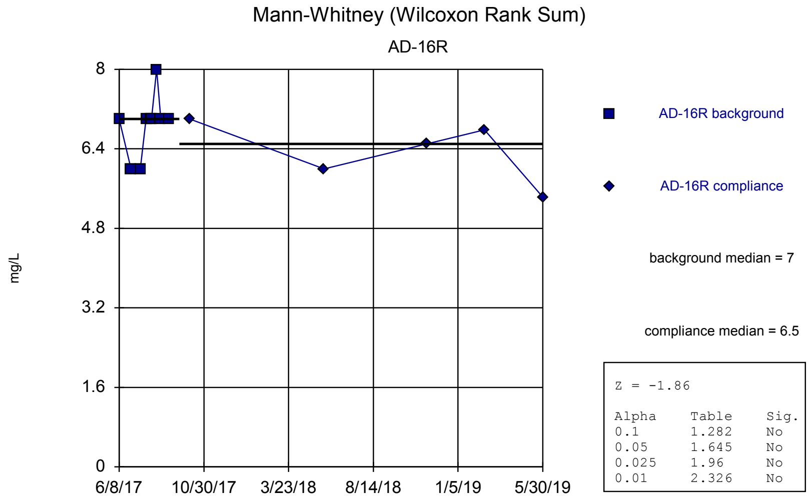
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



```
Z = -1.279

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Chloride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

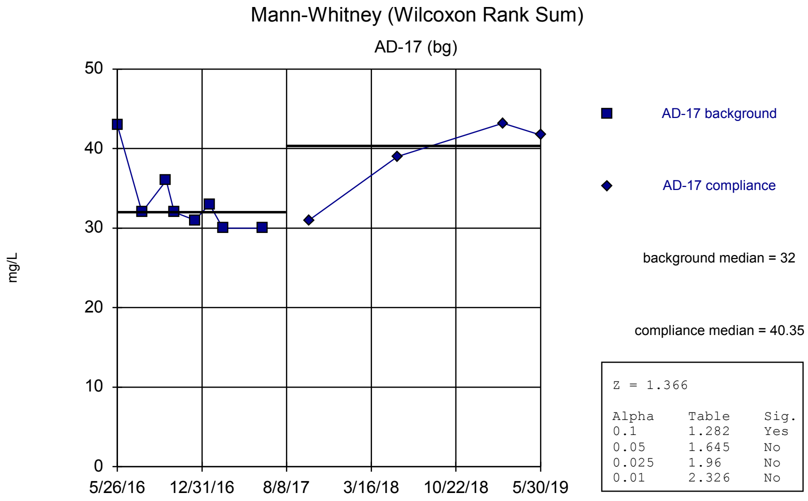
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



```
Z = -1.86

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Chloride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

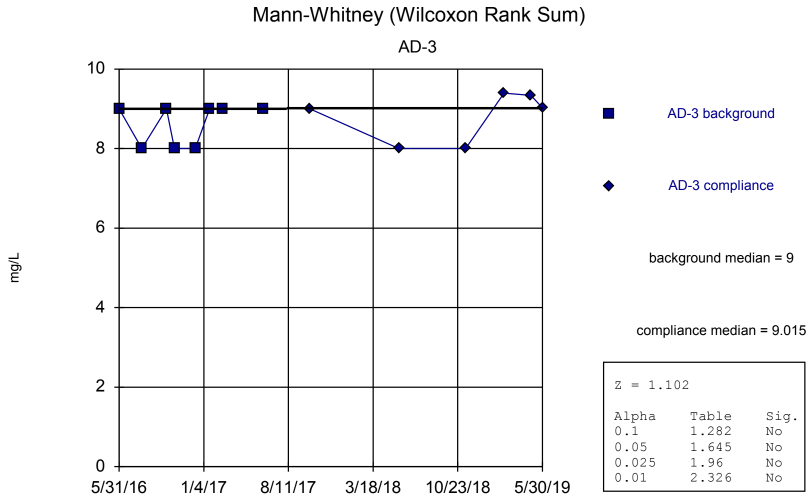
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



```
Z = 1.366

Alpha     Table     Sig.
0.1       1.282     Yes
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Chloride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



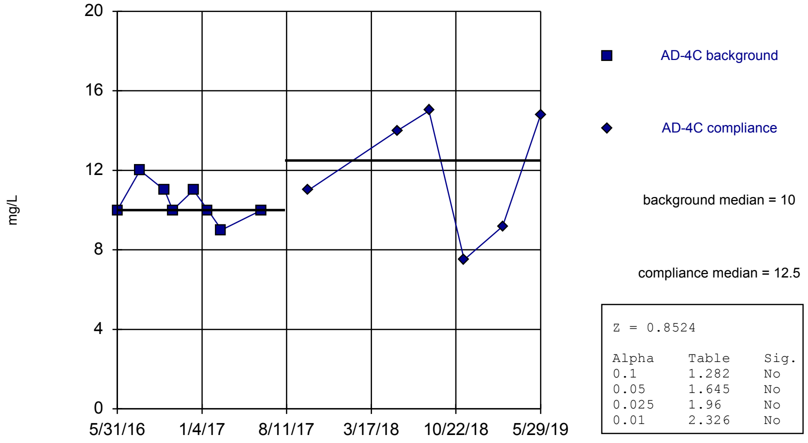
```
Z = 1.102

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

Constituent: Chloride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-4C



Z = 0.8524

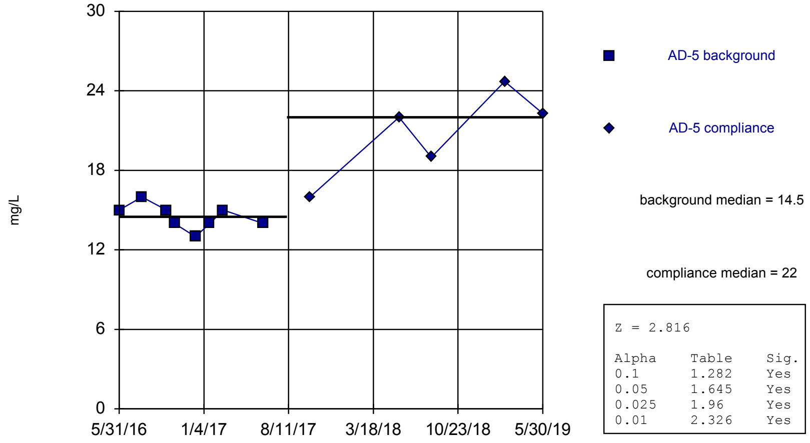
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Chloride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-5 (bg)



Z = 2.816

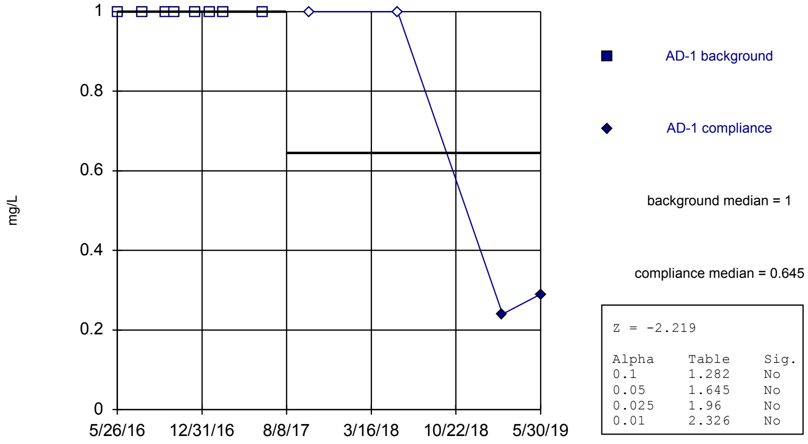
Alpha	Table	Sig.
0.1	1.282	Yes
0.05	1.645	Yes
0.025	1.96	Yes
0.01	2.326	Yes

Constituent: Chloride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-1 (bg)



Z = -2.219

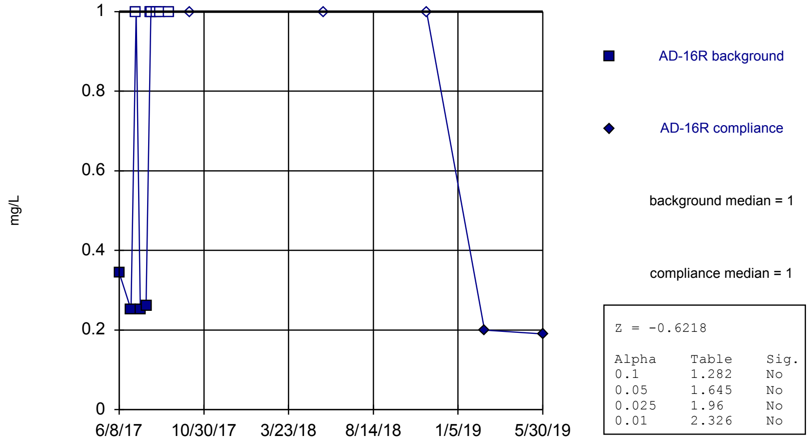
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Fluoride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-16R

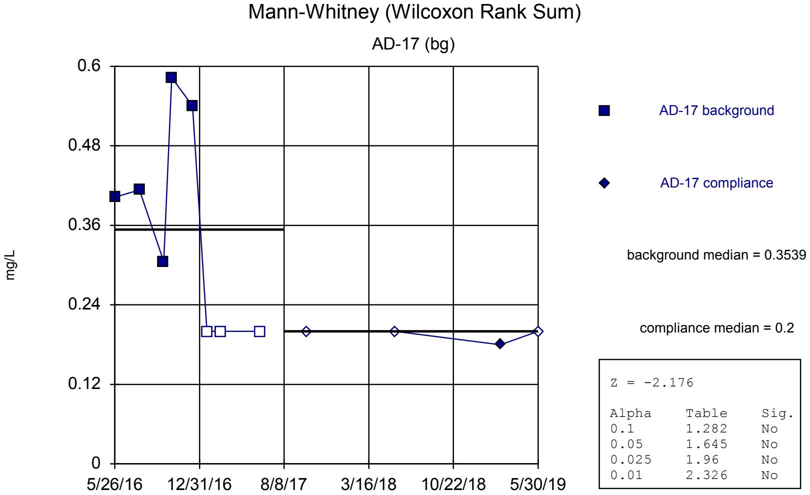


Z = -0.6218

Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Fluoride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

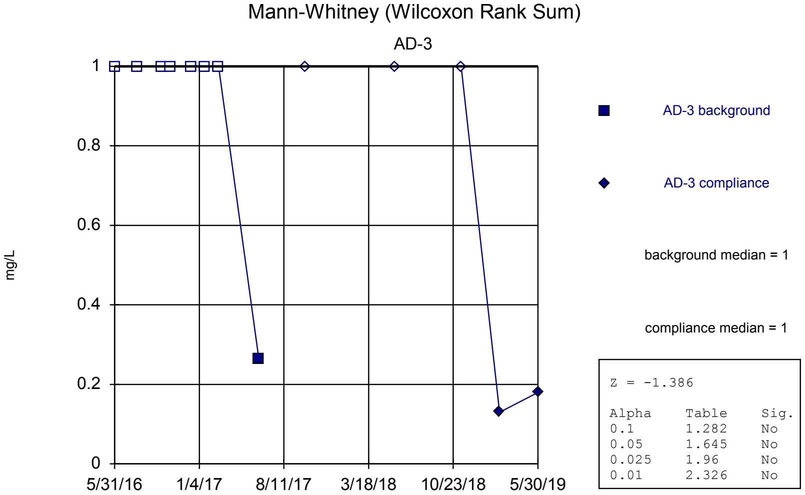


Z = -2.176

Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Fluoride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

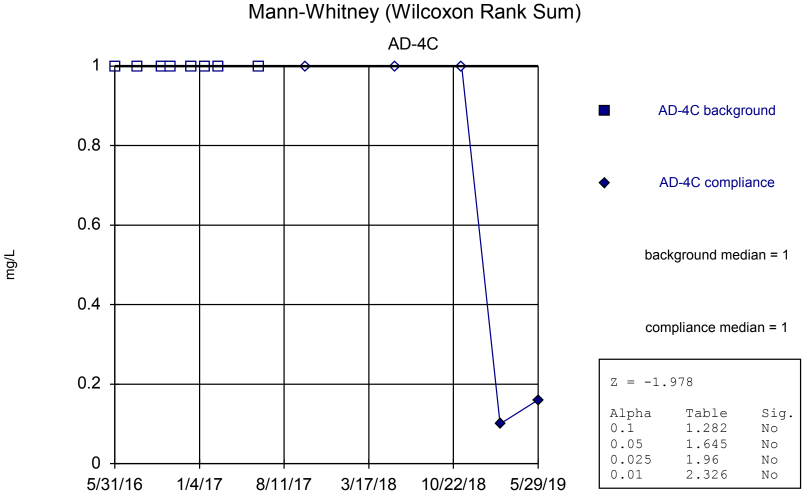


Z = -1.386

Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Fluoride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

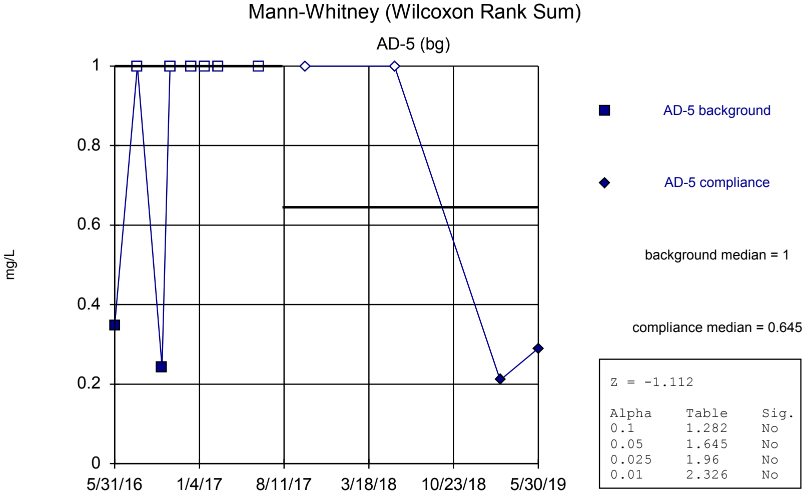


Z = -1.978

Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Fluoride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Z = -1.112

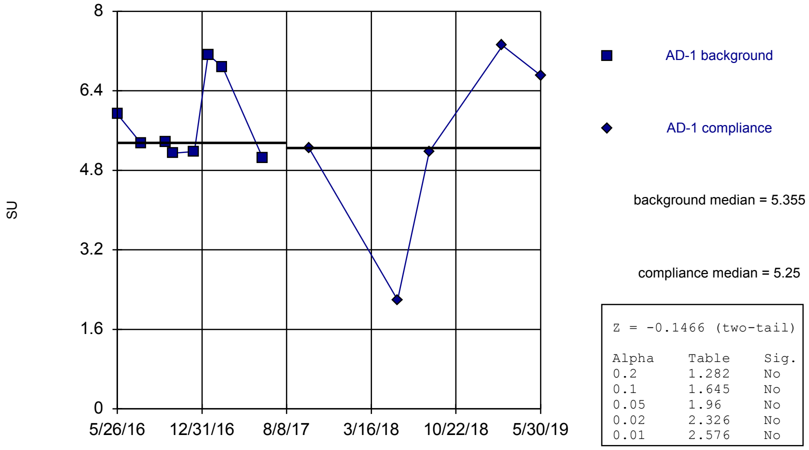
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Fluoride Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-1 (bg)



background median = 5.355

compliance median = 5.25

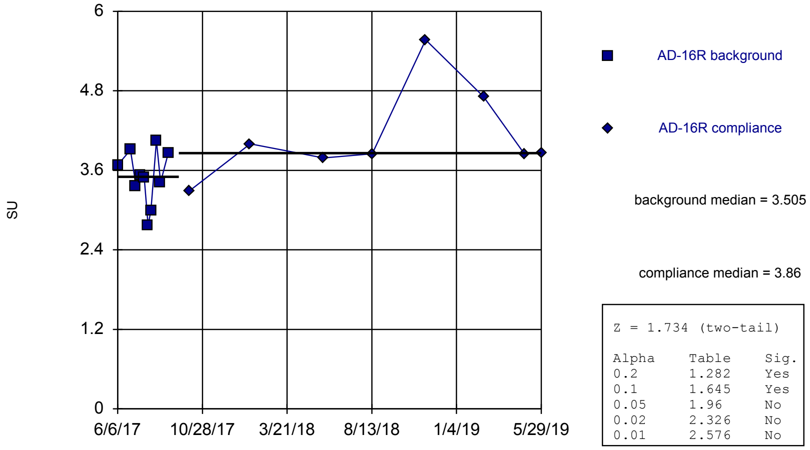
```
Z = -0.1466 (two-tail)

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 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16R



background median = 3.505

compliance median = 3.86

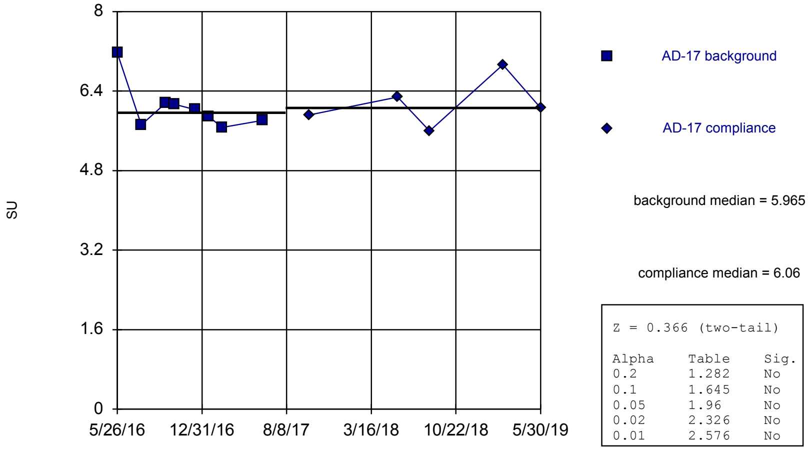
```
Z = 1.734 (two-tail)

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: pH, field Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17 (bg)



background median = 5.965

compliance median = 6.06

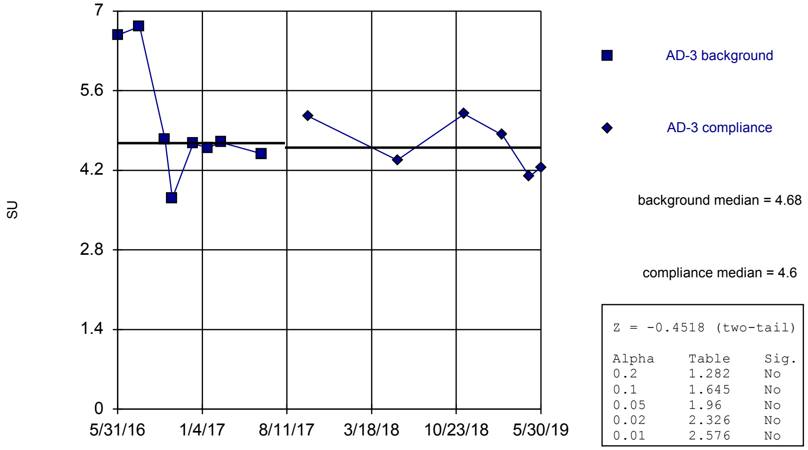
```
Z = 0.366 (two-tail)

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 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3



background median = 4.68

compliance median = 4.6

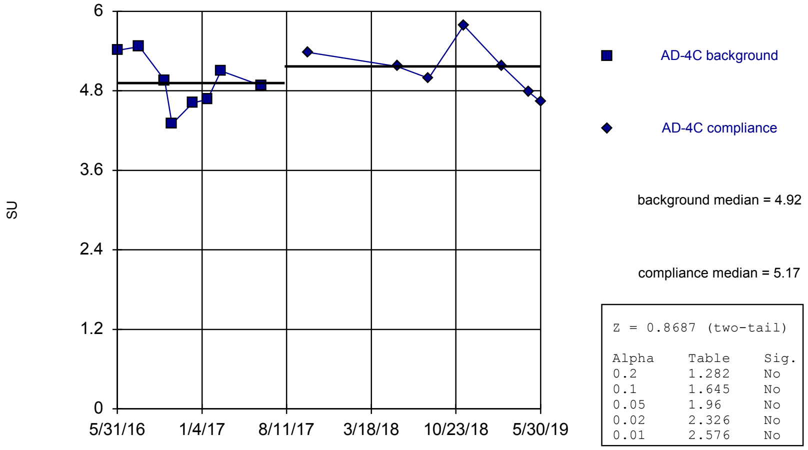
```
Z = -0.4518 (two-tail)

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 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-4C



background median = 4.92

compliance median = 5.17

```
Z = 0.8687 (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
```

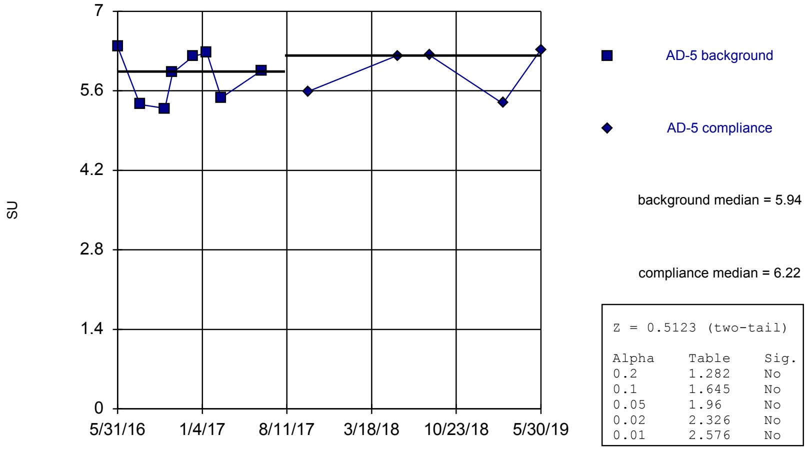
Constituent: pH, field   Analysis Run 11/7/2019 10:35 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-5 (bg)



background median = 5.94

compliance median = 6.22

```
Z = 0.5123 (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
```

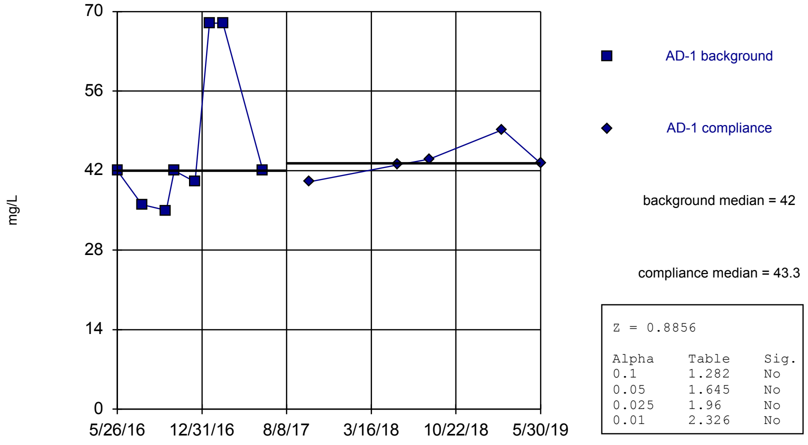
Constituent: pH, field   Analysis Run 11/7/2019 10:35 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-1 (bg)



background median = 42

compliance median = 43.3

```
Z = 0.8856

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

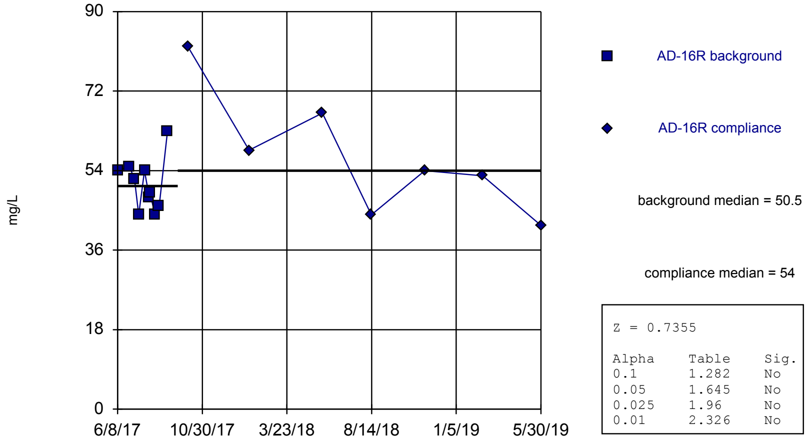
Constituent: Sulfate   Analysis Run 11/7/2019 10:35 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16R



background median = 50.5

compliance median = 54

```
Z = 0.7355

Alpha     Table     Sig.
0.1       1.282     No
0.05      1.645     No
0.025     1.96      No
0.01      2.326     No
```

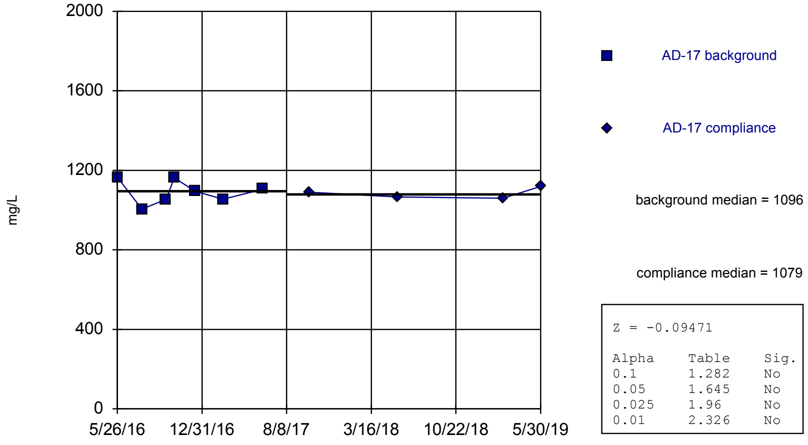
Constituent: Sulfate   Analysis Run 11/7/2019 10:35 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17 (bg)



Z = -0.09471

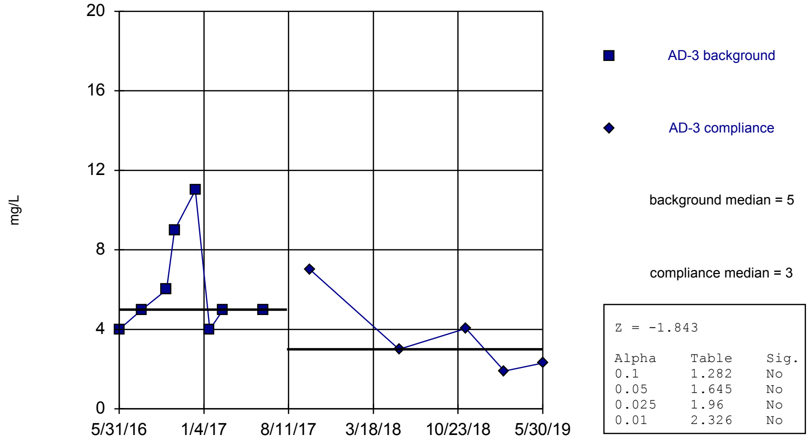
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Sulfate Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3



Z = -1.843

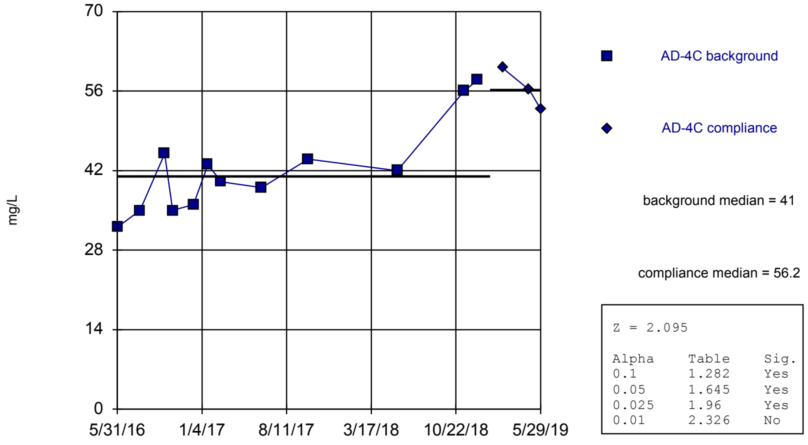
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Sulfate Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-4C



Z = 2.095

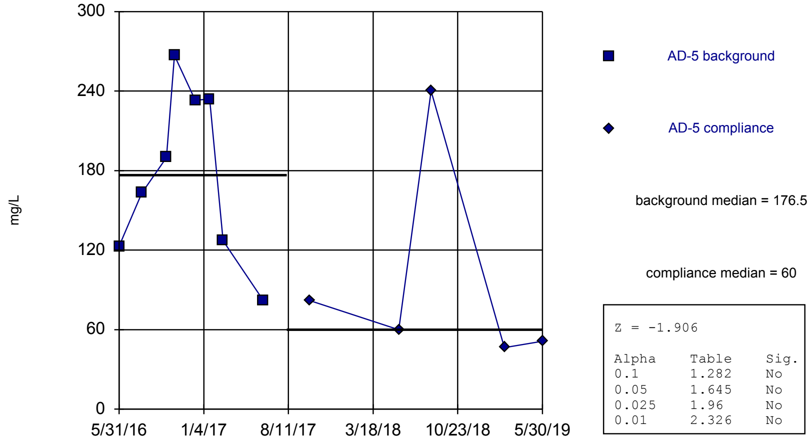
Alpha	Table	Sig.
0.1	1.282	Yes
0.05	1.645	Yes
0.025	1.96	Yes
0.01	2.326	No

Constituent: Sulfate Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-5 (bg)



Z = -1.906

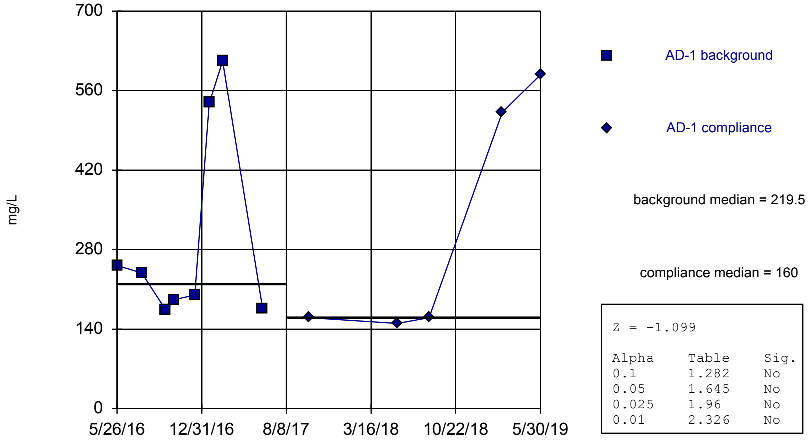
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Sulfate Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-1 (bg)



background median = 219.5

compliance median = 160

Z = -1.099

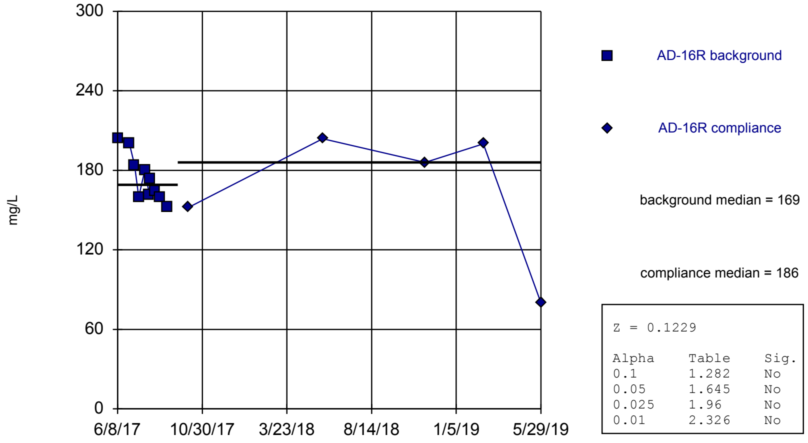
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16R



background median = 169

compliance median = 186

Z = 0.1229

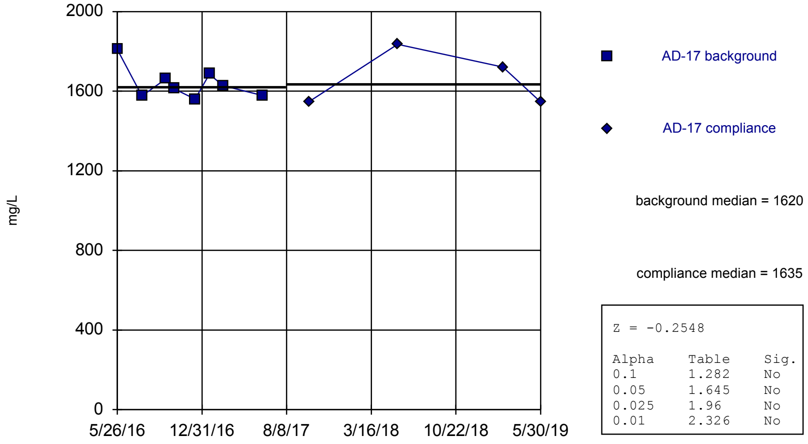
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17 (bg)



background median = 1620

compliance median = 1635

Z = -0.2548

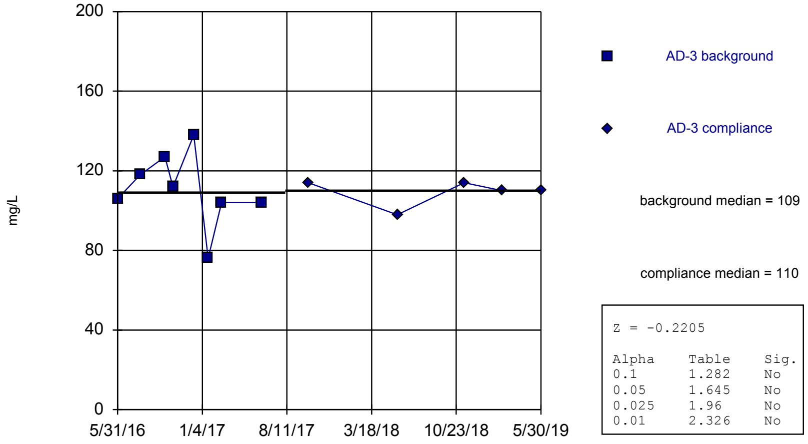
Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3



background median = 109

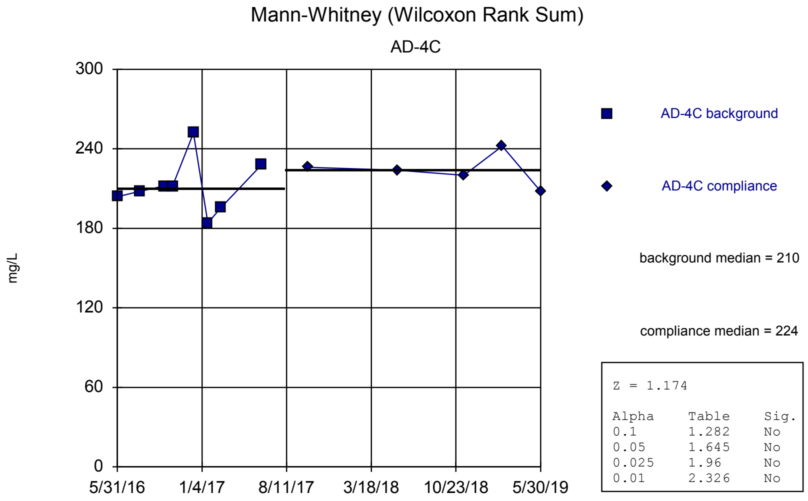
compliance median = 110

Z = -0.2205

Alpha	Table	Sig.
0.1	1.282	No
0.05	1.645	No
0.025	1.96	No
0.01	2.326	No

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:35 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

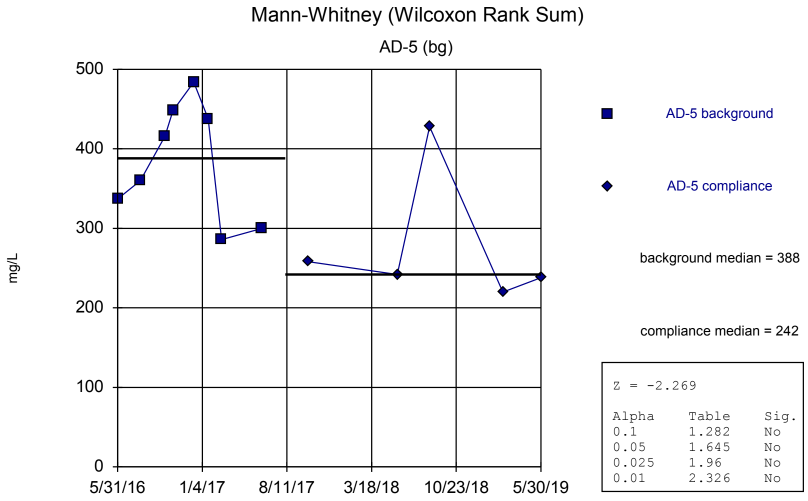


```
Z = 1.174

Alpha    Table    Sig.
0.1      1.282    No
0.05     1.645    No
0.025    1.96     No
0.01     2.326    No
```

Constituent: Total Dissolved Solids   Analysis Run 11/7/2019 10:35 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



```
Z = -2.269

Alpha    Table    Sig.
0.1      1.282    No
0.05     1.645    No
0.025    1.96     No
0.01     2.326    No
```

Constituent: Total Dissolved Solids   Analysis Run 11/7/2019 10:35 AM

Welsh BASP   Client: Geosyntec   Data: Welsh BASP

Figure E. Date Ranges

Date: 11/7/2019 10:33 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sulfate (mg/L)

AD-4C background:5/26/2016-12/18/2018

Figure F. Intrawell Prediction Limit Summary Table - All Results

Welsh BASP Client: Geosyntec Data: Welsh BASP Printed 11/7/2019, 10:39 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	AD-1	0.7429	n/a	n/a	1 future	n/a	13	0.4661	0.1333	0	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-16R	0.06376	n/a	n/a	1 future	n/a	16	0.03651	0.01384	6.25	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-17	0.2176	n/a	n/a	1 future	n/a	13	0.3711	0.0459	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-3	0.05798	n/a	n/a	1 future	n/a	14	0.1432	0.04783	7.143	None	sqrt(x)	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-4C	0.05294	n/a	n/a	1 future	n/a	14	0.02629	0.01306	7.143	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-5	0.05876	n/a	n/a	1 future	n/a	13	0.04224	0.007957	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-1	206	n/a	n/a	1 future	n/a	12	3.196	1.283	0	None	x^(1/3)	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-16R	3.149	n/a	n/a	1 future	n/a	14	1.802	0.66	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-17	206.7	n/a	n/a	1 future	n/a	12	193.3	6.384	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-3	1.319	n/a	n/a	1 future	n/a	12	0.773	0.2586	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-4C	0.9607	n/a	n/a	1 future	n/a	12	0.6093	0.1664	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-5	58.47	n/a	n/a	1 future	n/a	12	41.36	8.1	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-1	5.523	n/a	n/a	1 future	n/a	12	16.46	6.652	0	None	x^2	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-16R	8.015	n/a	n/a	1 future	n/a	14	6.694	0.6474	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-17	46.13	n/a	n/a	1 future	n/a	12	35.16	5.195	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-3	9.4	n/a	n/a	1 future	n/a	14	n/a	n/a	0	n/a	n/a	0.008612	NP Intra (normality) 1 of 2
Chloride (mg/L)	AD-4C	15.56	n/a	n/a	1 future	n/a	14	11.03	2.219	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-5	24.81	n/a	n/a	1 future	n/a	13	16.92	3.8	0	None	No	0.002505	Param Intra 1 of 2
Fluoride (mg/L)	AD-1	1	n/a	n/a	1 future	n/a	12	n/a	n/a	83.33	n/a	n/a	0.01077	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-16R	1	n/a	n/a	1 future	n/a	15	n/a	n/a	60	n/a	n/a	0.007533	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-17	0.583	n/a	n/a	1 future	n/a	12	n/a	n/a	50	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Fluoride (mg/L)	AD-3	1	n/a	n/a	1 future	n/a	13	n/a	n/a	76.92	n/a	n/a	0.009692	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-4C	1	n/a	n/a	1 future	n/a	13	n/a	n/a	84.62	n/a	n/a	0.009692	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-5	1	n/a	n/a	1 future	n/a	12	n/a	n/a	66.67	n/a	n/a	0.01077	NP Intra (NDs) 1 of 2
pH, field (SU)	AD-1	8.335	2.846	n/a	1 future	n/a	13	5.591	1.322	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-16R	4.977	2.578	n/a	1 future	n/a	18	3.778	0.6212	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-17	7.077	5.138	n/a	1 future	n/a	13	6.108	0.4667	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-3	6.604	3.124	n/a	1 future	n/a	14	4.864	0.8526	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-4C	5.809	4.235	n/a	1 future	n/a	15	5.022	0.3924	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-5	6.756	5.031	n/a	1 future	n/a	13	5.894	0.4153	0	None	No	0.001253	Param Intra 1 of 2
Sulfate (mg/L)	AD-1	68	n/a	n/a	1 future	n/a	13	n/a	n/a	0	n/a	n/a	0.009692	NP Intra (normality) 1 of 2
Sulfate (mg/L)	AD-16R	73.19	n/a	n/a	1 future	n/a	17	53.47	10.11	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-17	1194	n/a	n/a	1 future	n/a	11	1089	48.34	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-3	10.55	n/a	n/a	1 future	n/a	13	5.173	2.589	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-4C	63.73	n/a	n/a	1 future	n/a	15	44.94	9.37	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-5	311.7	n/a	n/a	1 future	n/a	13	146.1	79.77	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-1	612	n/a	n/a	1 future	n/a	13	n/a	n/a	0	n/a	n/a	0.009692	NP Intra (normality) 1 of 2
Total Dissolved Solids (mg/L)	AD-16R	221	n/a	n/a	1 future	n/a	15	30087	9358	0	None	x^2	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1857	n/a	n/a	1 future	n/a	12	1647	99.38	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-3	140.4	n/a	n/a	1 future	n/a	13	110.1	14.61	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-4C	254.6	n/a	n/a	1 future	n/a	13	216.6	18.3	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-5	533.7	n/a	n/a	1 future	n/a	13	342.7	91.96	0	None	No	0.002505	Param Intra 1 of 2

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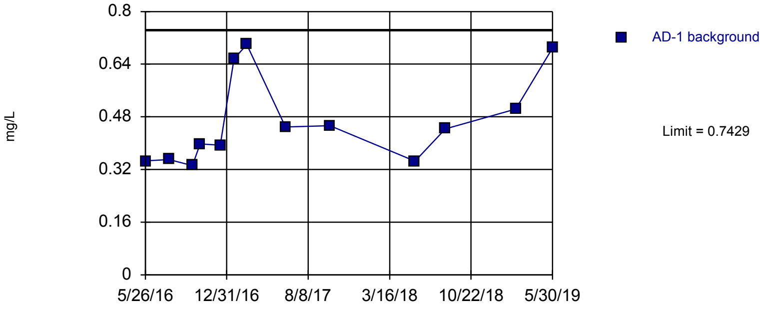
Prediction Limit

Intrawell Parametric, AD-1 (bg)



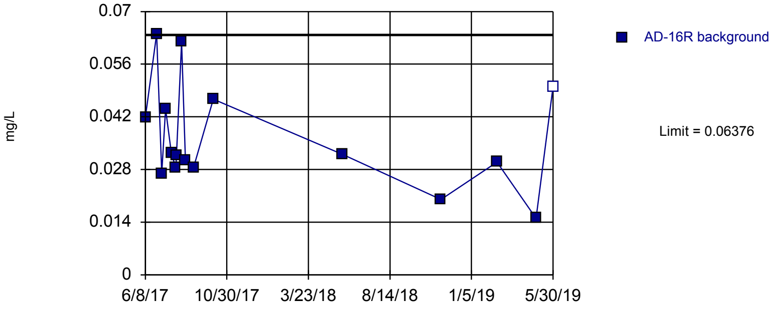
Background Data Summary: Mean=0.4661, Std. Dev.=0.1333, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8345, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-16R



Background Data Summary: Mean=0.03651, Std. Dev.=0.01384, n=16, 6.25% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9241, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

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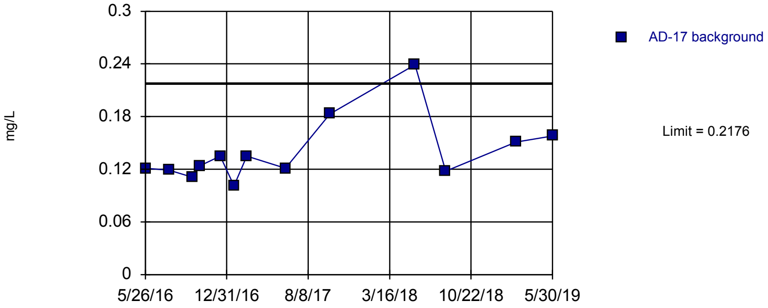
Prediction Limit

Intrawell Parametric, AD-17 (bg)



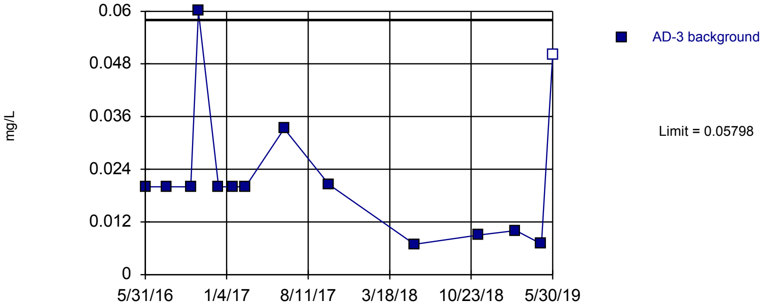
Background Data Summary (based on square root transformation): Mean=0.3711, Std. Dev.=0.0459, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8526, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-3



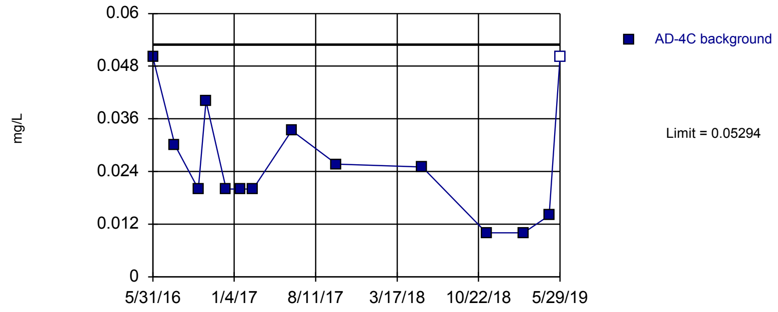
Background Data Summary (based on square root transformation): Mean=0.1432, Std. Dev.=0.04783, n=14, 7.143% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8693, critical = 0.825. Kappa = 2.041 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-4C



Background Data Summary: Mean=0.02629, Std. Dev.=0.01306, n=14, 7.143% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9069, critical = 0.825. Kappa = 2.041 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

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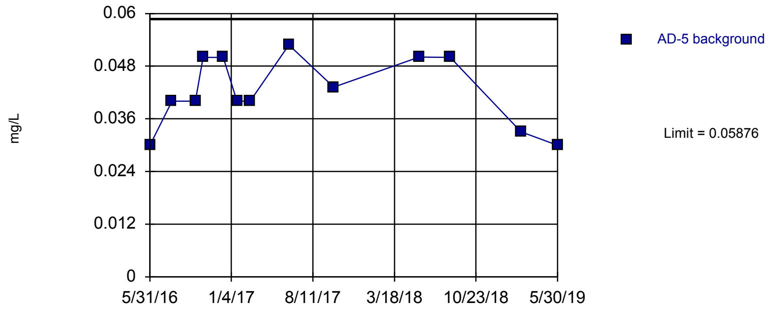
Prediction Limit

Intrawell Parametric, AD-5 (bg)



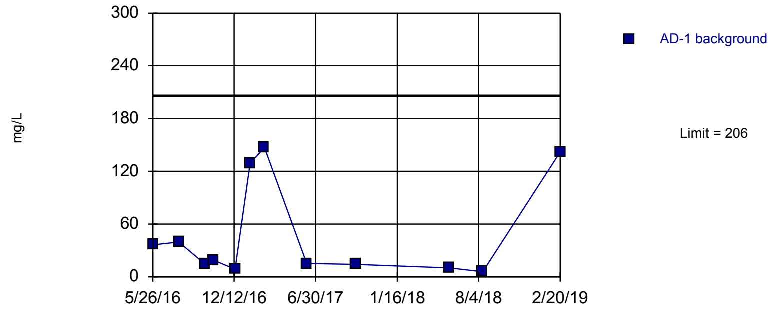
Background Data Summary: Mean=0.04224, Std. Dev.=0.007957, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8882, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



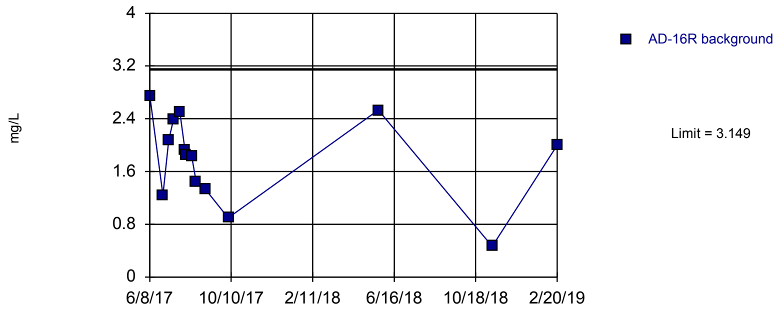
Background Data Summary (based on cube root transformation): Mean=3.196, Std. Dev.=1.283, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8246, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



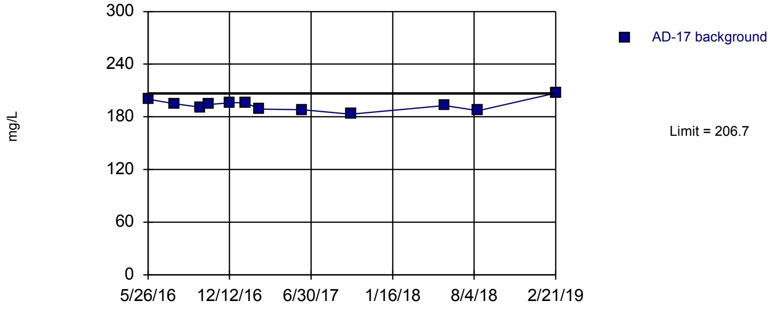
Background Data Summary: Mean=1.802, Std. Dev.=0.66, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9618, critical = 0.825. Kappa = 2.041 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



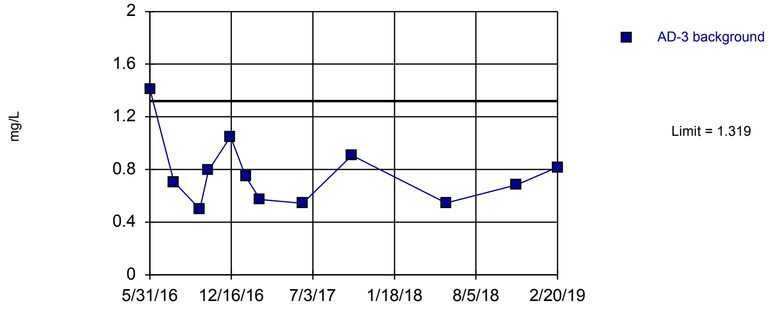
Background Data Summary: Mean=193.3, Std. Dev.=6.384, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9698, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



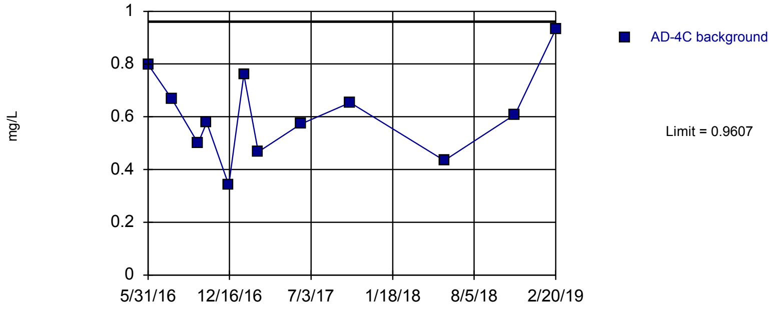
Background Data Summary: Mean=0.773, Std. Dev.=0.2586, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8744, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



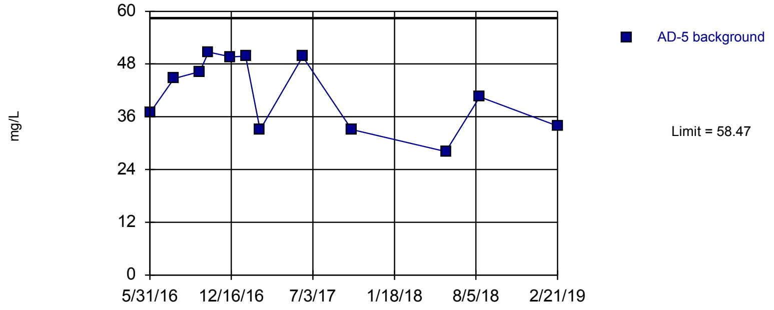
Background Data Summary: Mean=0.6093, Std. Dev.=0.1664, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9854, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



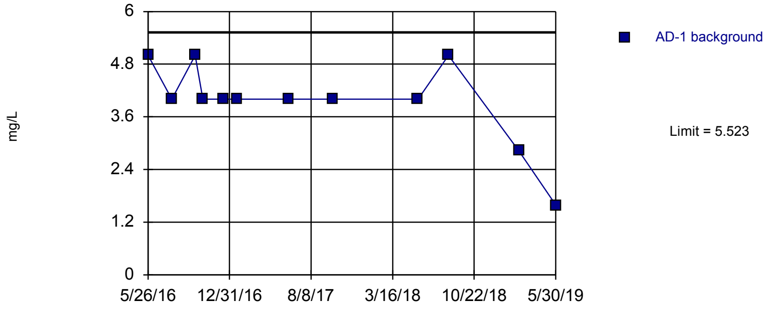
Background Data Summary: Mean=41.36, Std. Dev.=8.1, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8897, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



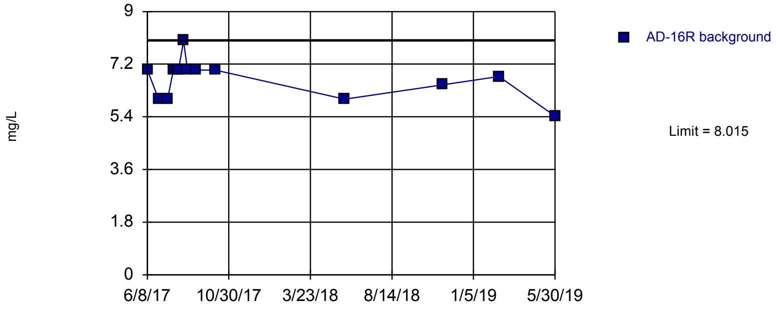
Background Data Summary (based on square transformation): Mean=16.46, Std. Dev.=6.652, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8287, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



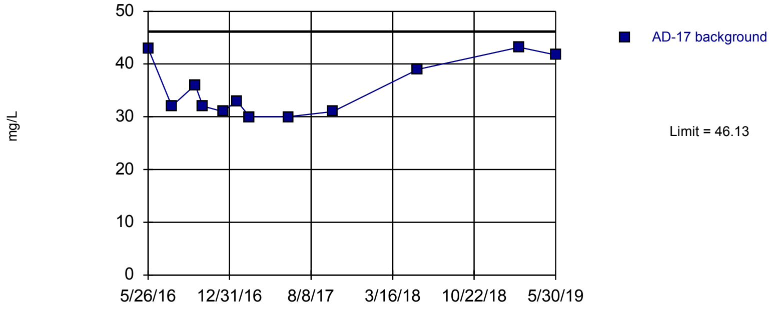
Background Data Summary: Mean=6.694, Std. Dev.=0.6474, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8766, critical = 0.825. Kappa = 2.041 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



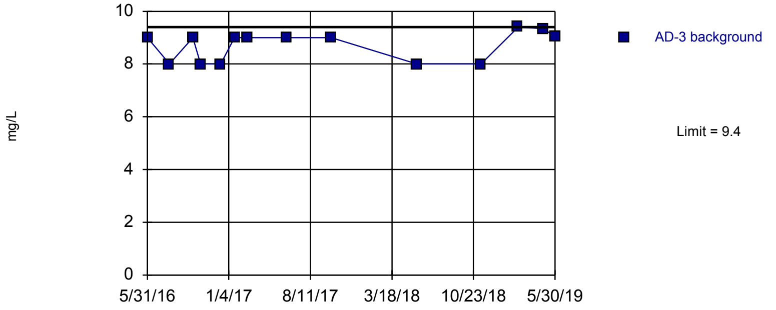
Background Data Summary: Mean=35.16, Std. Dev.=5.195, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8334, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-3



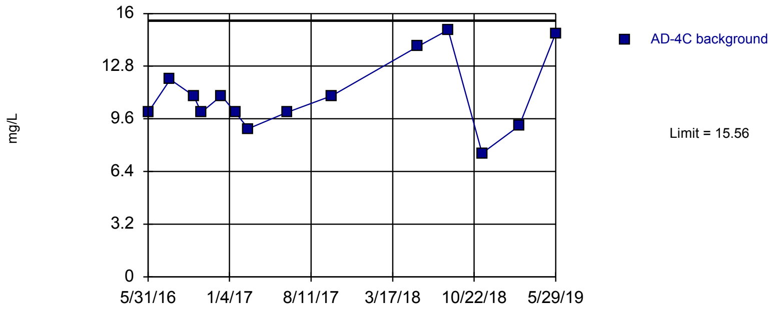
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 14 background values. Well-constituent pair annual alpha = 0.01715. Individual comparison alpha = 0.008612 (1 of 2). Assumes 1 future value.

Constituent: Chloride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



Background Data Summary: Mean=11.03, Std. Dev.=2.219, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9097, critical = 0.825. Kappa = 2.041 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

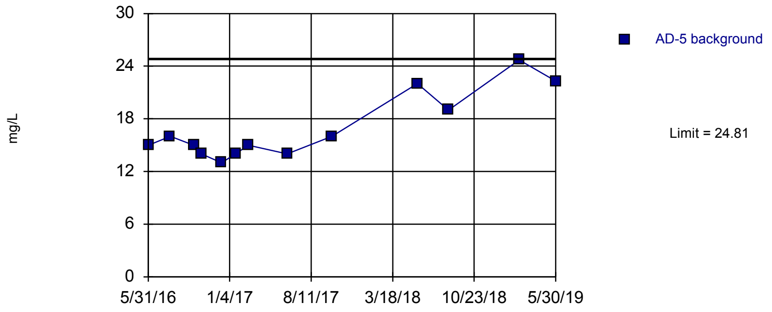
Constituent: Chloride Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



Background Data Summary: Mean=16.92, Std. Dev.=3.8, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8277, 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: Chloride Analysis Run 11/7/2019 10:38 AM

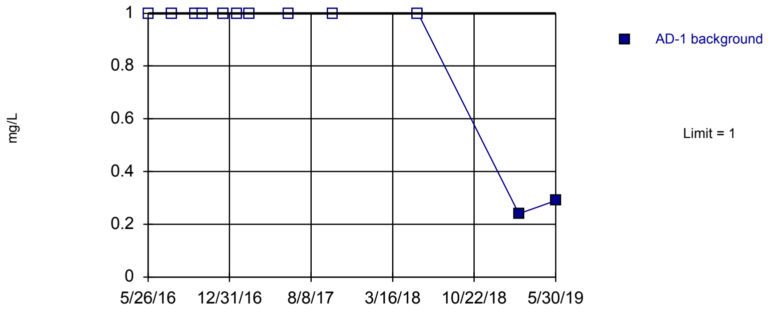
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 12 background values. 83.33% NDs. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 11/7/2019 10:38 AM

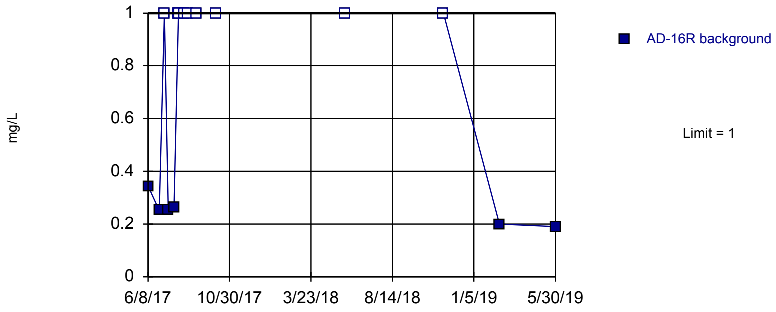
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-16R



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 15 background values. 60% NDs. Well-constituent pair annual alpha = 0.01501. Individual comparison alpha = 0.007533 (1 of 2). Assumes 1 future value.

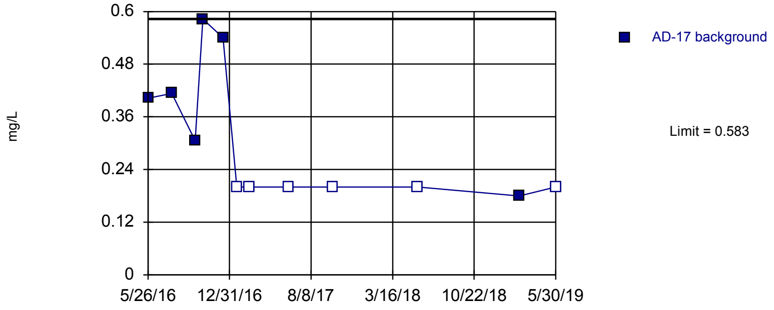
Constituent: Fluoride Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-17 (bg)



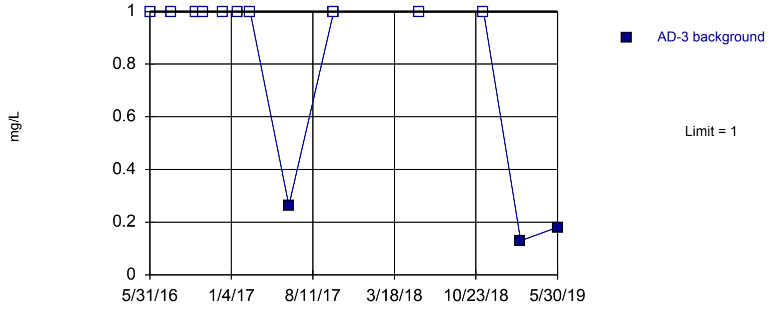
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. 50% NDs. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-3



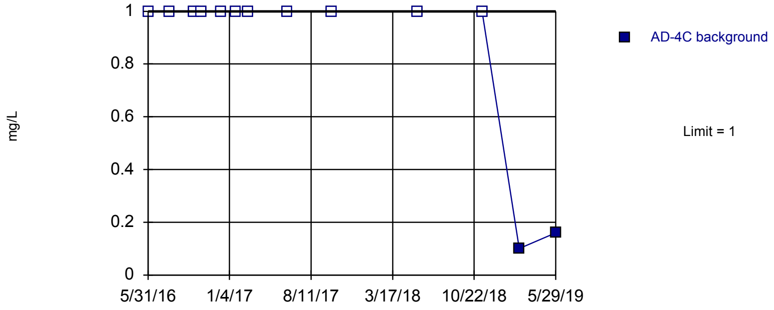
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 13 background values. 76.92% NDs. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-4C



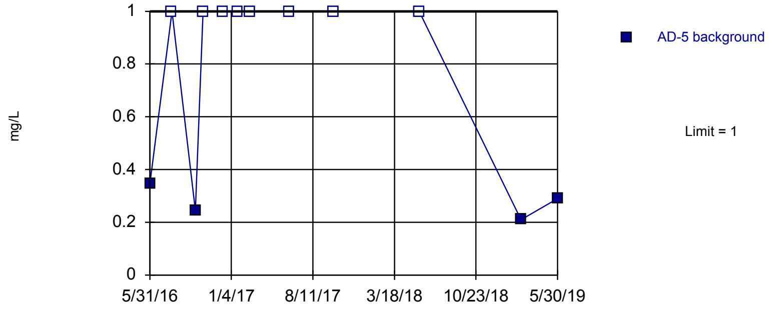
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 13 background values. 84.62% NDs. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-5 (bg)



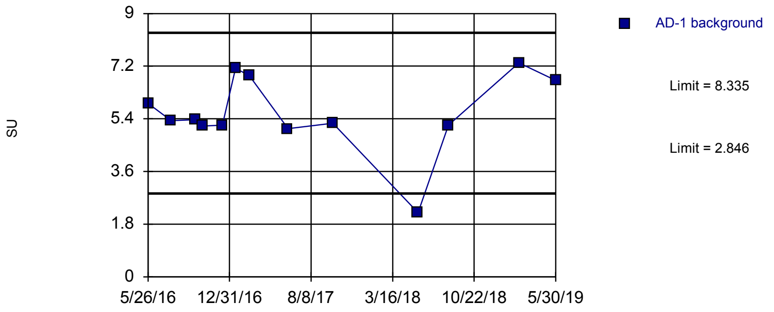
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 12 background values. 66.67% NDs. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



Background Data Summary: Mean=5.591, Std. Dev.=1.322, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8413, 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.

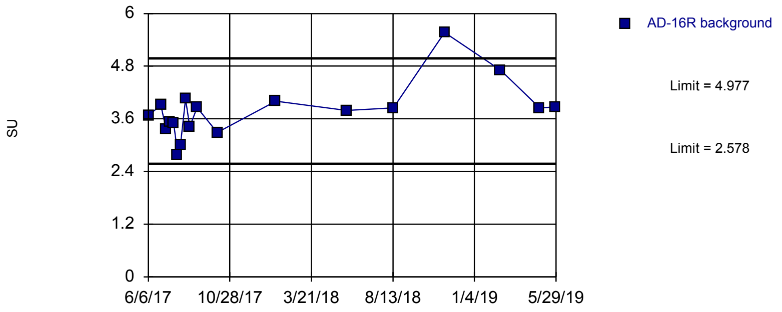
Constituent: pH, field Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



Background Data Summary: Mean=3.778, Std. Dev.=0.6212, n=18. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8834, critical = 0.858. Kappa = 1.931 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

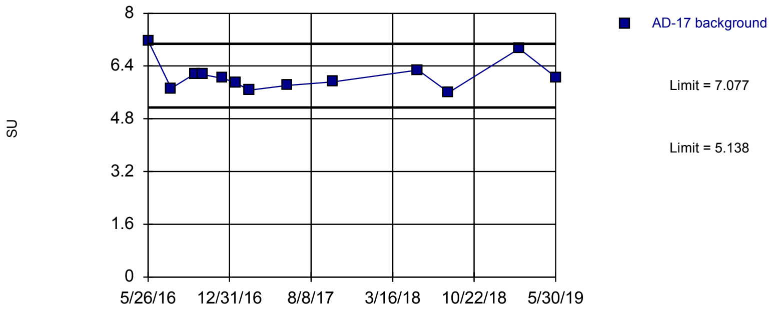
Constituent: pH, field Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



Background Data Summary: Mean=6.108, Std. Dev.=0.4667, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8501, 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.

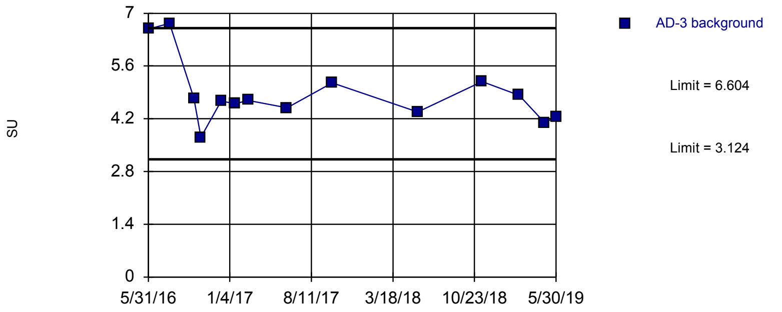
Constituent: pH, field Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



Background Data Summary: Mean=4.864, Std. Dev.=0.8526, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8501, critical = 0.825. Kappa = 2.041 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

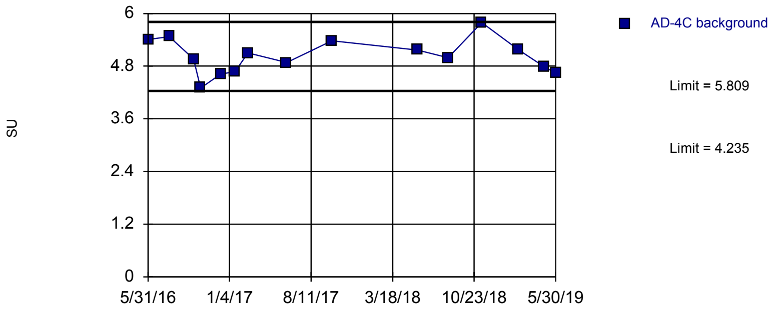
Constituent: pH, field Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



Background Data Summary: Mean=5.022, Std. Dev.=0.3924, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9865, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

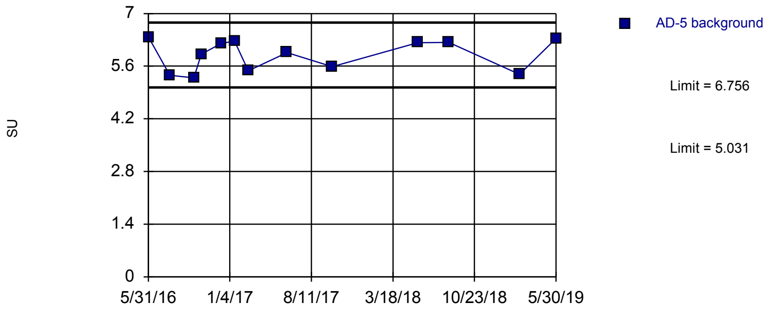
Constituent: pH, field Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



Background Data Summary: Mean=5.894, Std. Dev.=0.4153, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8601, 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.

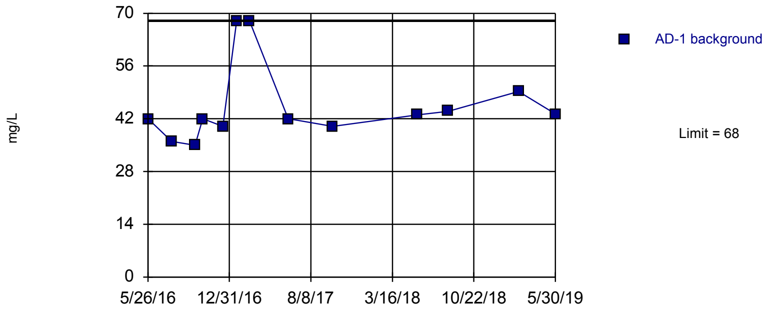
Constituent: pH, field Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



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 13 background values. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

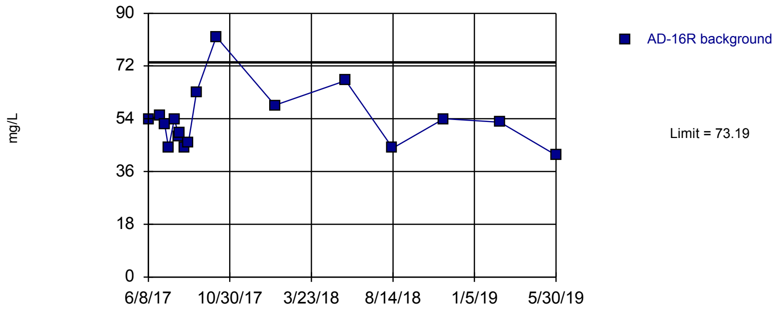
Constituent: Sulfate Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



Background Data Summary: Mean=53.47, Std. Dev.=10.11, n=17. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8735, critical = 0.851. Kappa = 1.951 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

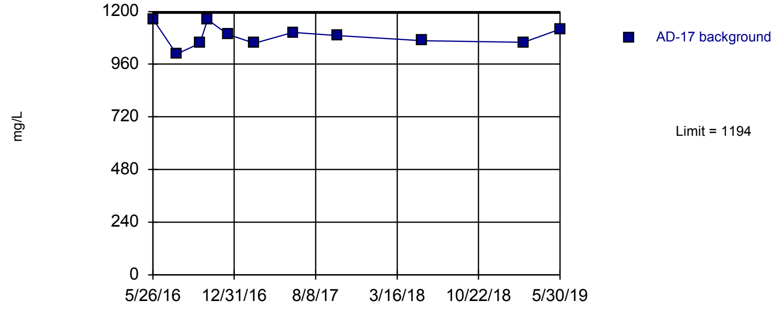
Constituent: Sulfate Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



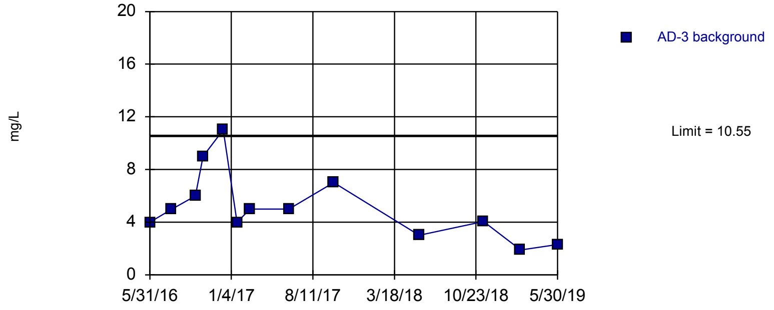
Background Data Summary: Mean=1089, Std. Dev.=48.34, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9517, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



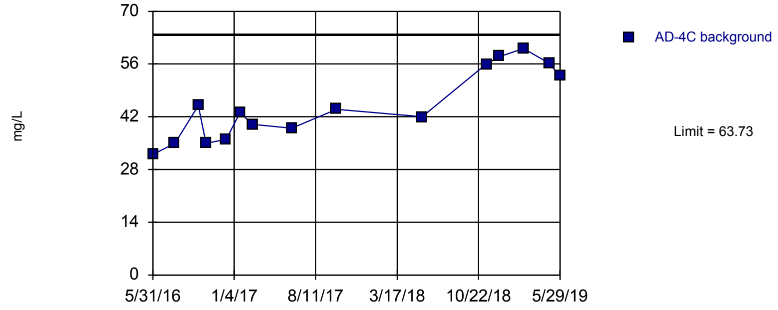
Background Data Summary: Mean=5.173, Std. Dev.=2.589, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9137, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



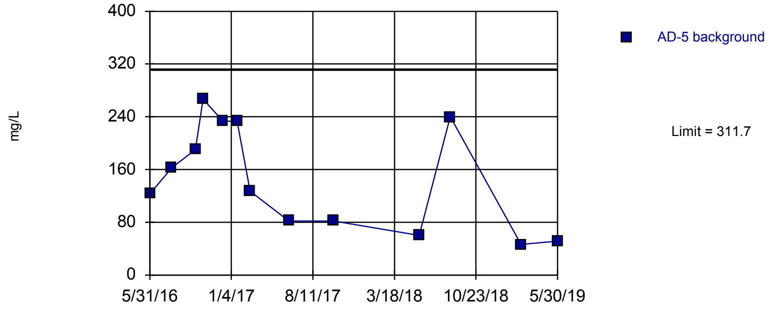
Background Data Summary: Mean=44.94, Std. Dev.=9.37, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9138, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



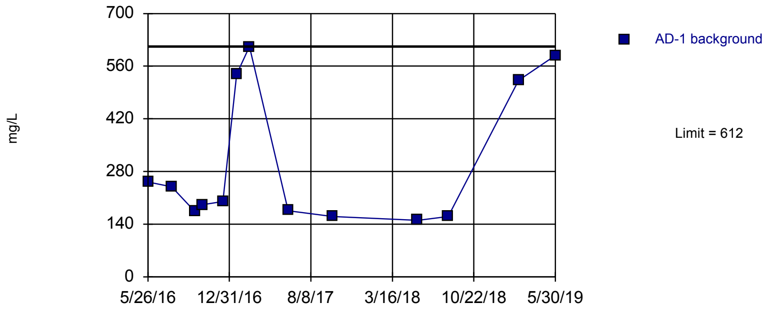
Background Data Summary: Mean=146.1, Std. Dev.=79.77, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9036, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



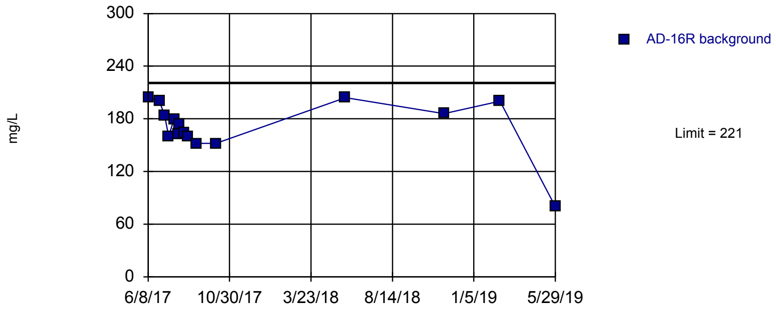
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 13 background values. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



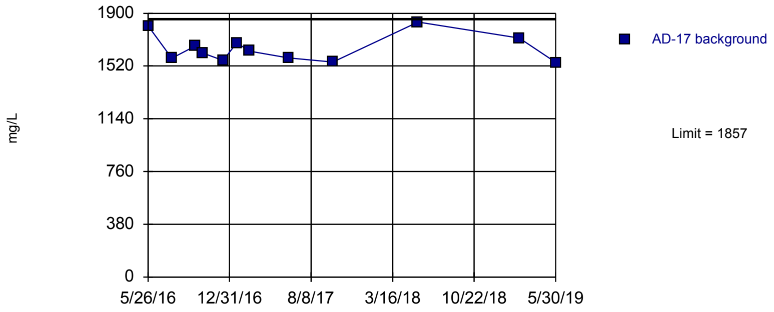
Background Data Summary (based on square transformation): Mean=30087, Std. Dev.=9358, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9045, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



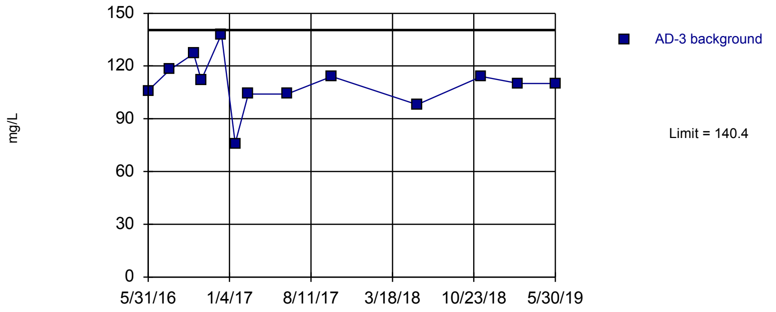
Background Data Summary: Mean=1647, Std. Dev.=99.38, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8827, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3

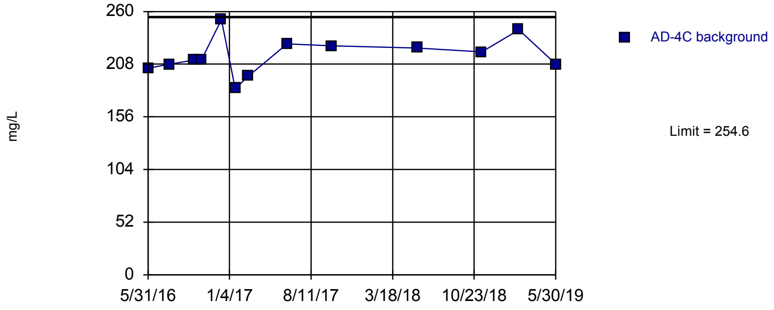


Background Data Summary: Mean=110.1, Std. Dev.=14.61, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9352, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:38 AM
Welsh BASP Client: Geosyntec Data: Welsh BASP

Prediction Limit

Intrawell Parametric, AD-4C



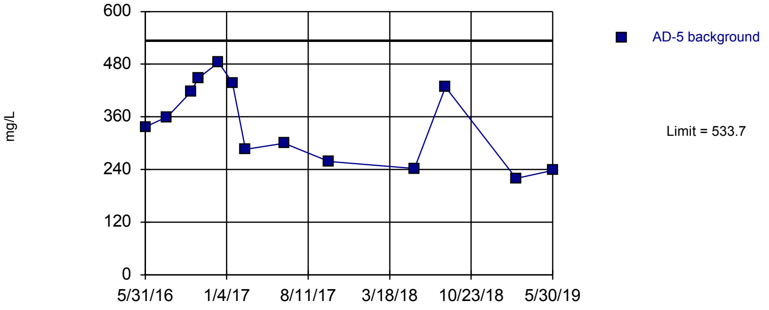
Background Data Summary: Mean=216.6, Std. Dev.=18.3, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9809, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

Prediction Limit

Intrawell Parametric, AD-5 (bg)



Background Data Summary: Mean=342.7, Std. Dev.=91.96, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9173, 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 Analysis Run 11/7/2019 10:38 AM

Welsh BASP Client: Geosyntec Data: Welsh BASP

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

J. Robert Welsh Plant
Pittsburg, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

94 Chatham Lane
Suite 103
Columbus, Ohio 43221

January 7, 2019

CHA8462

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
BASP	Bottom Ash Storage Pond
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LPL	Lower Prediction Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

Eight to ten background monitoring events were conducted at the Welsh Bottom Ash Storage Pond (BASP), 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. Prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is concluded only if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed. Following two detection monitoring events at the BASP, an SSI for chloride at well AD-4C was identified by intrawell analysis.

A summary of the detection monitoring analytical results and the calculated prediction limits to which they were compared is provided in Table 1.

1.1 CCR Rule Requirements

In accordance with the United States Environmental Protection Agency (USEPA) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments, Rule 40 CFR 257.94(e)(2) states the following:

> *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. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer verifying the accuracy of the information in the report.*

Two detection monitoring events were conducted on May 23-24, 2018 and August 14, 2018 at the Welsh BASP to identify SSIs over background limits. The CCR Rule allows the owner or operator 90 days from the determination of an SSI to demonstrate that the SSI resulted from a source other than the regulated CCR unit, such as an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

Pursuant to the Rule, Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report, which documents that the SSIs cited above should not be attributed to the Welsh BASP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which identified SSIs 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 increases in constituent concentrations were based on a Type IV cause and not by a release from the Welsh BASP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The CCR Rule allows the owner or operator 90 days from the determination of an SSI to demonstrate that a source other than the CCR unit caused the SSI. Identified SSIs, evaluation methodology, 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 did not identify ASDs due to Type I or Type II issues. A review of the statistical analyses did not identify any Type III issues. An initial review of site geochemistry revealed natural variation as a source of the observed chloride SSI at well AD-4C.

A site map showing well locations is presented in Figure 1. Groundwater flow beneath the BASP is typically to the southeast, as shown in Figure 2. Wells of interest to this ASD include AD-1, which lies upgradient of the BASP and downgradient wells AD-3 and AD-4C.

Figure 3 summarizes groundwater composition at the wells of interest using a Schoeller diagram. The Schoeller diagram shows that downgradient wells AD-4C and AD-3 are deficient in calcium, magnesium and bicarbonate (collectively known as hardness species), relative to AD-1. Contrary to the hardness species, the concentrations of sodium and chloride are identical between AD-1 and AD-4C. During two sampling events AD-1 groundwater is in equilibrium with calcite, a major mineral in limestone, whereas both AD-3 and AD-4C are significantly undersaturated based on the calculated saturation indices (Table 2). Both AD-3 and AD-4C strongly resemble storm water due to the near absence of calcium and magnesium (both were less than 1 mg/L during the sampling event).

AD-4C could be susceptible to surface water or rainwater intrusion due to its shallow construction. The filter pack extends to four feet below ground surface (ft bgs) and the screened interval is from 5-15 ft bgs (Arcadis, 2018). Figure 4 shows an inverse relationship between groundwater elevation and chloride concentration over time. These results suggest that as groundwater rises, likely due to infiltration from surface water, the chloride concentration in the groundwater is diluted. The groundwater elevation at AD-4C appears to be trending downwards since January 2017, with an increasing trend for chloride observed. Despite recent increases, the concentrations remain consistent with historical values at the well.

The second semi-annual detection monitoring event for 2018 was completed in November 2018, with a reported chloride concentration of 7.5 milligrams per liter (mg/L), which is below the UPL of 14 mg/L. The decline in chloride concentrations at AD-4C suggest that the SSI was due to a temporary variation in groundwater conditions and is an additional line of evidence that the chloride SSI should not be attributed to a release from the BASP.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSIs are not due to a release from the Welsh BASP, the unit will remain in the detection monitoring program. Groundwater at the unit will be sampled for Appendix III parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.94(e)(2) and supports the position that the SSIs in Appendix III detection monitoring constituents are not due to a release from the Welsh BASP during the May and August 2018 sampling events. The identified SSI for chloride at well AD-4C was attributed to natural variation, and concentrations have since declined below the upper prediction limit. Therefore, no further action is warranted and the Welsh BASP will remain in the detection monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment A.

SECTION 4

REFERENCES

Arcadis, 2018. Bottom Ash Storage Pond – CCR Groundwater Monitoring Well Network Evaluation. February 2018.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October

U.S. EPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (Final Rule). Fed. Reg. 80 FR 21301, pp. 21301-21501, 40 CFR Parts 257 and 261, April.

TABLES

Table 1: Detection Monitoring Data Evaluation
Welsh Plant - Bottom Ash Storage Pond

Parameter	**Units**	**Description**	AD-3	AD-4C		AD-16R	
			5/24/2018	5/24/2018	8/14/2018	5/23/2018	8/14/2018
Boron	mg/L	Intrawell Background Value (UPL)	0.0333	0.0571		0.0700	
		Detection Monitoring Data	0.0069 J	0.0251	--	0.0320	--
Calcium	mg/L	Intrawell Background Value (UPL)	1.541	0.962		3.069	
		Detection Monitoring Data	0.545	0.434	--	2.53	--
Chloride	mg/L	Intrawell Background Value (UPL)	9	12.6		8.3	
		Detection Monitoring Data	8	**14**	**15**	6	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1	1		1	
		Detection Monitoring Data	<0.083	<0.083	--	<0.083	--
pH	SU	Intrawell Background Value (UPL)	7.63	5.91		4.4	
		Intrawell Background Value (LPL)	2.43	3.95		2.61	
		Detection Monitoring Data	4.38	5.17	--	3.79	--
Sulfate	mg/L	Intrawell Background Value (UPL)	12.4	49.0		64.1	
		Detection Monitoring Data	3	42	--	**67**	44
TDS	mg/L	Intrawell Background Value (UPL)	156	263		214	
		Detection Monitoring Data	98	224	--	204	--

Notes

UPL: Upper prediction limit

LPL: Lower prediction limit

TDS: Total dissolved solids

J: Estimated value

<: Indicates the parameter was not detected

Bold values exceed the background value.

Background values are shaded gray.

--: sample was not collected

Table 2: Calculated Calcite Saturation Indices
Welsh Bottom Ash Storage Pond

Well ID	Date	Calcite ($CaCO_3$) Saturation Index
AD-1	10/21/2016	-3.12
	01/20/2017	0.22
	02/24/2017	0.19
	06/08/2017	-3.48
AD-3	10/21/2016	-6.37
	01/20/2017	-6.04
	02/24/2017	-6.04
	06/08/2017	-6.15
AD-4	10/21/2016	-5.97
	01/20/2017	-5.82
	02/24/2017	-5.73
	06/08/2017	-5.77

Notes:

Calculated SIs greater than -0.2 suggest saturation of the mineral and are shaded red in red text.

FIGURES

Monitoring Well Network

⊕ Downgradient Sampling Location
⊕ Background Sampling Location

▭ Bottom Ash Storage Pond

Notes
- Monitoring well coordinates provided by AEP.
- Site features based on information avilable in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).

500 250 0 500
Feet

Site Layout
Bottom Ash Storage Pond

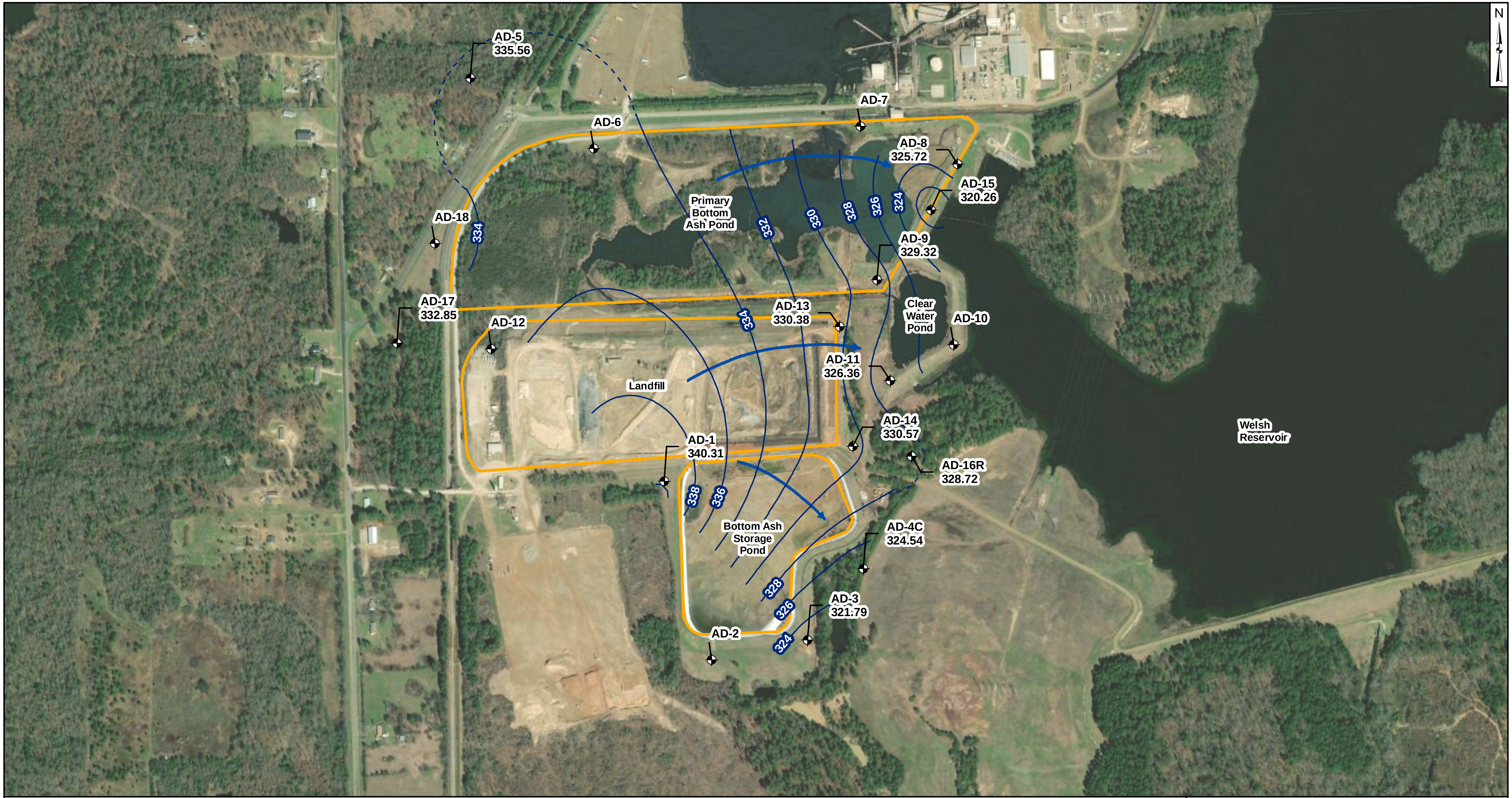
AEP Welsh Power Plant
Cason, Texas

Geosyntec consultants

Columbus, Ohio
2018/01/26

Figure
1

C:\Users\mmuenich\Documents\local_projects\AEP_GIS\Welsh\MXDs\AEP-Welsh_BASP_Site_Layout.mxd. MMuenich. 1/26/2018. CHA8423/14/08.



Legend

- ⊕ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - - Inferred Groundwater Elevation Contour
- ▭ CCR Units

Notes

- Monitoring well coordinates and water level data (collected on May 23, 2018) provided by AEP.
- Site features based on information avilable in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- Inferred groundwater contours were extrapolated from topgraphic and hydrographic information as well as previous monitoring events.
- AD-16 was replaced with AD-16R on 4/12/2017.
- Wells AD-2, -6, -7, -10 ,-12, and -18 were not gauged during the May 2018 sampling event.

750 375 0 750
Feet

Groundwater Potentiometric Map
May 2018

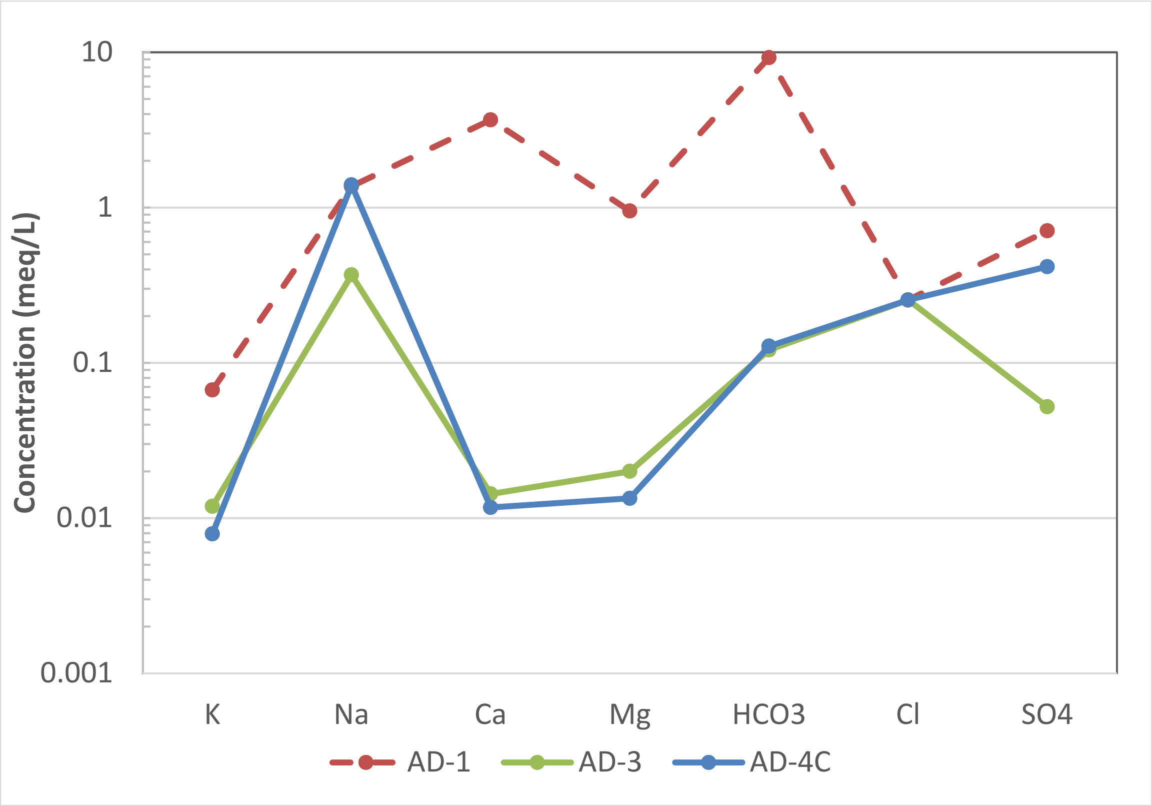
AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2018/10/24

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2018\AEP-Welsh_GW_2018-05May.mxd. SKaroly. 10/24/2018. CHA8423/14/08.



Notes: Schoeller diagram for BASP upgradient well AD-1 and downgradient wells based on February 24, 2017 groundwater sampling event.

Schoeller Diagram

Welsh Bottom Ash Storage Pond

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure 3

Columbus, Ohio

4-JAN-2019

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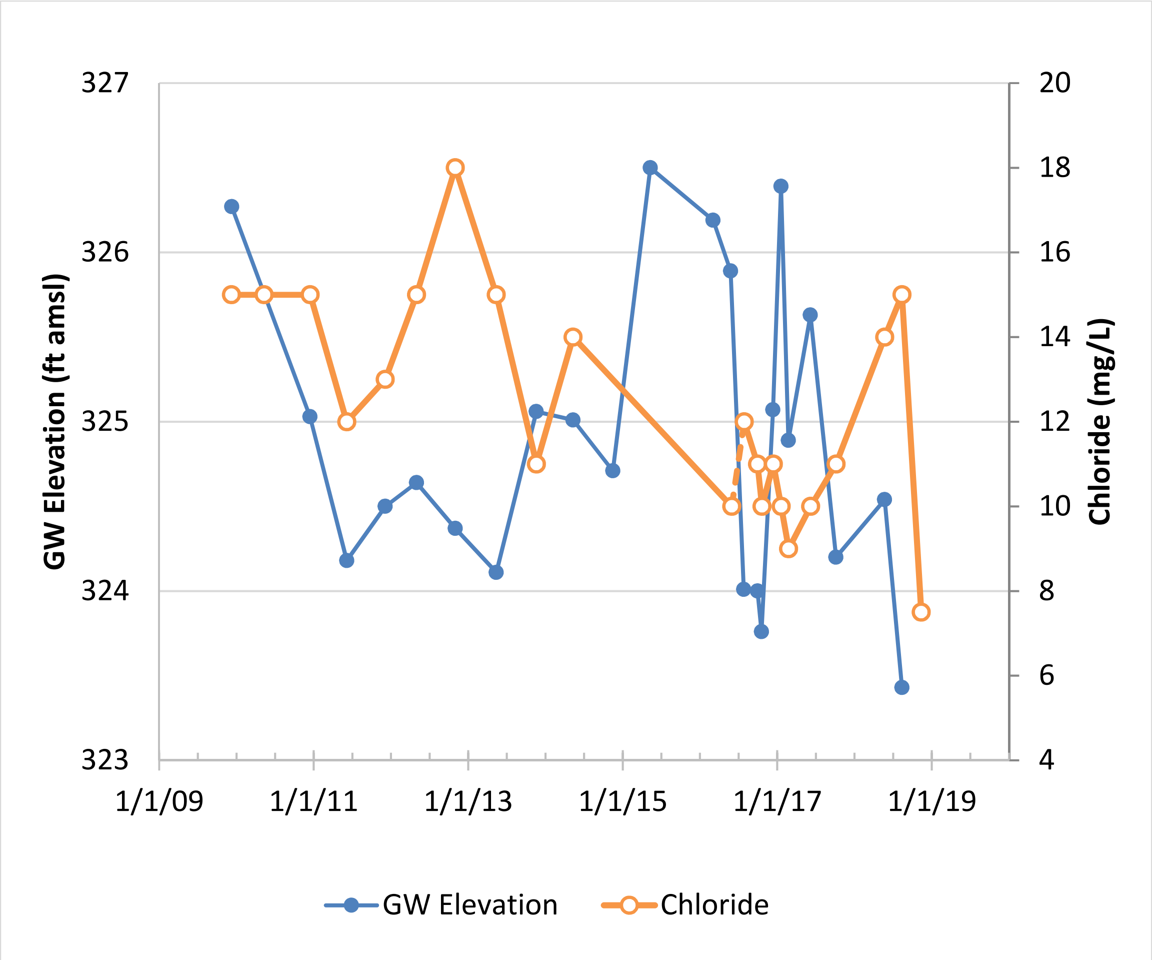

Notes: Chloride data includes both historic data and data collected for CCR Rule compliance.

AD-4C Time Series Graph

Welsh Bottom Ash Storage Pond

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AMERICAN ELECTRIC POWER

Figure

4

Columbus, Ohio

4-JAN-2019

ATTACHMENT A

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 Welsh Bottom Ash Storage Pond CCR management area and that the requirements of 40 CFR 257.94(e)(2) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

01.07.19
Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

J. Robert Welsh Plant
Bottom Ash Storage Pond
Pittsburg, 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

May 17, 2019

CHA8462

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
BASP	Bottom Ash Storage Pond
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LPL	Lower Prediction Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

Eight to ten background monitoring events were conducted at the Welsh Bottom Ash Storage Pond (BASP). 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. Prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is concluded only if both samples in a series of two exceeds the UPL and for pH exceeds the LPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

The second semi-annual detection monitoring event was performed in November 2018 (initial sampling event) and December 2018 (re-sampling event), and the results were compared to the calculated prediction limits. An SSI was identified for sulfate at well AD-4C by intrawell analysis. A summary of the detection monitoring analytical results and the calculated prediction limits to which they were compared is provided in Table 1.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations 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. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer… verifying the accuracy of the information in the report.*

Sulfate concentrations of 56 mg/L and 58 mg/L were reported for the sampling and re-sampling events on November 13, 2018 and December 18, 2018, respectively. Both concentrations exceeded the UPL value for sulfate of 49 mg/L. 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 that the SSI for sulfate at AD-4C should not be attributed to the Welsh BASP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSI 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 increases in constituent concentrations were based on either a Type IV or Type V cause and not by a release from the Welsh BASP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The method used to assess possible alternative sources of the SSI for sulfate at AD-4C and the proposed alternative source are described below. In addition, the statistical revision of the background concentration for sulfate at AD-4C and the future sampling requirements for the Welsh BASP are presented.

2.1 Proposed Alternative Source

An initial review of field forms, site geochemistry, and laboratory QA/QC data did not identify alternative sources due to Type I or Type II issues. A review of the statistical analyses of the groundwater data for sulfate did not identify any Type III issues. However, a review of site geochemistry and historic operations revealed a change in chemistry at an upgradient well, due to either Type IV or Type V causes, as a potential source of the observed sulfate SSI at well AD-4C.

A site map showing the location of AD-4C and other network well locations is presented in Figure 1. Groundwater flow beneath the BASP is typically toward the southeast, as shown in Figure 2. The monitoring network includes background locations AD-1, AD-5, and AD-17 and compliance wells AD-3, AD-4C, and AD-16R.

The two exceedances for sulfate at AD-4C in November and December 2018 are shown in a time-series graph (Figure 3), where the dashed line represents the intrawell UPL for sulfate (49 mg/L). Overall, the concentration of sulfate appears to be increasing. Also shown are the sulfate concentrations at background well AD-1, which is the background well closest to AD-4C. The sulfate concentrations at AD-1 are commensurate with those of AD-4C in eight of the ten background monitoring events. In January and February 2017, sulfate at AD-1 was 68 mg/L, which was considerably higher than the other eight results for AD-1 as well as the results for AD-4C.

A Schoeller diagram was prepared for AD-1 to illustrate major constituent behavior for the four background sampling events where all data were available (Figure 4). Note that concentration units were converted to milli-equivalents per liter (meq/L), which allows the major cations and anions to be compared on a charge-equivalent basis. The rule of charge balance also requires that the sum of the major cations (potassium + sodium + calcium + magnesium) must be equal to the sum of the major anions (chloride + sulfate + bicarbonate + carbonate [if pH > 10]), when expressed in meq/L units. Calcium, magnesium and bicarbonate (collectively known as hardness species) were up to an order of magnitude higher in January and February 2017 compared to October 2016 and June 2017. In contrast, the concentration of sulfate increased approximately 50%, while sodium and chloride changed very little. Thus, while the sulfate concentration changed during these events, the magnitude of change in its concentration was much smaller than the charge in hardness species during the same time period.

A geochemical model (PHREEQC) was used to help explain the significance of species concentrations with respect to equilibrium with aquifer minerals. Calculated mineral saturation indices for calcite and gypsum for background well AD-1 and compliance wells AD-3 and AD-4C, which are located downgradient of AD-1, are presented in Table 2. Mineral saturation indices with a numerical value of zero (±0.2) indicate that the represented minerals are in equilibrium with the groundwater. Values less than -0.2 indicate undersaturation, implying that the represented minerals are not present in the aquifer. Model results show that AD-1 groundwater was in equilibrium with the mineral calcite ($CaCO_3$) during January and February 2017. However, the groundwater was undersaturated with respect to both calcite and gypsum in the October 2016 and June 2017 events. All AD-3 and AD-4C samples were significantly undersaturated with respect to calcite, as indicated by the large negative values in Table 2. Modeling results indicate that groundwater in wells AD-1, AD-3 and AD-4C is undersaturated with respect to gypsum ($CaSO_4 \cdot 2H_2O$) at all sampling events. Calcite crystals are known to precipitate and dissolve quickly as groundwater conditions either become conducive to calcite formation or disfavor it (Sanjuan and Girard, 1996). However, it is infeasible for the mineralogy of an entire aquifer to change in a matter of months. Therefore, the model results suggest that calcite is typically not present in the aquifer. The situation at AD-1, where the groundwater became saturated with respect to calcite in January and February 2017, appears to be transient and caused by a rapid increase in calcium and alkalinity, along with other subtle changes in composition (Figure 4). At other times (e.g., October 2016 and June 2017) the unidentified source of calcium and alkalinity is not active, and groundwater no longer appears to be in equilibrium with calcite.

Concentrations of sulfate at upgradient well AD-1 have been even higher in the past than the values observed in 2017 during the CCR Rule background monitoring period. Prior to establishing the groundwater monitoring network for the BASP, the Plant monitored wells AD-1 and AD-4C for sulfate and other groundwater constituents. Sulfate concentrations at AD-4C were typically around 25-30 mg/L between 2009 and 2014, which is lower than the concentrations observed during the background monitoring period (35-45 mg/L, as shown in Figure 3). Prior to 2009, sulfate concentrations at AD-1 were generally much higher and subject to significant upward swings, including a peak value of 616 mg/L sulfate on in June 2007 (Figure 5).

Sulfate concentrations are also high at other locations across the Site. Upgradient well AD-17, which is located further northwest from the BASP than AD-1, had sulfate concentrations above 1,000 mg/L for the entire background monitoring period (Figure 6). Groundwater samples collected from borings advanced in 2009 approximately 0.5 miles to the north of the BASP to evaluate background conditions identified a maximum sulfate concentration of 156 mg/L (Geosyntec, 2009). These results suggest either sulfate is naturally highly variable or groundwater concentrations are fluctuating in response to a variety of possible sources (such as site activities) across the site.

While the source of upgradient impacts to AD-1, and thus the increase in sulfate at AD-4C cannot be identified, it does not appear to be caused by a release from the pond. No other Appendix III species have a similar increase, which would be expected if there was a release (Figure 7). This includes several species which are more conservative than sulfate and have relatively higher concentrations in the pond water than in groundwater, such as potassium and sodium (Figure 8), suggesting that no mixing is occurring between the pond water and groundwater at AD-4C.

The recent SSI for sulfate at AD-4C is best attributed to variations in the groundwater chemistry that are observed at multiple locations. The source of the perturbations in groundwater is not known and could include either natural variability or plant activities, such as site construction or pond management, which could affect groundwater quality. Additionally, the lack of increase in other constituent concentrations suggests that the sulfate SSI should not be attributed to a release from the BASP.

2.2 Statistical Revision

When historical data is included with results collected under the CCR Rule, an upward trend is observed for sulfate at AD-4C (Figure 9). This trend may be representative of higher sulfate concentrations observed across the site, including at upgradient locations AD-1 and AD-17. As the increase in sulfate does not appear to be related to a release from the BASP, the background dataset was revised to include the four most recent sampling events (October 2017, 44 mg/L; May 2018, 42 mg/L; November 2018, 56 mg/L; December 2018, 58 mg/L). The intrawell UPL at AD-4C for sulfate was recalculated as 59.1 mg/L. This value will be used in detection monitoring events going forward until the background dataset is revised following the collection of at least four additional samples. The revised statistics are provided in Attachment A.

2.3 Sampling Requirements

As the ASD described above supports the position that the identified SSIs are not due to a release from the Welsh BASP, the unit will remain in the detection monitoring program. Groundwater at the unit will be sampled for Appendix III parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.94(e)(2) and supports the position that the SSIs in Appendix III detection monitoring constituents are not due to a release from the Welsh BASP during the November and December 2018 sampling events. The identified SSI for sulfate at well AD-4C was attributed to either natural variation or anthropogenic impacts, which may be related to the sulfate perturbation that was detected at AD-1. Therefore, no further action is warranted, and the Welsh BASP will remain in the detection monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

REFERENCES

Arcadis, 2018. Bottom Ash Storage Pond – CCR Groundwater Monitoring Well Network Evaluation. February.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.

Geosyntec, 2009. Geology and Hydrogeology Report for Proposed Metal Cleaning Waste Pond. October.

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Sanjuan B. and Girard J.P., 1996. Review of Kinetic Data on Carbonate Mineral Precipitation. BRGM Report R39062, 91 p.

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TABLES

Table 1: Detection Monitoring Data Evaluation
Welsh Plant - Bottom Ash Storage Pond

Parameter	Units	Description	AD-3		AD-4C		AD-16R	
			11/13/2018	12/18/2018	11/13/2018	12/18/2018	11/13/2018	1/11/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.033		0.057		0.070	
		Detection Monitoring Result	0.009	-	0.01	-	0.02	-
Calcium	mg/L	Intrawell Background Value (UPL)	1.54		0.962		3.07	
		Detection Monitoring Result	0.684	-	0.609	-	0.467	-
Chloride	mg/L	Intrawell Background Value (UPL)	9.0		12.6		8.3	
		Detection Monitoring Result	8	-	7.5	-	6.5	-
Fluoride	mg/L	Intrawell Background Value (UPL)	1		1		1	
		Detection Monitoring Result	<0.083	-	<0.083	-	<0.083	-
pH	SU	Intrawell Background Value (UPL)	7.63		5.91		4.40	
		Intrawell Background Value (LPL)	2.43		3.95		2.61	
		Detection Monitoring Result	5.19	-	5.79	-	**5.57**	2.66
Sulfate	mg/L	Intrawell Background Value (UPL)	12.4		49.0		64.1	
		Detection Monitoring Result	4.05	-	**56**	**58**	54	-
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	156		263		214	
		Detection Monitoring Result	114	-	220	-	186	-

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

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 calculated background

Table 2: Calculated Mineral Saturation Indices
Welsh Bottom Ash Storage Pond

Well ID	Sampling Date	Calcite	Gypsum
AD-1	1/20/2017	0.2	-1.6
	2/24/2017	0.2	-1.6
	6/8/2017	-3.5	-2.4
	10/21/2016	-3.1	-2.4
AD-3	1/20/2017	-6.0	-4.6
	2/24/2017	-6.0	-4.6
	6/8/2017	-6.2	-4.7
	10/21/2016	-6.4	-4.3
AD-4C	1/20/2017	-5.8	-3.7
	2/24/2017	-5.7	-3.9
	6/8/2017	-5.8	-3.8
	10/21/2016	-6.0	-3.9

Note:
Values between -0.2 and 0.2 indicate the mineral is in equilibrium with groundwater.
Results with values indicating equilibrium are highlighted in red.

FIGURES

Monitoring Well Network

- ⊕ Downgradient Sampling Location
- ⊕ Background Sampling Location

▭ Bottom Ash Storage Pond

Notes
- Monitoring well coordinates provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluation (Arcadis, 2016).

500 250 0 500
Feet

Site Layout
Bottom Ash Storage Pond

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Columbus, Ohio
2018/01/26

Figure
1

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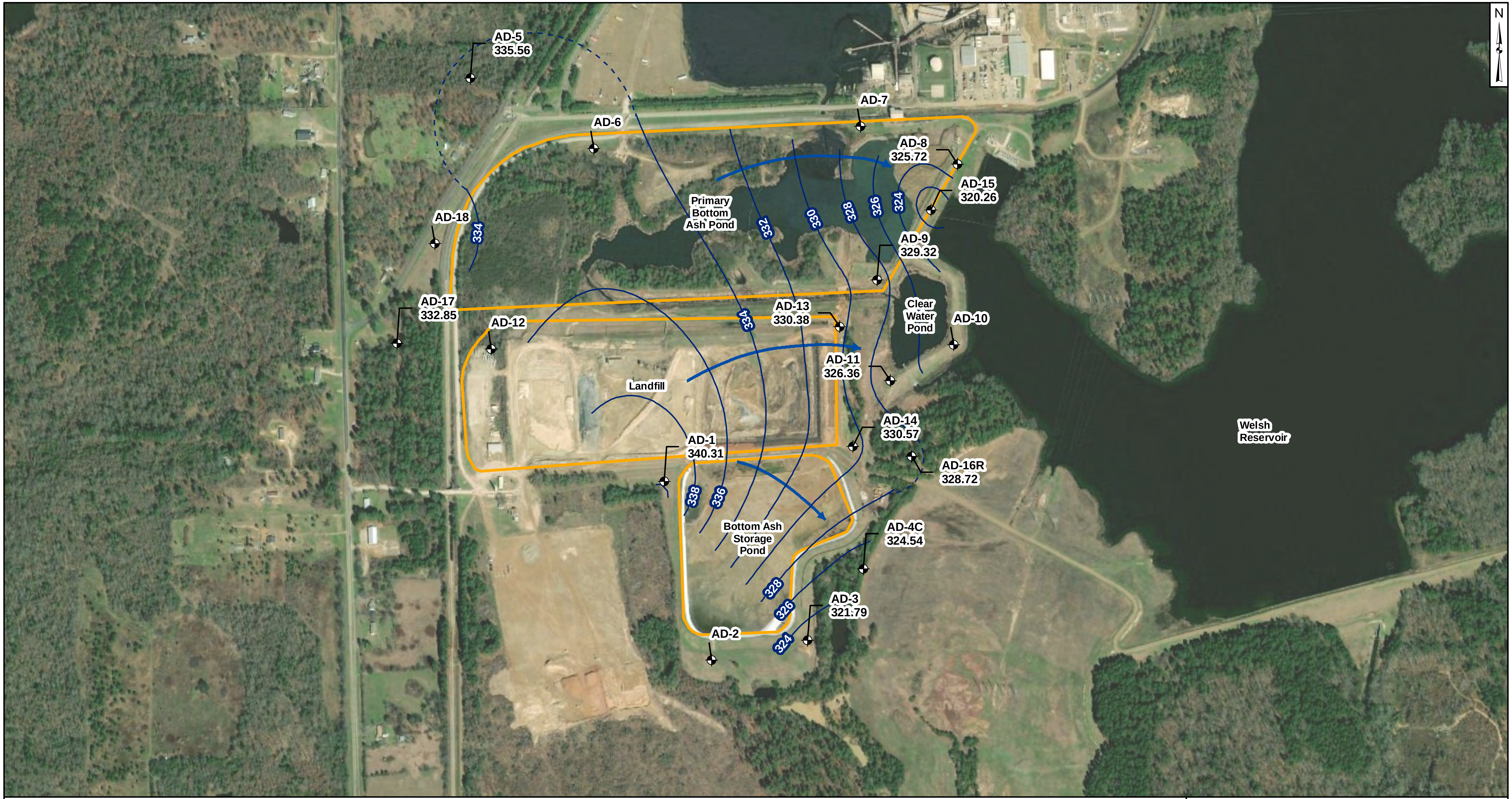

Legend

- Groundwater Monitoring Well
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- CCR Units

Notes

- Monitoring well coordinates and water level data (collected on May 23, 2018) provided by AEP.
- Site features based on information avilable in CCR Groundwater Monitoring Well Network Evaluation (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- Inferred groundwater contours were extrapolated from topographic and hydrographic information as well as previous monitoring events.
- AD-16 was replaced with AD-16R on 4/12/2017.
- Wells AD-2, -6, -7, -10 ,-12, and -18 were not gauged during the May 2018 sampling event.

750 375 0 750
Feet

Groundwater Potentiometric Map
May 2018

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2018/10/24

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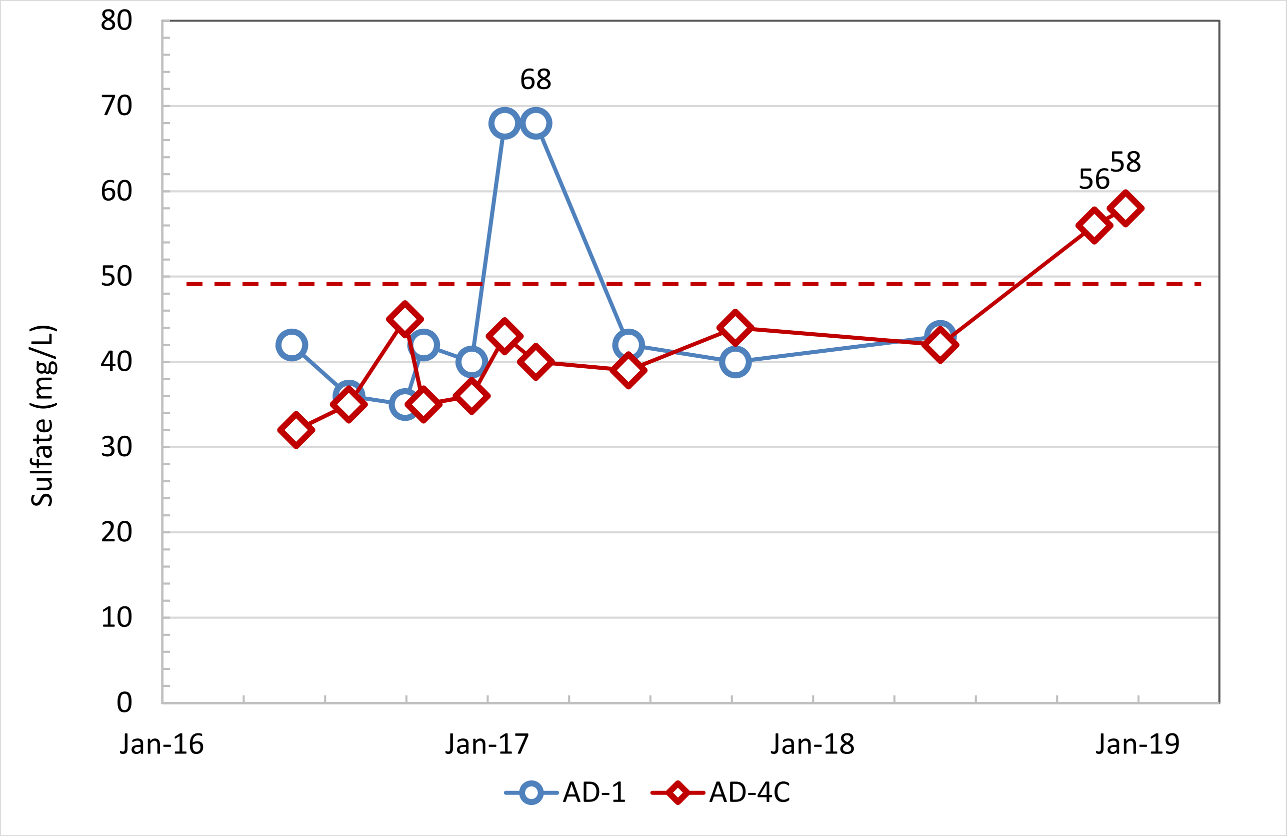

Notes: Sulfate time series diagram for BASP upgradient well AD-1 and downgradient well AD-4C under the CCR Rule program. The dashed line represents the intrawell UPL for sulfate at AD-4C (49 mg/L).

Sulfate Time Series Graph

Welsh Bottom Ash Storage Pond

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Figure

3

Columbus, Ohio

14-FEB-2019

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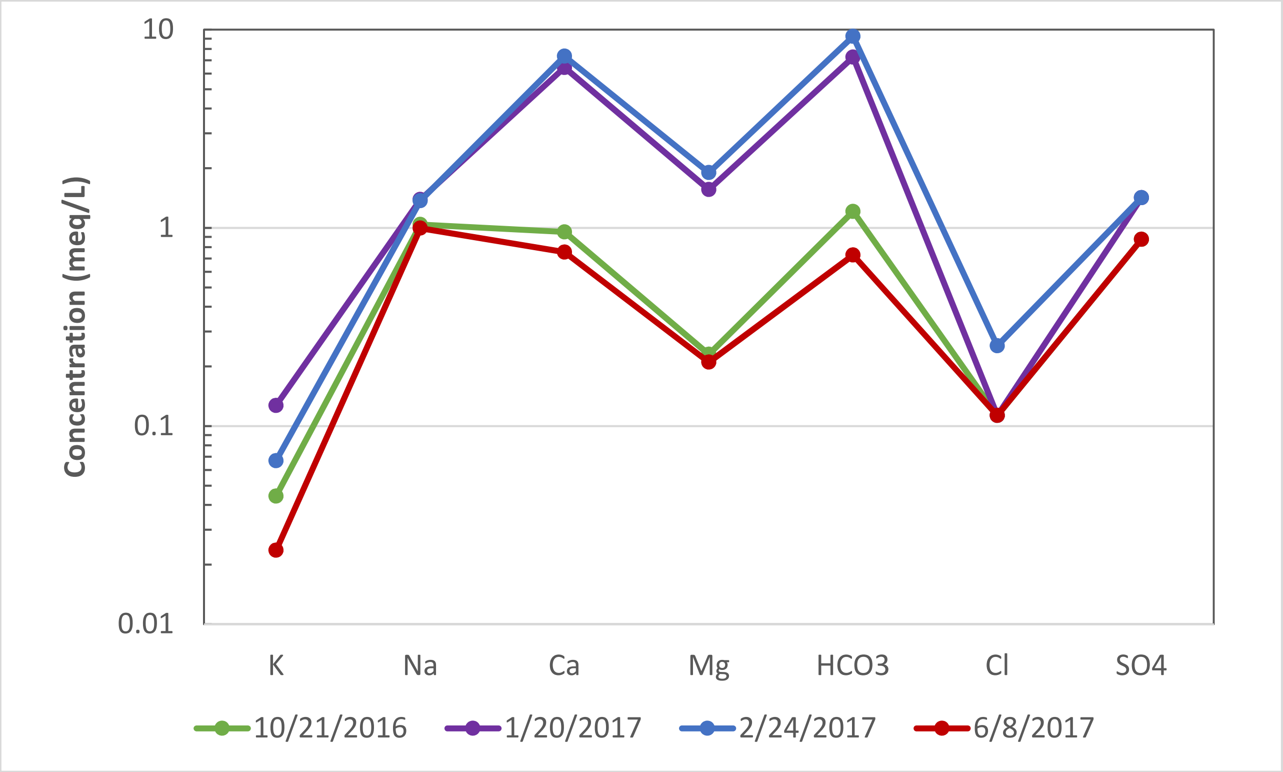

Notes: Schoeller diagram for BASP upgradient well AD-1 for four groundwater sampling events where data for all major constituents was available.

AD-1 Schoeller Diagram

Welsh Bottom Ash Storage Pond

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure

4

Columbus, Ohio

4-JAN-2019

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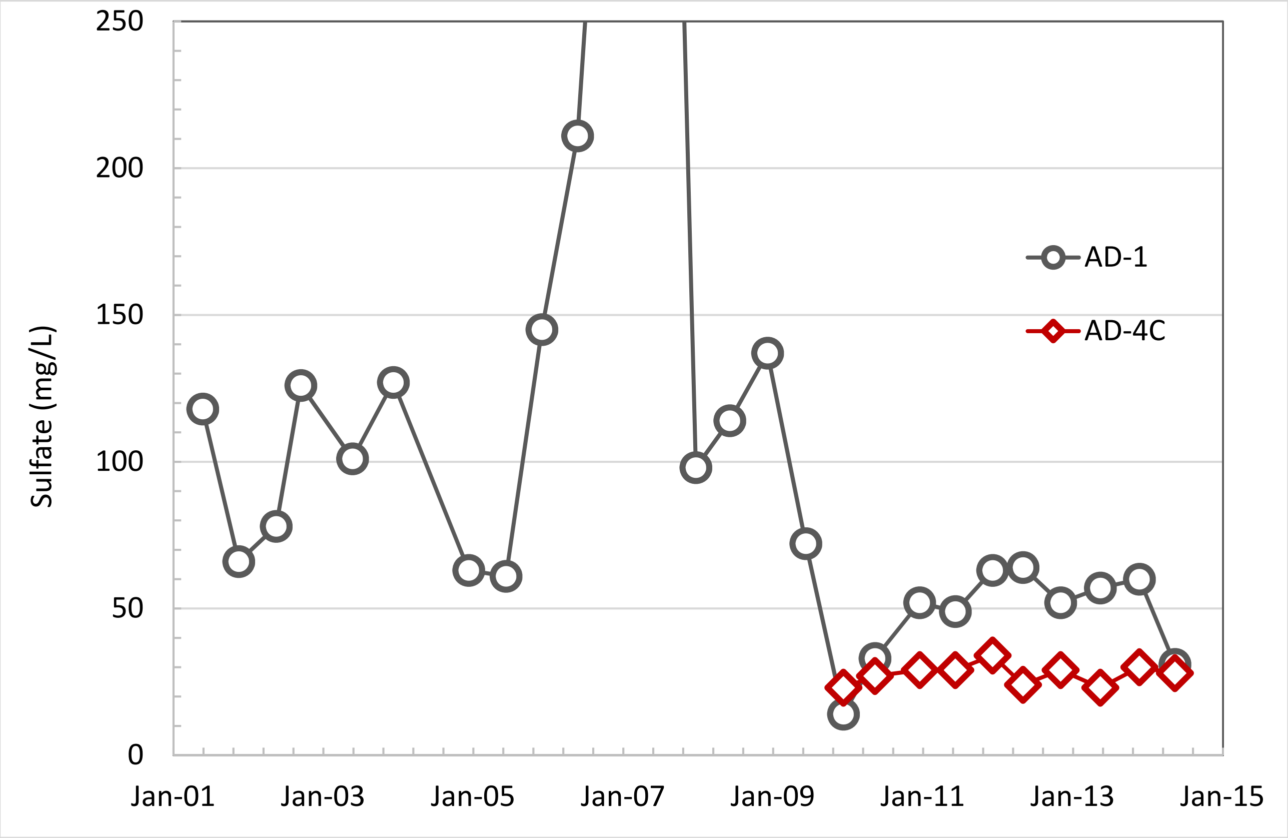

Notes: Concentrations of sulfate at AD-1 and AD-4C, based on samples that were collected for compliance with state regulations. Sulfate at AD-1 (off scale) was 616 mg/L on 6/13/2007.

Historical Sulfate Concentrations
Welsh Bottom Ash Storage Pond

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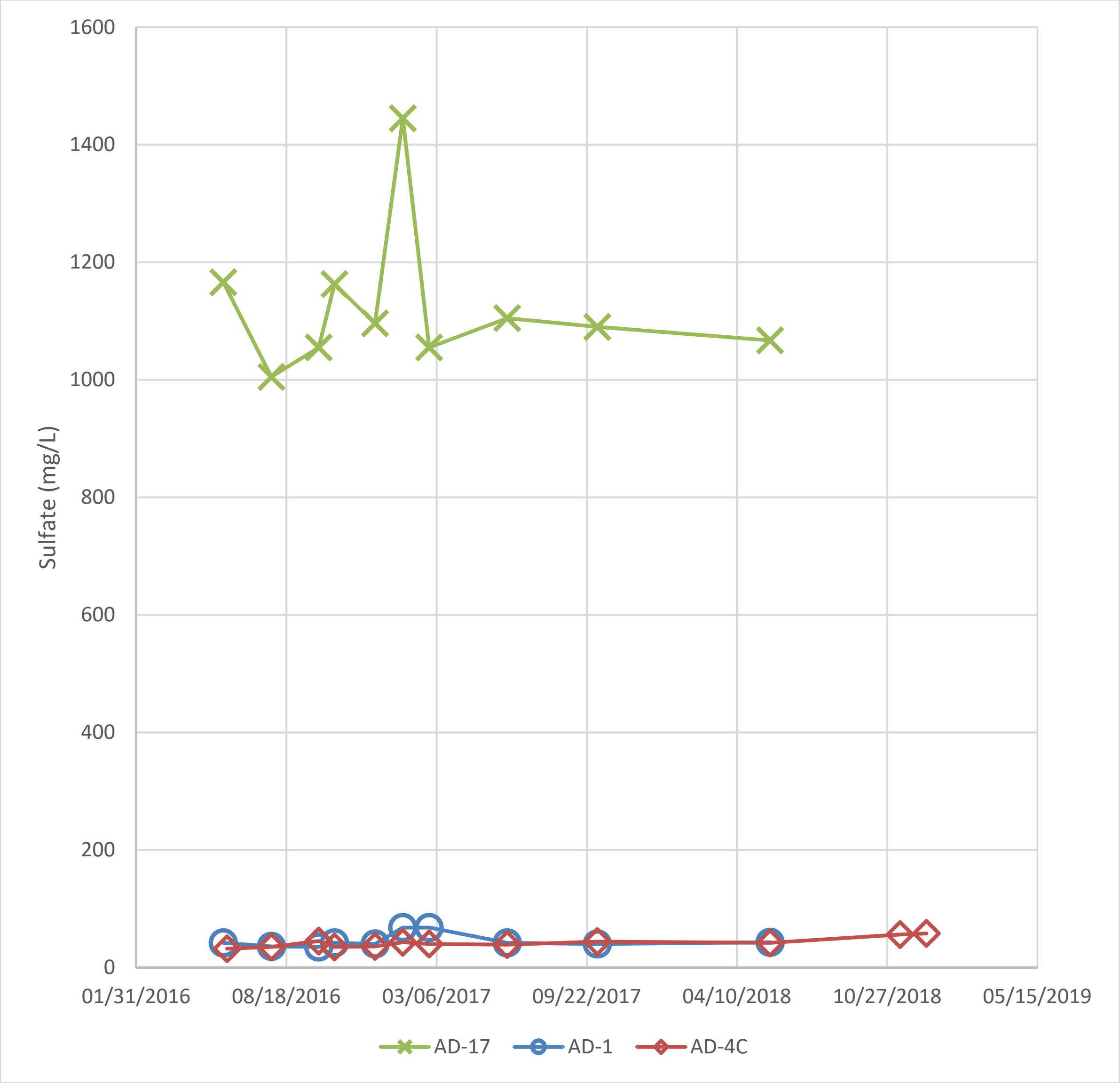
Figure
5

Columbus, Ohio

4-JAN-2019



Notes: Data were collected as part of the background monitoring period for the Federal CCR Rule.

AD-17 Sulfate Time Series Graph

Welsh Bottom Ash Storage Pond

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Figure

6

Columbus, Ohio

08-Apr-2019

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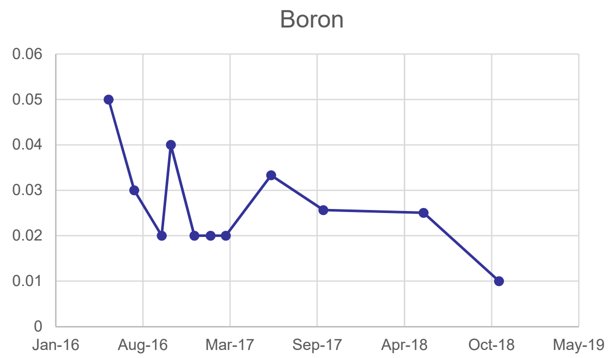
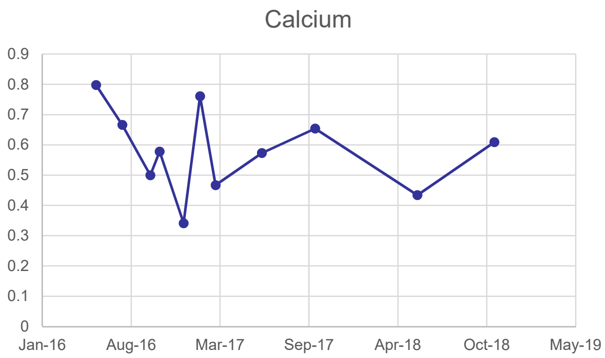
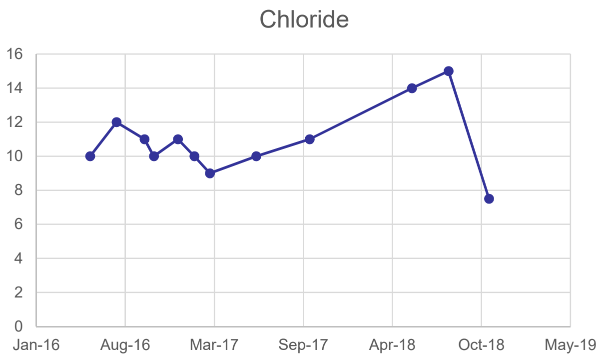
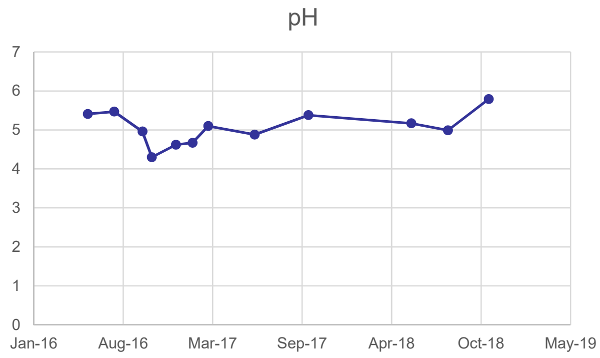
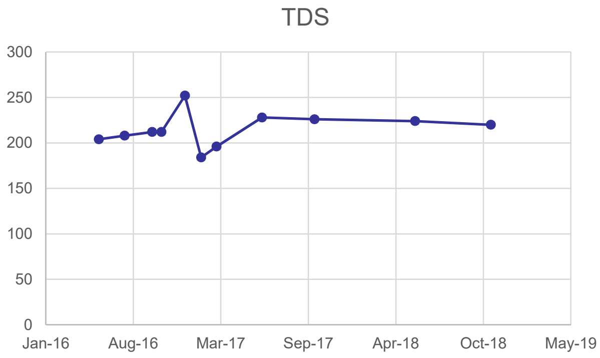
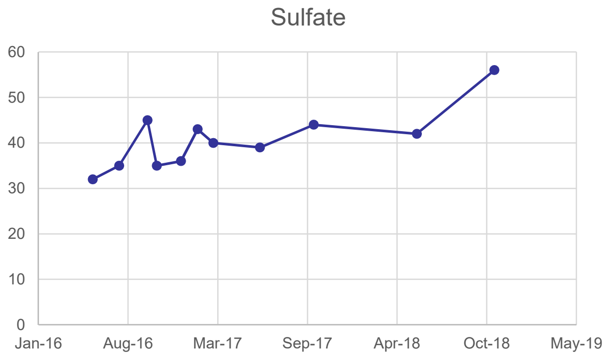












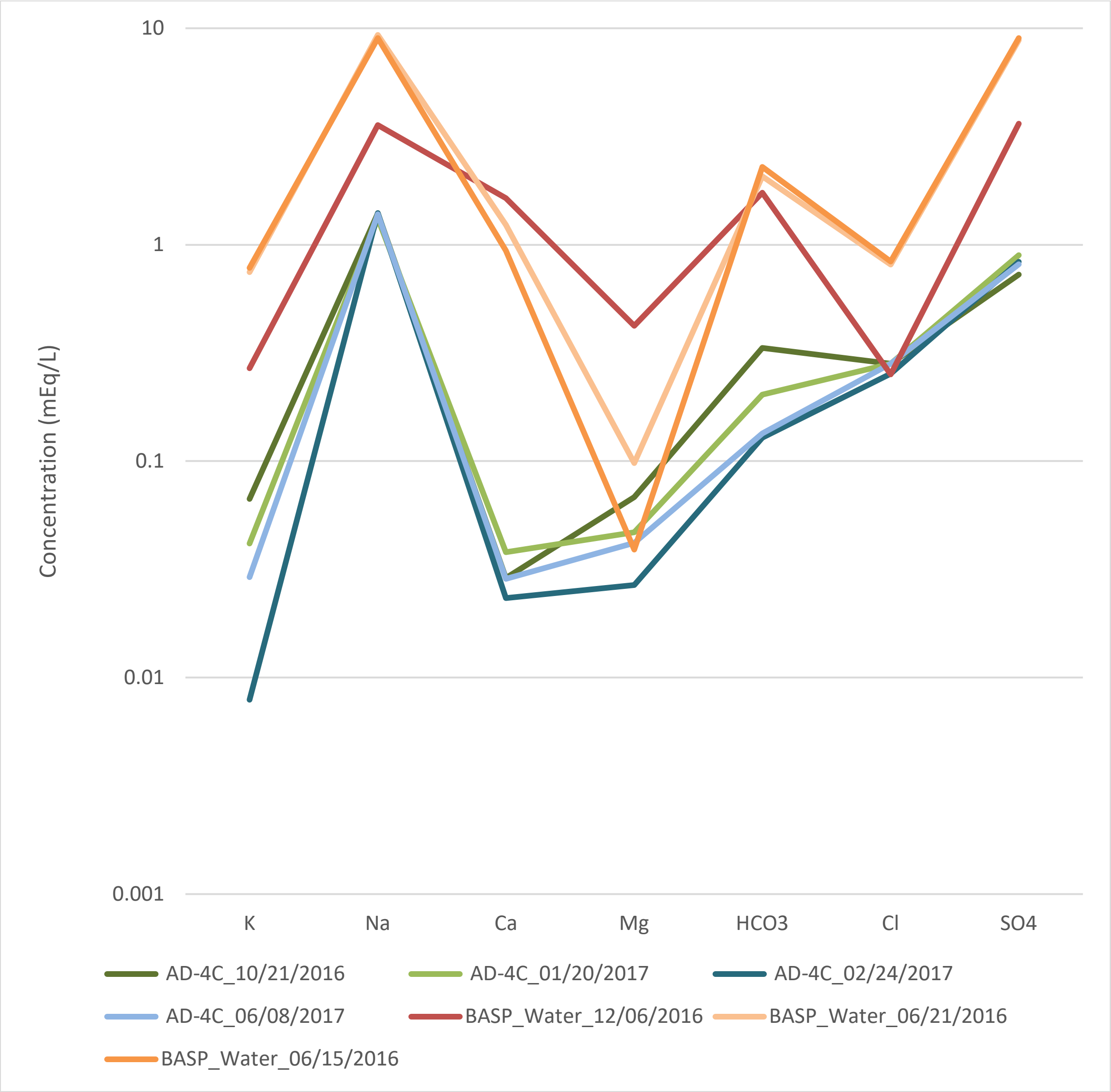
Notes: Fluoride was not detected in any sample above the reporting limit of 0.083 mg/L. All parameters except pH reported as milligrams per liter (mg/L). pH reported as specific units (SU)

Appendix III Time Series Graphs
Welsh Bottom Ash Storage Pond

Geosyntec consultants

Columbus, OH
11-Apr-2019

Figure
7



Notes: BASP water samples were collected as part of a water balance study (AECOM, 2017).

Pond Water Chemistry

Welsh Bottom Ash Storage Pond

Geosyntec consultants

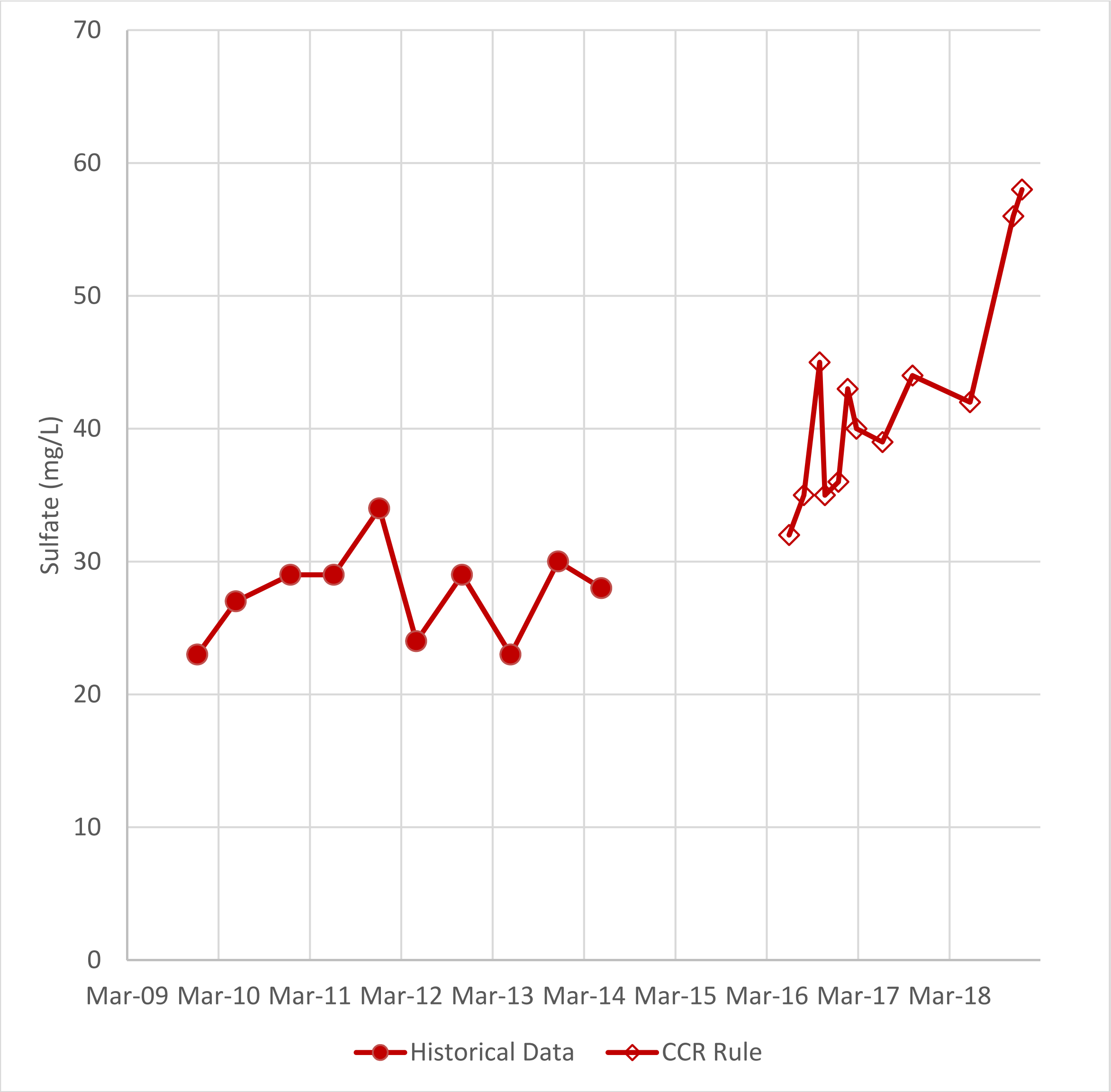
AMERICAN ELECTRIC POWER

Columbus, Ohio

24-Apr-2019

Figure
8

internal info: path, date revised, author



Notes: Historical data were not collected under the CCR Rule.

AD-4C Sulfate Time Series Graph

Welsh Bottom Ash Storage Pond

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure

9

Columbus, Ohio

5-MAY-2019

internal info: path, date revised, author

ATTACHMENT A

Revised Statistical Analysis Output

Intrawell Prediction Limit Summary

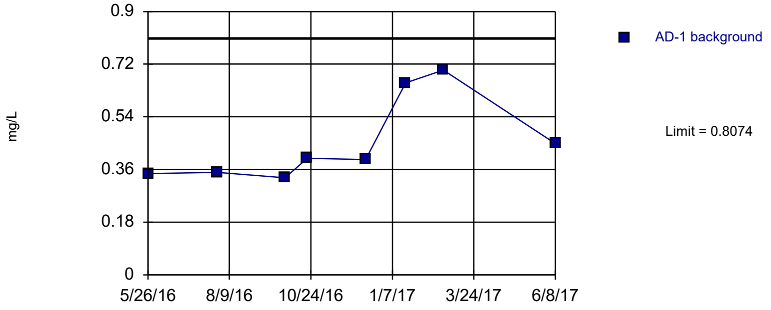
Welsh BASP Client: Geosyntec Data: Welsh BASP Printed 5/9/2019, 1:03 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	AD-1	0.8074	n/a	8	0.4531	0.1441	0	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-5	0.06141	n/a	8	0.04285	0.00755	0	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-17	0.1488	n/a	8	0.1209	0.01137	0	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-3	0.03326	n/a	7	n/a	n/a	0	n/a	n/a	0.02765	NP Intra (normality) 1 of 2
Boron (mg/L)	AD-4C	0.05712	n/a	8	0.02916	0.01137	0	None	No	0.002505	Param Intra 1 of 2
Boron (mg/L)	AD-16R	0.07001	n/a	10	0.03904	0.01384	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-1	224.6	n/a	8	6.363	3.508	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-5	61.45	n/a	8	45.09	6.656	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-17	203.5	n/a	8	193.6	4.033	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-3	1.541	n/a	8	0.7903	0.3055	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-4C	0.9615	n/a	8	0.5855	0.153	0	None	No	0.002505	Param Intra 1 of 2
Calcium (mg/L)	AD-16R	3.069	n/a	10	1.933	0.5077	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-1	9	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Chloride (mg/L)	AD-5	16.78	n/a	8	14.5	0.9258	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-17	44.04	n/a	8	33.38	4.34	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-3	9	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Chloride (mg/L)	AD-4C	12.63	n/a	8	10.38	0.9161	0	None	No	0.002505	Param Intra 1 of 2
Chloride (mg/L)	AD-16R	8.3	n/a	9	6.889	0.6009	0	None	No	0.002505	Param Intra 1 of 2
Fluoride (mg/L)	AD-1	1	n/a	8	n/a	n/a	100	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-5	1	n/a	8	n/a	n/a	75	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-17	0.6953	n/a	8	0.4488	0.1003	37.5	Kaplan-Meier	No	0.002505	Param Intra 1 of 2
Fluoride (mg/L)	AD-3	1	n/a	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-4C	1	n/a	8	n/a	n/a	100	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride (mg/L)	AD-16R	1	n/a	10	n/a	n/a	60	n/a	n/a	0.01476	NP Intra (NDs) 1 of 2
pH, field (SU)	AD-1	7.766	3.744	8	5.755	0.8183	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-5	6.916	4.802	8	5.859	0.4299	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-17	7.253	4.899	8	6.076	0.4789	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-3	7.628	2.427	8	5.028	1.058	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-4C	5.907	3.945	8	4.926	0.3991	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-16R	4.402	2.612	10	3.507	0.3998	0	None	No	0.001253	Param Intra 1 of 2
Sulfate (mg/L)	AD-1	82.3	n/a	8	6.772	0.9358	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-5	336.4	n/a	8	177.4	64.69	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-17	1471	n/a	8	1136	136.3	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-3	12.35	n/a	8	6.125	2.532	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-4C	59.09	n/a	12	42.08	8.051	0	None	No	0.002505	Param Intra 1 of 2
Sulfate (mg/L)	AD-16R	64.14	n/a	10	50.9	5.915	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-1	784.8	n/a	8	16.71	4.598	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-5	563.5	n/a	8	383.6	73.17	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1840	n/a	8	1639	81.77	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-3	156	n/a	8	110.6	18.45	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-4C	262.7	n/a	8	212	20.62	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-16R	213.7	n/a	10	174	17.74	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



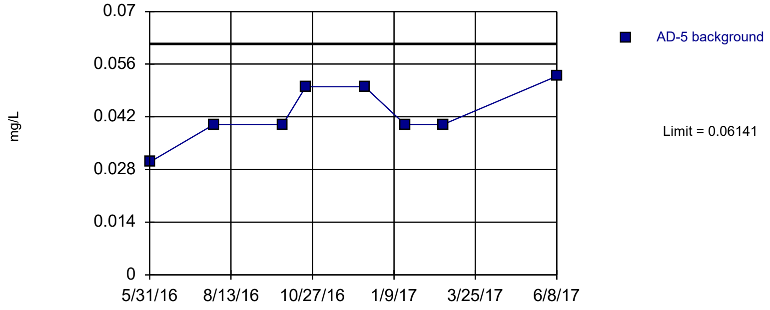
Background Data Summary: Mean=0.4531, Std. Dev.=0.1441, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7868, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



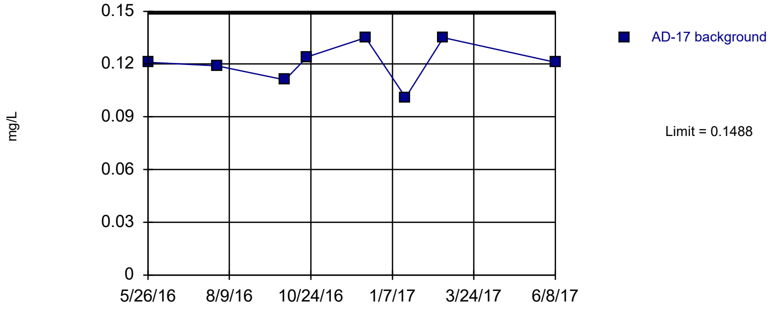
Background Data Summary: Mean=0.04285, Std. Dev.=0.00755, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8774, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



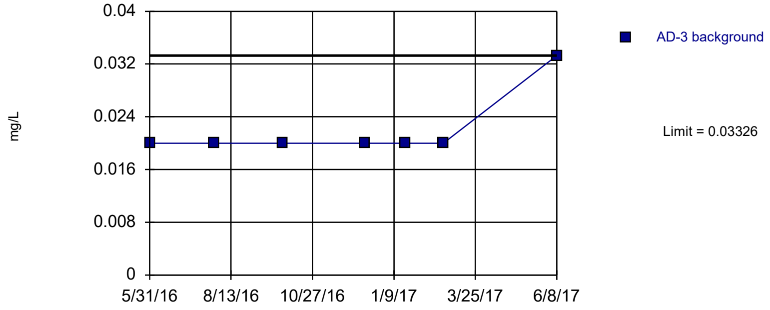
Background Data Summary: Mean=0.1209, Std. Dev.=0.01137, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9321, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-3



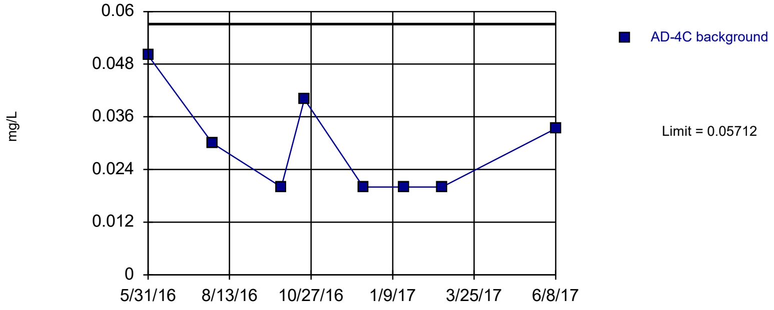
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 7 background values. Well-constituent pair annual alpha = 0.05455. Individual comparison alpha = 0.02765 (1 of 2). Assumes 1 future value.

Constituent: Boron Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



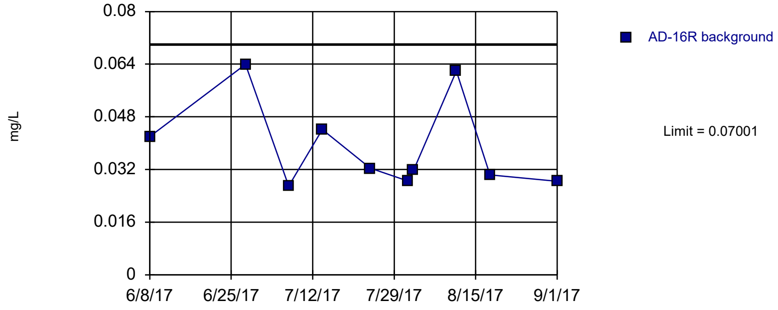
Background Data Summary: Mean=0.02916, Std. Dev.=0.01137, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8271, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



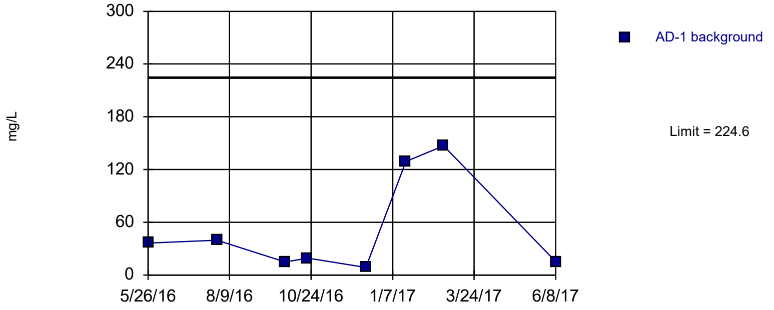
Background Data Summary: Mean=0.03904, Std. Dev.=0.01384, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7973, critical = 0.781. Kappa = 2.238 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



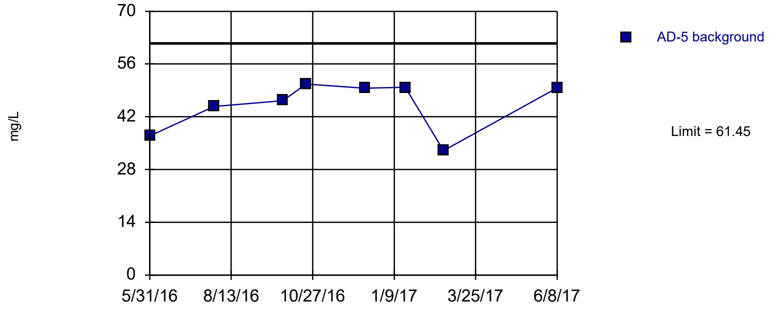
Background Data Summary (based on square root transformation): Mean=6.363, Std. Dev.=3.508, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8248, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



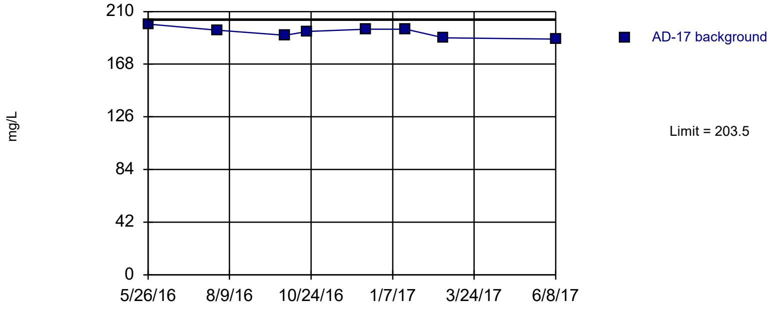
Background Data Summary: Mean=45.09, Std. Dev.=6.656, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8101, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



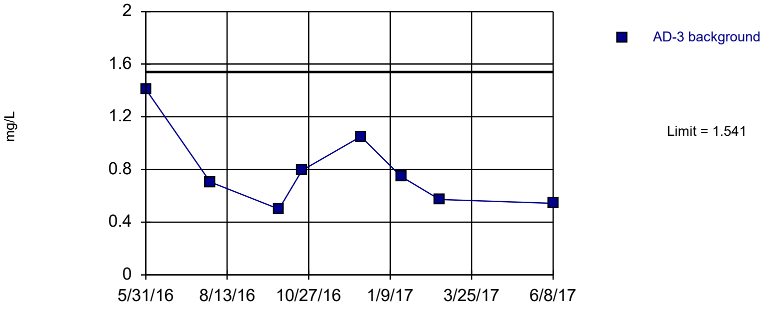
Background Data Summary: Mean=193.6, Std. Dev.=4.033, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9507, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



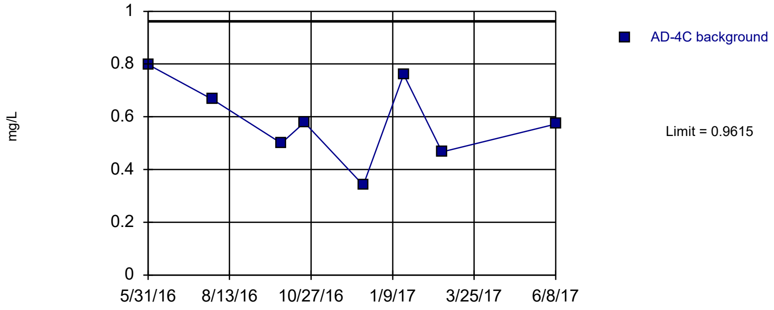
Background Data Summary: Mean=0.7903, Std. Dev.=0.3055, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8655, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



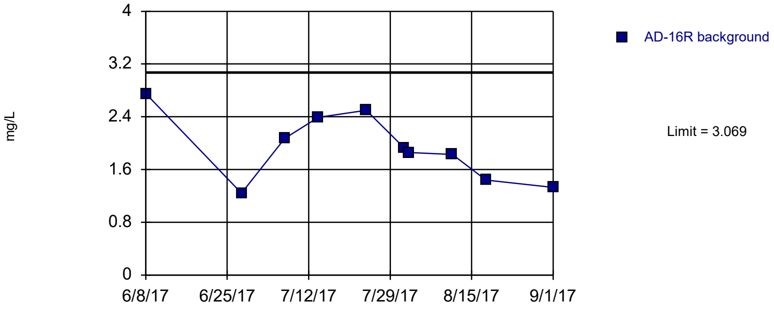
Background Data Summary: Mean=0.5855, Std. Dev.=0.153, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9711, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



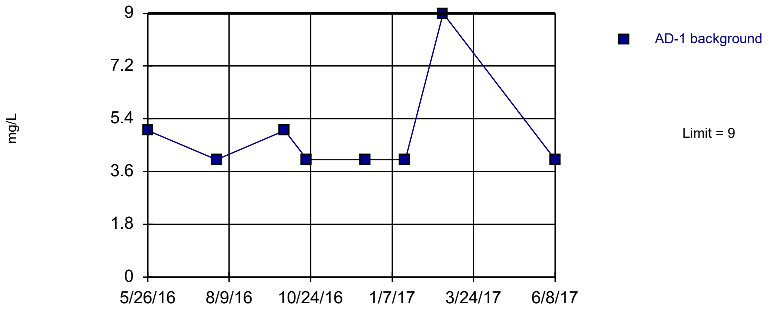
Background Data Summary: Mean=1.933, Std. Dev.=0.5077, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.953, critical = 0.781. Kappa = 2.238 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



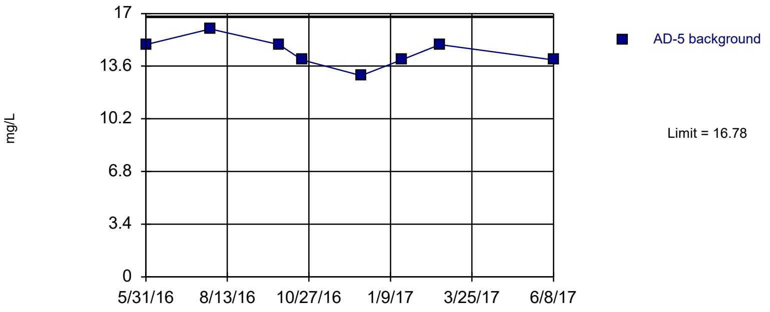
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Chloride Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



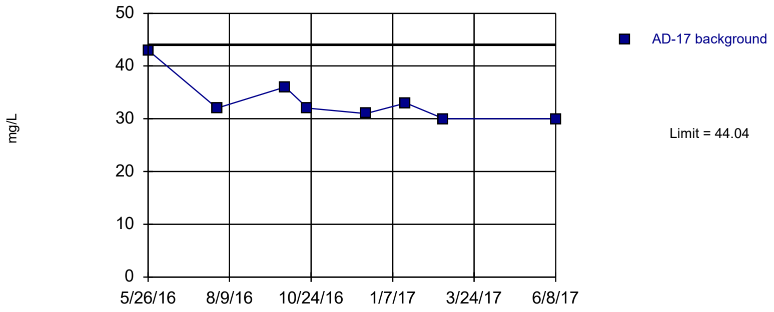
Background Data Summary: Mean=14.5, Std. Dev.=0.9258, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9302, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



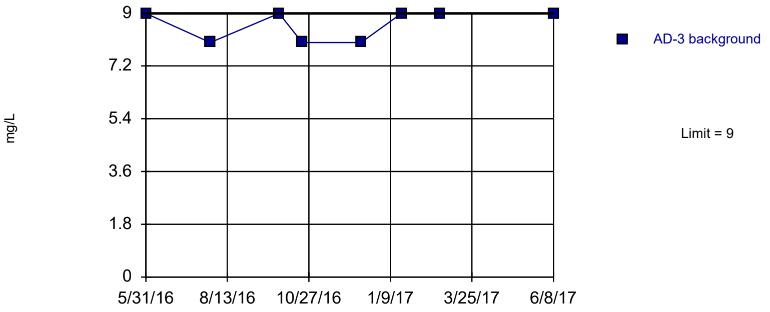
Background Data Summary: Mean=33.38, Std. Dev.=4.34, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-3



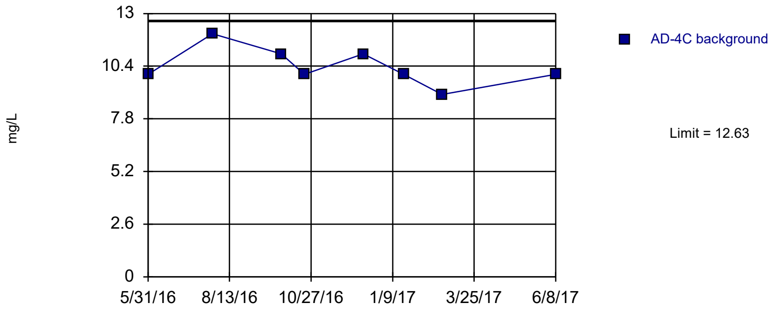
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Chloride Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



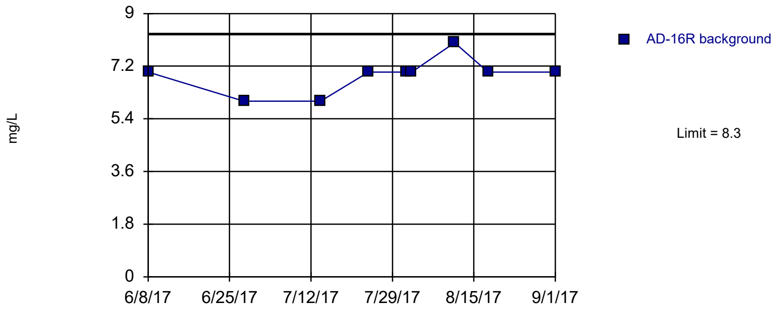
Background Data Summary: Mean=10.38, Std. Dev.=0.9161, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9054, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 5/9/2019 1:00 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



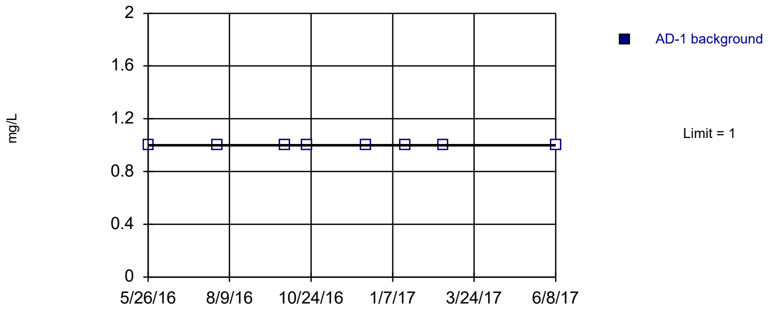
Background Data Summary: Mean=6.889, Std. Dev.=0.6009, n=9. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7809, critical = 0.764. Kappa = 2.348 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



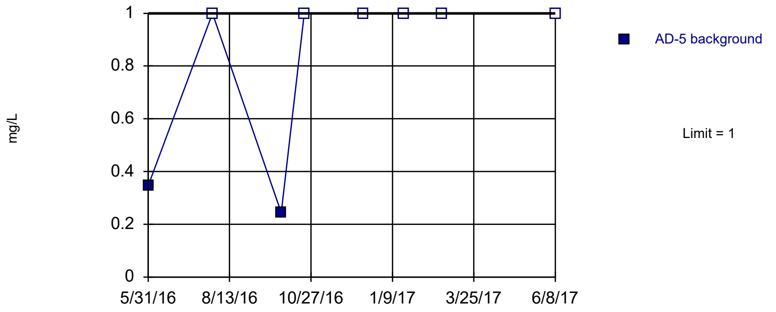
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-5 (bg)



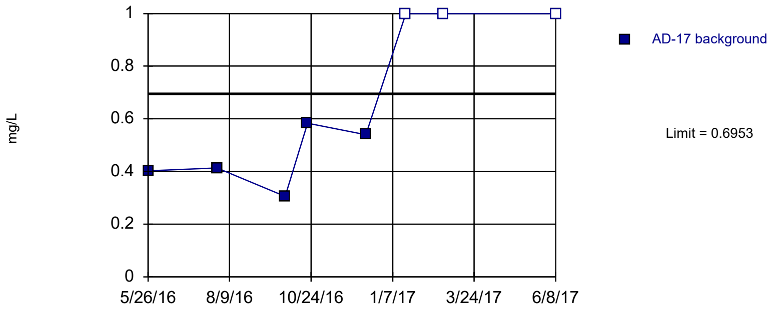
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 75% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-17 (bg)



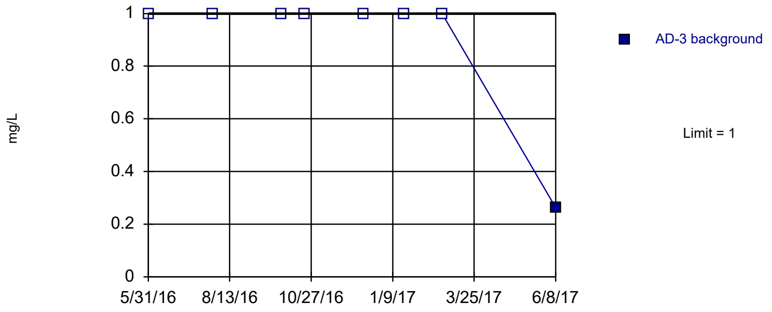
Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.4488, Std. Dev.=0.1003, n=8, 37.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8226, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Fluoride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-3



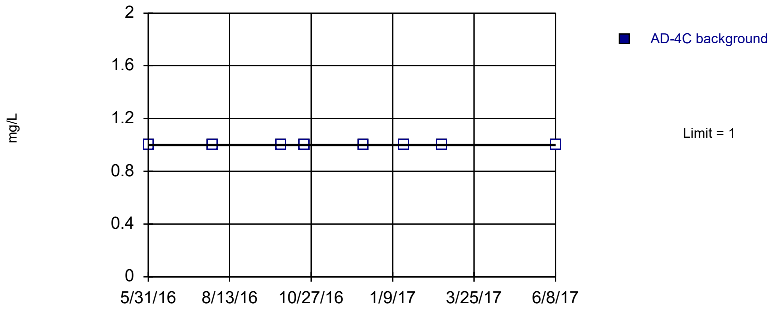
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-4C



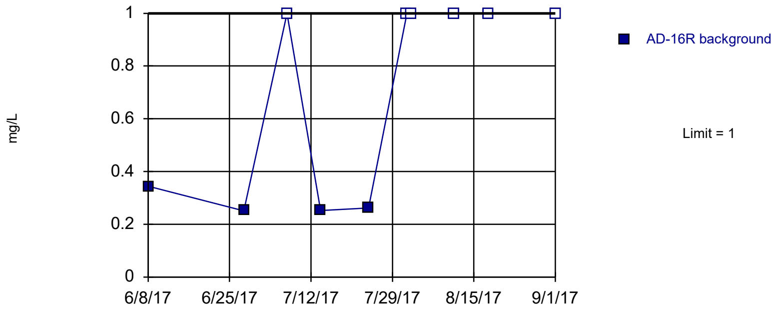
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-16R



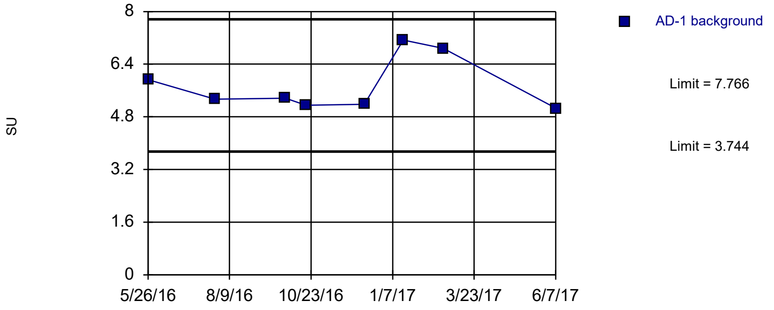
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 10 background values. 60% NDs. Well-constituent pair annual alpha = 0.0293. Individual comparison alpha = 0.01476 (1 of 2). Assumes 1 future value.

Constituent: Fluoride Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



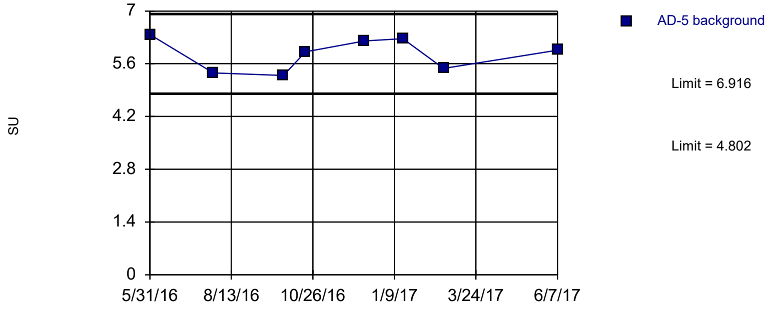
Background Data Summary: Mean=5.755, Std. Dev.=0.8183, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



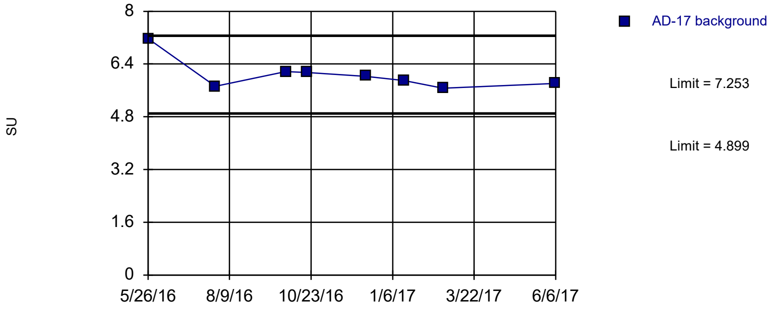
Background Data Summary: Mean=5.859, Std. Dev.=0.4299, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8966, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



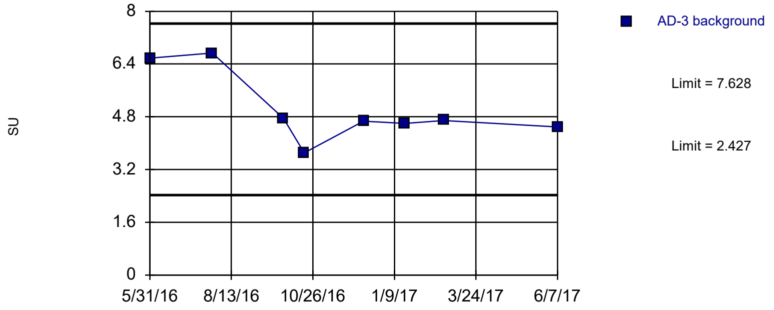
Background Data Summary: Mean=6.076, Std. Dev.=0.4789, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7745, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



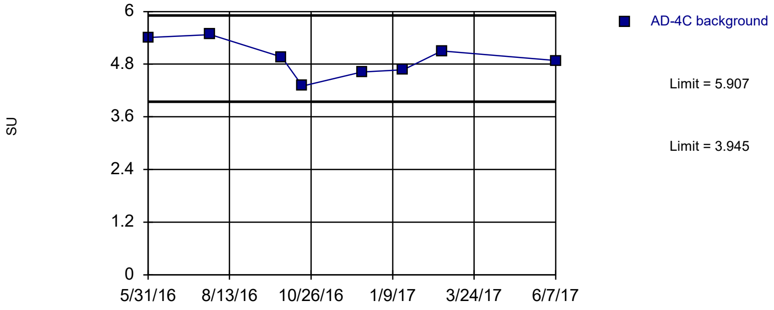
Background Data Summary: Mean=5.028, Std. Dev.=1.058, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8081, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



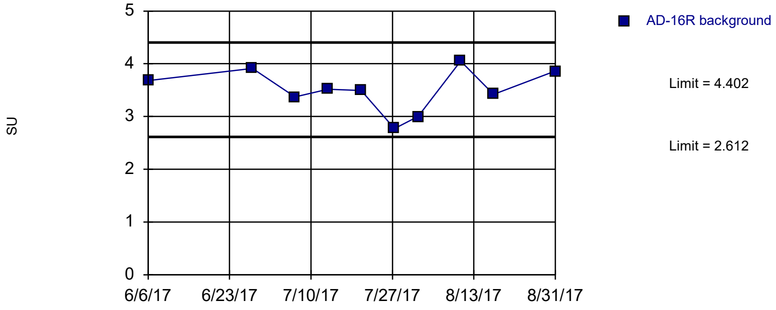
Background Data Summary: Mean=4.926, Std. Dev.=0.3991, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9655, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



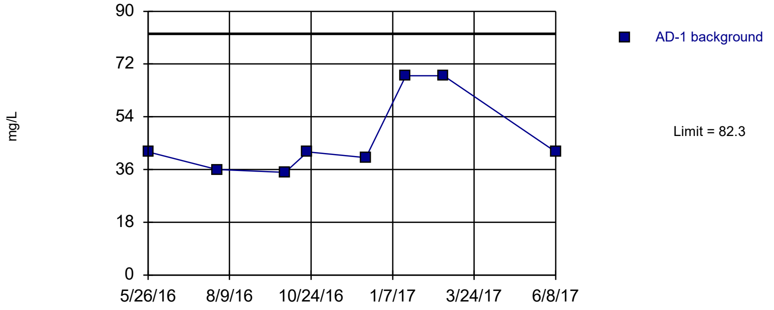
Background Data Summary: Mean=3.507, Std. Dev.=0.3998, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.781. Kappa = 2.238 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



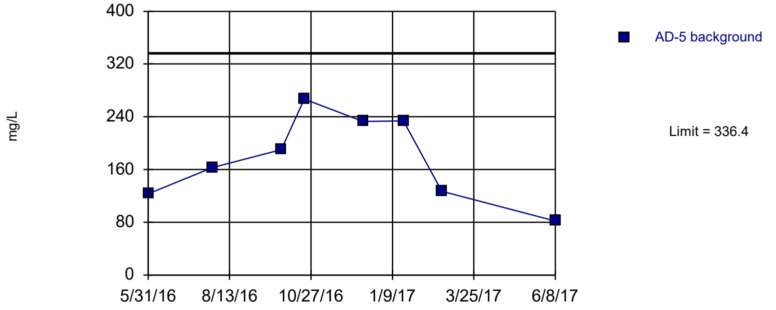
Background Data Summary (based on square root transformation): Mean=6.772, Std. Dev.=0.9358, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7528, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



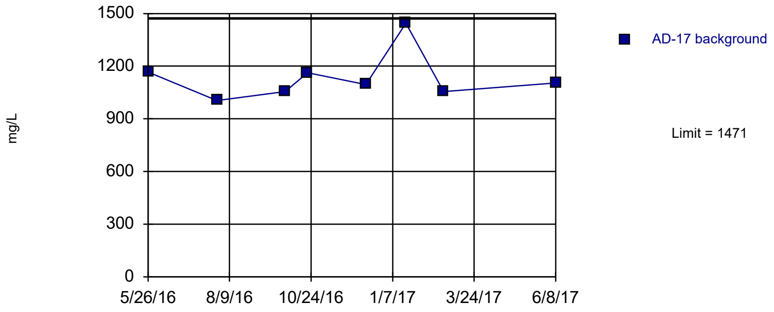
Background Data Summary: Mean=177.4, Std. Dev.=64.69, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.953, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



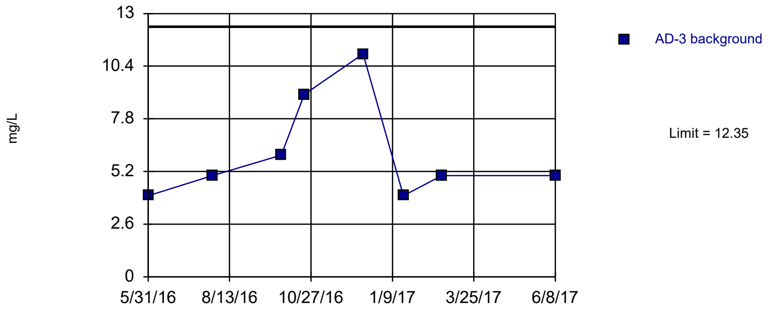
Background Data Summary: Mean=1136, Std. Dev.=136.3, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7916, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



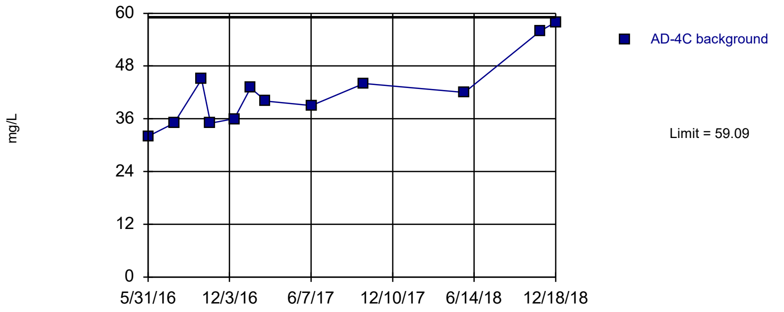
Background Data Summary: Mean=6.125, Std. Dev.=2.532, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8003, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



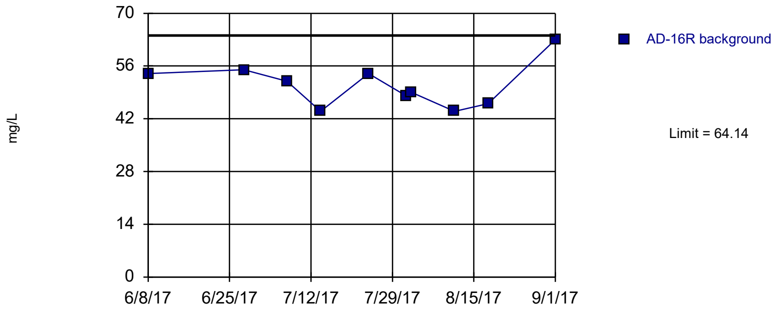
Background Data Summary: Mean=42.08, Std. Dev.=8.051, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8952, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



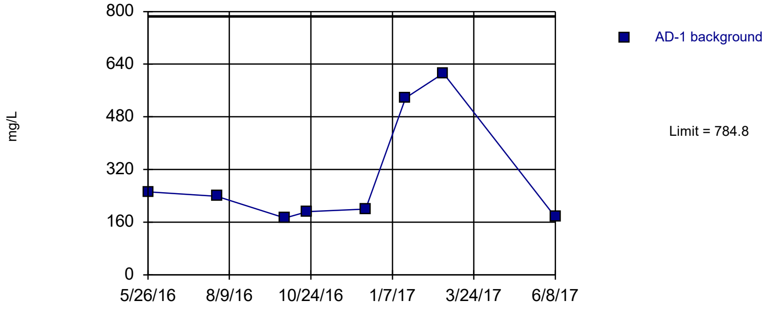
Background Data Summary: Mean=50.9, Std. Dev.=5.915, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9276, critical = 0.781. Kappa = 2.238 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



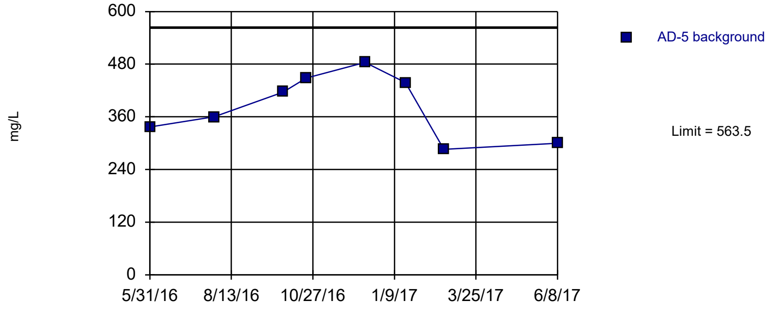
Background Data Summary (based on square root transformation): Mean=16.71, Std. Dev.=4.598, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.756, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



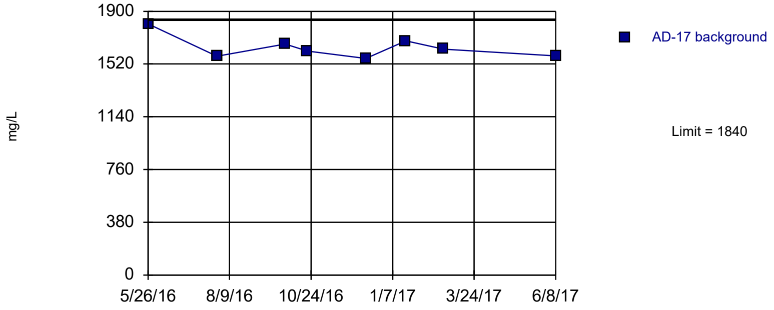
Background Data Summary: Mean=383.6, Std. Dev.=73.17, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.937, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



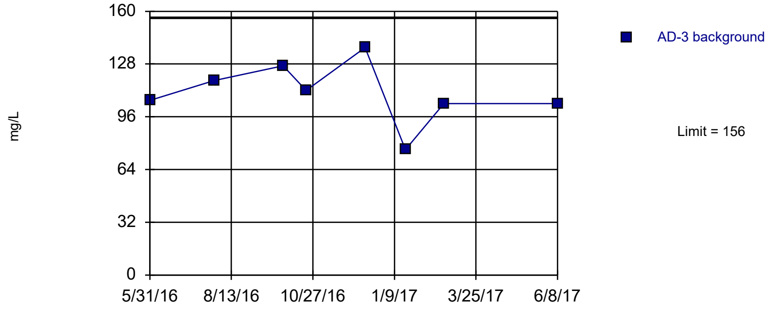
Background Data Summary: Mean=1639, Std. Dev.=81.77, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8702, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3



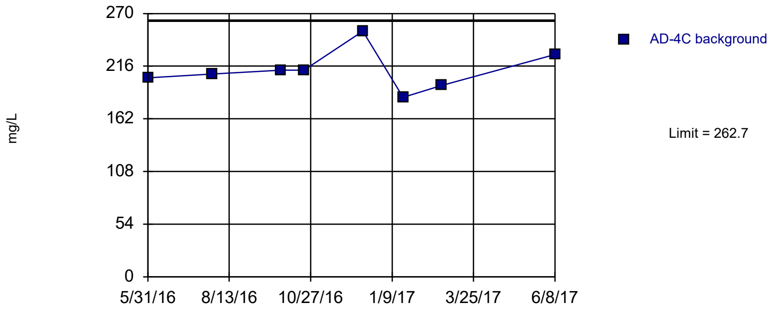
Background Data Summary: Mean=110.6, Std. Dev.=18.45, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9503, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4C



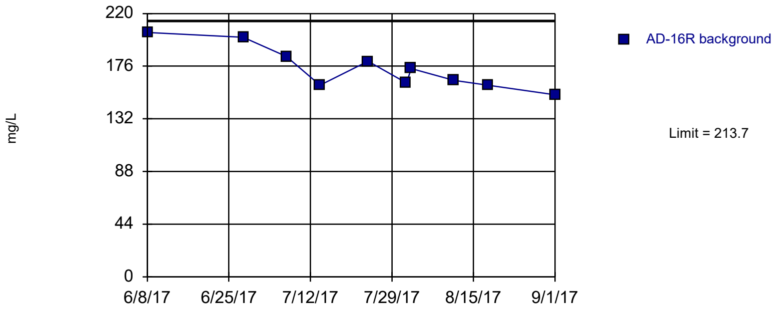
Background Data Summary: Mean=212, Std. Dev.=20.62, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9402, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

Sanitas™ v.9.6.12h Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16R



Background Data Summary: Mean=174, Std. Dev.=17.74, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9094, critical = 0.781. Kappa = 2.238 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 5/9/2019 1:01 PM View: PL's - Intrawell
Welsh BASP Client: Geosyntec Data: Welsh BASP

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 Welsh Bottom Ash Storage Pond 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
79864

Beth Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	5/17/2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

J. Robert Welsh Plant
Bottom Ash Storage Pond
Pittsburg, 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

August 22, 2019

CHA8462

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
BASP	Bottom Ash Storage Pond
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LPL	Lower Prediction Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

Eight to ten background monitoring events were conducted at the Welsh Bottom Ash Storage Pond (BASP). 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. Prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is concluded only if both samples in a series of two exceeds the UPL and for pH exceeds the LPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

The first semi-annual detection monitoring event of 2019 was performed in February 2019 (initial sampling event) and April 2019 (re-sampling event), and the results were compared to the calculated prediction limits. An SSI was identified for chloride at well AD-3 by intrawell analysis. A summary of the detection monitoring analytical results and the calculated prediction limits to which they were compared is provided in Table 1.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (U.S. EPA) 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. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer… verifying the accuracy of the information in the report.*

Chloride concentrations of 9.40 milligrams per liter (mg/L) and 9.34 mg/L were reported for the sampling and re-sampling events on February 20, 2019 and April 30, 2019, respectively. Both concentrations exceeded the UPL value for chloride of 9 mg/L. 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 that the SSI for chloride at AD-3 should not be attributed to the Welsh BASP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSI 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 increases in constituent concentrations were based on a Type II cause and not by a release from the Welsh BASP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The method used to assess possible alternative sources of the SSI for chloride at AD-3 and the proposed alternative source are described below. In addition, the future sampling requirements for the Welsh BASP are presented.

2.1 Proposed Alternative Source

Initial review of field forms, site geochemistry, and site historical data did not identify alternative sources due to a Type I issue (sampling causes). Review of the laboratory results, however, identified a variation in the number of significant figures used in reported results that explains the SSI. This Type II issue is described below.

The eight samples collected from AD-3 during the background monitoring period were analyzed by AEP Analytical Chemistry Services in Shreveport, Louisiana using USEPA Method 300.0 and reported to the nearest 1 mg/L. Three background sample results for chloride were reported at 8 mg/L and five background results for chloride were 9 mg/L (Attachment A). Given the limited variability in the background dataset, the UPL for chloride at AD-3 was calculated non-parametrically as 9 mg/L, which is the highest value in the set of background data was used.

The samples for the first semi-annual detection monitoring event in 2019 were analyzed by AEP's Dolan Chemical Laboratory in Groveport, Ohio and reported to the nearest 0.01 mg/L. The initial and verification results for chloride were 9.40 mg/L and 9.34 mg/L respectively (Attachment B). These results are only above the UPL due to the additional significant figures provided by the laboratory. If the 2019 sample results had been reported to the same precision as the background samples, i.e., to the nearest 1 mg/L, they would be equal to the UPL and would not have triggered an SSI.

Furthermore, the detection monitoring samples were analyzed using USEPA Method 300.1, which prescribes ±15% variation as the quality control sample acceptance criteria (USEPA, 1999). Because both reported concentrations are within 15% (4.3% and 3.6% respectively) of the UPL, the differences observed are within acceptable variation in the analytical procedure.

Following completion of the first semi-annual CCR detection monitoring event, additional sampling was conducted at the BASP on May 30, 2019 for compliance with another regulatory program. The analysis was completed by AEP's Dolan Chemical Laboratory using USEPA Method 300.1. The reported chloride concentration for the sample from well AD-3 was 7.97 mg/L, which is below the UPL (Attachment C). Based on all results for AD-3 during the 2019 groundwater monitoring events, a positive trend is not demonstrated for chloride (Figure 1). Additionally, no other Appendix III exceedances were observed for AD-3 during the first semi-annual event of 2019. Thus, the observed chloride concentrations during the first semi-annual event are not considered indicative of a release from the BASP.

2.2 Sampling Requirements

The ASD described above supports the position that the identified SSI is not due to a release from the Welsh BASP. Therefore, the unit will remain in the detection monitoring. Groundwater at the unit will be sampled for Appendix III parameters on a semi-annual basis. In subsequent sampling events, results will be reported to the appropriate number of significant figures based on laboratory quality control protocols. As this detection monitoring event represent the fourth monitoring event since the initial background dataset was established, the results of the detection monitoring events will be compared to the existing background dataset and added to the dataset as appropriate and as recommended by the Unified Guidance (USEPA, 2009).

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.94(e)(2) and supports the position that the SSIs in Appendix III detection monitoring constituents are not due to a release from the Welsh BASP during the February and April 2019 sampling events. The identified SSI for chloride at well AD-3 was attributed to differences in laboratory reporting practices. Therefore, no further action is warranted, and the Welsh BASP will remain in the detection monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment D.

SECTION 4

REFERENCES

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.

Geosyntec, 2019. Alternative Source Demonstration Report – Federal CCR Rule. J. Robert Welsh Plant. January.

USEPA, 1999. Method 300.1 Determination of Inorganic Anions in Drinking Water by Ion Chromatography. Revision 1.0. Office of Research and Development. Cincinnati, OH.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

USEPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (Final Rule). Fed. Reg. 80 FR 21301, pp. 21301-21501, 40 CFR Parts 257 and 261, April.

TABLES

Table 1: Detection Monitoring Data Evaluation
Welsh Plant - Bottom Ash Storage Pond

Parameter	Units	Description	AD-3		AD-4C		AD-16R	
			2/20/2019	4/30/2019	2/20/2019	4/30/2019	2/20/2019	4/30/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.0333		0.0571		0.0700	
		Detection Monitoring Data	0.01 J	0.0070	0.01 J	0.0140	0.03 J	**0.0150**
Calcium	mg/L	Intrawell Background Value (UPL)	1.54		0.962		3.07	
		Detection Monitoring Data	0.817	--	0.931	--	2.00	-
Chloride	mg/L	Intrawell Background Value (UPL)	9		12.6		8.30	
		Detection Monitoring Data	**9.40**	**9.34**	9.18	--	6.78	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1.0		1.0		1.0	
		Detection Monitoring Data	0.13	--	0.10	--	0.20	--
pH	SU	Intrawell Background Value (UPL)	7.6		5.9		4.4	
		Intrawell Background Value (LPL)	2.4		3.9		2.6	
		Detection Monitoring Data	4.8	4.1	5.2	4.8	**4.7**	3.9
Sulfate	mg/L	Intrawell Background Value (UPL)	12.4		59.1		64.1	
		Detection Monitoring Data	1.90	--	**60.1**	56.2	52.8	--
TDS	mg/L	Intrawell Background Value (UPL)	156		263		214	
		Detection Monitoring Data	110	--	242	--	200	--

Notes

UPL: Upper prediction limit

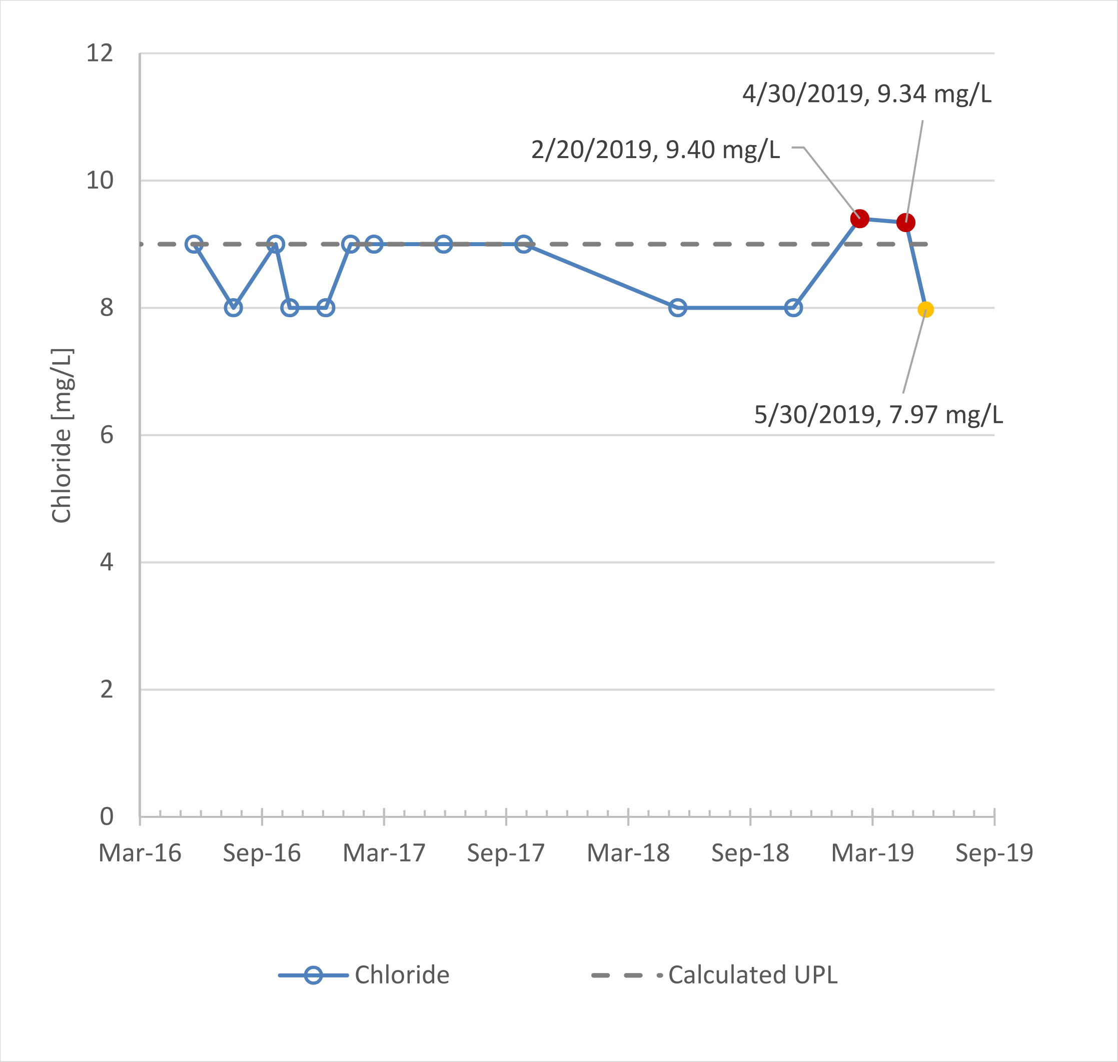
LPL: Lower prediction limit

TDS: Total dissolved solids

Bold values exceed the background value.

Background values are shaded gray.

FIGURES



Notes: Initial sampling for the first semi-annual detection monitoring event of 2019 occurred on 02/20/2019. Verification sampling for the first semi-annual event occurred on 04/30/2019. These events are shown with red symbols. Sampling for another program occurred on 5/30/2019 (yellow symbol). The upper prediction limit (UPL) was calculated using intrawell analyses.

Chloride Time Series Graph at AD-3

Welsh BASP

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure

1

Columbus, Ohio

18-Jul-2019

internal info: path, date revised, author

ATTACHMENT A

Background Monitoring Data Laboratory Reports

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 33094
Date Received: 06/01/2016
Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816
Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 196453
Cust Sample ID:
Sample Desc.: AD- 3
Collected Date: 05/31/2016
Location: Welsh Power Plant CCR
By: MH
Matrix: Water

Metals (196453)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Barium	0.053	mg/L	0.001	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Boron	0.02	mg/L	0.01	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Calcium	1.41	mg/L	0.01	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Lithium	0.01	mg/L	0.001	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Mercury	0.00085	mg/L	0.000025	1	EPA 7470A 1994	06/17/2016 15:24		JDB
Molybdenum	< 0.005	mg/L	0.005	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	07/06/2016 17:09		JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	07/06/2016 17:09		JDB

Water (196453)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Chloride	9	mg/L	1	1	EPA 300.0	06/01/2016 14:55		GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	06/01/2016 14:55		GB
Solids, Total Dissolved (TDS)	106	mg/L	5	1	SM 2540 C-2011	06/02/2016 15:45		JTM
Sulfate	4	mg/L	1	1	EPA 300.0	06/01/2016 14:55		GB

AEP ANALYTICAL CHEMISTRY SERVICES
Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 33451
Date Received: 07/29/2016

Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816

Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 197834
Cust Sample ID:
Sample Desc.: AD-3

Collected Date: 07/27/2016
Location: Welsh Power Plant

By: MH/KM
Matrix: Water

Metals (197834)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Barium	0.036	mg/L	0.001	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Boron	0.02	mg/L	0.01	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Calcium	0.706	mg/L	0.01	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Lithium	0.024	mg/L	0.001	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Mercury	0.000589	mg/L	0.000025	1	EPA 7470A 1994	08/18/2016 12:22		JDB
Molybdenum	< 0.005	mg/L	0.005	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	09/09/2016 10:09		JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	09/13/2016 17:50		JDB

Water (197834)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Chloride	8	mg/L	1	1	EPA 300.0	07/31/2016 11:43		GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	07/31/2016 11:43		GB
Solids, Total Dissolved (TDS)	118	mg/L	5	1	SM 2540 C-2011	08/02/2016 16:15		JTM
Sulfate	5	mg/L	1	1	EPA 300.0	07/31/2016 11:43		GB

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 33888
Date Received: 09/30/2016

Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816

Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 199549
Cust Sample ID:
Sample Desc.: AD-3

Collected Date: 09/30/2016
Location: Welsh P.S.

By: MH/KM
Matrix: Water

Metals (199549)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Barium	0.043	mg/L	0.001	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Boron	0.02	mg/L	0.01	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Calcium	< 0.5	mg/L	0.5	1:50	EPA 6010B 1996	10/26/2016 17:28		JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Lithium	0.019	mg/L	0.001	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Mercury	0.00039	mg/L	0.000025	1	EPA 7470A 1994	10/06/2016 10:06		LNM
Molybdenum	< 0.005	mg/L	0.005	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	10/26/2016 20:53		JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	10/26/2016 20:53		JDB

Water (199549)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Chloride	9	mg/L	1	1	EPA 300.0	10/05/2016 17:04		GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	10/05/2016 17:04		GB
Solids, Total Dissolved (TDS)	127	mg/L	5	1	SM 2540 C-2011	10/03/2016 16:30		JTM
Sulfate	6	mg/L	1	1	EPA 300.0	10/05/2016 17:04		GB

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 34036
Date Received: 10/21/2016

Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816

Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 200428
Cust Sample ID:
Sample Desc.: AD-3

Collected Date: 10/19/2016
Location: Welsh P.S.

By: MH/KM
Matrix: Water

Metals (200428)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Barium	0.041	mg/L	0.001	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Boron	0.06	mg/L	0.01	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Calcium	0.794	mg/L	0.01	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Lithium	0.018	mg/L	0.001	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Mercury	0.000351	mg/L	0.000025	1	EPA 7470A 1994	10/27/2016 10:57		LNM
Molybdenum	0.006	mg/L	0.005	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	12/20/2016 1:25		JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	12/21/2016 21:04		JDB

Water (200428)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Chloride	8	mg/L	1	1	EPA 300.0	10/29/2016 22:09		GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	10/29/2019 22:09		GB
Solids, Total Dissolved (TDS)	112	mg/L	5	1	SM 2540 C-2011	10/24/2016 16:30		JTM
Sulfate	9	mg/L	1	1	EPA 300.0	10/29/2016 22:09		GB

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID :	34314	**Company:**	SEP - Environmental (JP-W)	**Address:**	502 N. Allen Avenue Shreveport, LA 71101
Date Received:	12/14/2016	**Contact:**	Jill Parker-Witt		
		Phone:	(318) 673-3816	**Fax:**	(318) 673-3960
AEP Sample ID :	202088	**Collected Date:**	12/12/2016	**By:**	MH/KM
Cust Sample ID:		**Location:**	Welsh Power Plant	**Matrix:**	Water
Sample Desc.:	AD-3				

Metals (202088)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Barium	0.045	mg/L	0.001	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Boron	0.02	mg/L	0.01	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Calcium	1.05	mg/L	0.01	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Lithium	0.017	mg/L	0.001	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Mercury	0.000321	mg/L	0.000025	1	EPA 7470A 1994	12/28/2016 12:52		LNM
Molybdenum	< 0.005	mg/L	0.005	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	01/31/2017 3:59		JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	01/31/2017 3:59		JDB

Water (202088)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Chloride	8	mg/L	1	1	EPA 300.0	12/21/2016 17:10		GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	12/21/2016 17:10		GB
Solids, Total Dissolved (TDS)	138	mg/L	5	1	SM 2540 C-2011	12/18/2016 14:45		JTM
Sulfate	11	mg/L	1	1	EPA 300.0	12/21/2016 17:10		GB

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 34517
Date Received: 01/20/2017

Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816

Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 202906
Cust Sample ID: AD-3
Sample Desc.:

Collected Date: 01/19/2017
Location: Welsh P.P.

By: MH
Matrix: Water

Metals (202906)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Barium	0.041	mg/L	0.001	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Boron	0.02	mg/L	0.01	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Calcium	0.746	mg/L	0.01	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Lithium	0.014	mg/L	0.001	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Magnesium	0.49	mg/L	0.01	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Mercury	0.000504	mg/L	0.000025	1	EPA 7470A 1994	01/24/2017 14:37		LNM
Molybdenum	< 0.005	mg/L	0.005	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Potassium	0.585	mg/L	0.01	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Sodium	7.77	mg/L	0.01	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Strontium	0.013	mg/L	0.001	1	EPA 6010B 1996	02/11/2017 0:42		JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	02/11/2017 0:42		JDB

Water (202906)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Alkalinity, Total	< 5	mg/L	5	1	SM 2320 B-2011	01/24/2017 17:30		JID
Bromide	< 1.0	mg/L	1.0	1	EPA 300.0	01/27/2017 12:21		GB
Chloride	9	mg/L	1	1	EPA 300.0	01/27/2017 12:21		GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	01/27/2017 12:21		GB
Solids, Total Dissolved (TDS)	76	mg/L	5	1	SM 2540 C-2011	01/21/2017 14:00		JID

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 34799
Date Received: 02/24/2017

Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816

Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 204458
Cust Sample ID: AD-3
Sample Desc.: Coal Combustion Residuals
Collected Date: 02/23/2017
Location: Welsh P.S.
By: MH
Matrix: Water

Metals (204458)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.005	mg/L	0.005	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Arsenic	< 0.005	mg/L	0.005	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Barium	0.037	mg/L	0.001	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Beryllium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Boron	0.02	mg/L	0.01	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Cadmium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Calcium	0.573	mg/L	0.01	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Chromium	< 0.001	mg/L	0.001	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Cobalt	< 0.005	mg/L	0.005	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Lead	< 0.005	mg/L	0.005	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Lithium	0.014	mg/L	0.001	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Magnesium	0.485	mg/L	0.01	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Mercury	0.000501	mg/L	0.000025	1	EPA 7470A 1994	03/01/2017 12:03	H1	LNM
Molybdenum	< 0.005	mg/L	0.005	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Potassium	0.464	mg/L	0.01	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Selenium	< 0.005	mg/L	0.005	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Sodium	8.45	mg/L	0.01	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Strontium	0.013	mg/L	0.001	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB
Thallium	< 0.002	mg/L	0.002	1	EPA 6010B 1996	03/01/2017 23:52	H1	JDB

Water (204458)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Alkalinity, Total	< 5	mg/L	5	1	SM 2320 B-2011	02/27/2017 9:56	H1	JID
Bromide	< 1.0	mg/L	1.0	1	EPA 300.0	02/28/2017 5:11	H1	GB
Chloride	9	mg/L	1	1	EPA 300.0	02/28/2017 5:11	H1	GB
Fluoride	< 1	mg/L	1	1	EPA 300.0	02/28/2017 5:11	H1	GB
Solids, Total Dissolved (TDS)	104	mg/L	5	1	SM 2540 C-2011	03/02/2017 9:00	H1	JKL

AEP ANALYTICAL CHEMISTRY SERVICES

Analysis Report

502 North Allen Ave.
Shreveport, LA 71101
Phone: (318) 673-3802
Fax: (318) 673-3960

Report ID : 35500
Date Received: 06/08/2017

Company: SEP - Environmental (JP-W)
Contact: Jill Parker-Witt
Phone: (318) 673-3816

Address: 502 N. Allen Avenue
Shreveport, LA 71101
Fax: (318) 673-3960

AEP Sample ID : 207456
Cust Sample ID: AD-3
Sample Desc.: Coal Combustion Residuals (CCR)

Collected Date: 06/07/2017
Location: Welsh P.S.

By: MH
Matrix: Water

Metals (207456)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Antimony	< 0.00093	mg/L	0.00093	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Arsenic	0.00191	mg/L	0.00105	1	EPA 6010B 1996	07/20/2017 8:43	J	JDB
Barium	0.038	mg/L	0.00015	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Beryllium	0.00024	mg/L	0.00002	1	EPA 6010B 1996	07/20/2017 8:43	J	JDB
Boron	0.03326	mg/L	0.00028	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Cadmium	0.00008	mg/L	0.00007	1	EPA 6010B 1996	07/20/2017 8:43	J	JDB
Calcium	0.543	mg/L	0.0096	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Chromium	0.00075	mg/L	0.00023	1	EPA 6010B 1996	07/20/2017 8:43	J	JDB
Cobalt	0.00128	mg/L	0.00014	1	EPA 6010B 1996	07/20/2017 8:43	J	JDB
Lead	< 0.00068	mg/L	0.00068	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Lithium	0.01503	mg/L	0.00013	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Magnesium	0.489	mg/L	0.01	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Mercury	0.000365	mg/L	0.000005	1	EPA 7470A 1994	06/23/2017 12:19		LNM
Molybdenum	< 0.00029	mg/L	0.00029	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Potassium	0.532	mg/L	0.01	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Selenium	< 0.00099	mg/L	0.00099	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Sodium	8.27	mg/L	0.01	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Strontium	0.012	mg/L	0.001	1	EPA 6010B 1996	07/20/2017 8:43		JDB
Thallium	< 0.00086	mg/L	0.00086	1	EPA 6010B 1996	07/20/2017 8:43		JDB

Water (207456)

Parameter	Value	Unit	Det. Limit	Dil./Conc.	Method	Analysis Date/Time	Codes	Tech
Alkalinity, Total	< 5	mg/L	5	1	SM 2320 B-2011	06/12/2017 10:43		JID
Bromide	< 1.0	mg/L	1.0	1	EPA 300.0	06/21/2017 13:18		GB
Chloride	9	mg/L	0.219	1	EPA 300.0	06/21/2017 13:18		GB
Fluoride	0.2625	mg/L	0.083	1	EPA 300.0	06/21/2017 13:18	J	GB
Solids, Total Dissolved (TDS)	104	mg/L	2	1	SM 2540 C-2011	06/12/2017 16:30	L4	JAR

ATTACHMENT B

Detection Monitoring Event Laboratory Reports

Form REP-703
Rev. 1, 11/2013

Dolan Chemical Laboratory
4001 Bixby Road
Groveport, OH 43125
T: 614-836-4221, Audinet 210-4221
F: 614-836-4168, Audinet 210-4168
http://aepenv/labs

Water Analysis

Location: Welsh PS ***Report Date: 2/28/2019***

AD-3

Sample Number: **190680-001** **Date Collected:** **02/20/2019 12:02** **Date Received:** **2/27/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	9.40	mg/L		0.04	0.01	CRJ	02/28/2019	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.13	mg/L		0.06	0.01	CRJ	02/28/2019	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	1.9	mg/L		0.4	0.06	CRJ	02/28/2019	EPA 300.1-1997, Rev. 1.0

AD-4C

Sample Number: **190680-002** **Date Collected:** **02/20/2019 11:13** **Date Received:** **2/27/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	9.18	mg/L		0.1	0.03	CRJ	02/27/2019	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.1	mg/L	J	0.2	0.04	CRJ	02/27/2019	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	60.1	mg/L		1	0.2	CRJ	02/27/2019	EPA 300.1-1997, Rev. 1.0

AD-16R

Sample Number: **190680-003** **Date Collected:** **02/20/2019 12:50** **Date Received:** **2/27/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	6.78	mg/L		0.1	0.03	CRJ	02/27/2019	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.20	mg/L		0.2	0.04	CRJ	02/27/2019	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	52.8	mg/L		1	0.2	CRJ	02/27/2019	EPA 300.1-1997, Rev. 1.0

Duplicate BASP

Sample Number: **190680-004** **Date Collected:** **02/20/2019 12:02** **Date Received:** **2/27/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	9.42	mg/L		0.04	0.01	CRJ	02/28/2019	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.13	mg/L		0.06	0.01	CRJ	02/28/2019	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	1.9	mg/L		0.4	0.06	CRJ	02/28/2019	EPA 300.1-1997, Rev. 1.0

Form REP-703
Rev. 1, 11/2013

Dolan Chemical Laboratory
4001 Bixby Road
Groveport, OH 43125
T: 614-836-4221, Audinet 210-4221
F: 614-836-4168, Audinet 210-4168
http://aepenv/labs

Water Analysis

Location: Welsh PS ***Report Date: 6/3/2019***

AD-3

Sample Number: **191516-001** **Date Collected:** **04/30/2019 10:27** **Date Received:** **5/2/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Boron, B	0.007	mg/L		0.005	0.0009	GES	05/21/2019 13:35	EPA 200.8-1994, Rev. 5.4
Chloride, Cl	9.34	mg/L		0.04	0.01	CRJ	05/15/2019 15:58	EPA 300.1-1997, Rev. 1.0

AD-4C

Sample Number: **191516-002** **Date Collected:** **04/30/2019 11:02** **Date Received:** **5/2/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Boron, B	0.014	mg/L		0.005	0.0009	GES	05/21/2019 13:40	EPA 200.8-1994, Rev. 5.4
Sulfate, SO4	56.2	mg/L		1	0.2	CRJ	05/15/2019 16:21	EPA 300.1-1997, Rev. 1.0

AD-16R

Sample Number: **191516-003** **Date Collected:** **04/30/2019 11:32** **Date Received:** **5/2/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Boron, B	0.015	mg/L		0.005	0.0009	GES	05/21/2019 15:20	EPA 200.8-1994, Rev. 5.4

AD-8

Sample Number: **191516-004** **Date Collected:** **04/30/2019 10:22** **Date Received:** **5/2/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Boron, B	1.21	mg/L		0.005	0.0009	GES	05/21/2019 15:25	EPA 200.8-1994, Rev. 5.4

AD-9

Sample Number: **191516-005** **Date Collected:** **04/30/2019 10:57** **Date Received:** **5/2/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Boron, B	0.070	mg/L		0.005	0.0009	GES	05/21/2019 15:30	EPA 200.8-1994, Rev. 5.4

AD-11

Sample Number: **191516-006** **Date Collected:** **04/30/2019 11:32** **Date Received:** **5/2/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Boron, B	1.34	mg/L		0.005	0.0009	GES	05/21/2019 15:35	EPA 200.8-1994, Rev. 5.4

ATTACHMENT C

May 2019 Sampling Laboratory Report

Duplicate Background

Sample Number: **191926-005** **Date Collected:** **05/30/2019 10:32** **Date Received:** **6/4/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	1.50	mg/L		0.1	0.03	CRJ	06/17/2019 20:28	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.31	mg/L		0.2	0.04	CRJ	06/17/2019 20:28	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	43.1	mg/L		1	0.2	CRJ	06/17/2019 20:28	EPA 300.1-1997, Rev. 1.0

AD-3

Sample Number: **191926-006** **Date Collected:** **05/30/2019 11:49** **Date Received:** **6/4/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	7.97	mg/L		0.04	0.01	CRJ	06/17/2019 21:14	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.21	mg/L		0.06	0.01	CRJ	06/17/2019 21:14	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	2.6	mg/L		0.4	0.06	CRJ	06/17/2019 21:14	EPA 300.1-1997, Rev. 1.0

AD-4C

Sample Number: **191926-007** **Date Collected:** **05/30/2019 10:52** **Date Received:** **6/4/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	14.6	mg/L		0.04	0.01	CRJ	06/17/2019 21:37	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.15	mg/L		0.06	0.01	CRJ	06/17/2019 21:37	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	52.6	mg/L		0.4	0.06	CRJ	06/17/2019 21:37	EPA 300.1-1997, Rev. 1.0

AD-16R

Sample Number: **191926-008** **Date Collected:** **05/29/2019 12:37** **Date Received:** **6/4/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	5.29	mg/L		0.04	0.01	CRJ	06/17/2019 23:55	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.18	mg/L		0.06	0.01	CRJ	06/17/2019 23:55	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	41.6	mg/L		0.4	0.06	CRJ	06/17/2019 23:55	EPA 300.1-1997, Rev. 1.0

Duplicate BASP

Sample Number: **191926-009** **Date Collected:** **05/30/2019 10:52** **Date Received:** **6/4/2019**

Parameter	Result	Units	Data Qual	RL	MDL	Analysis By	Analysis Date/Time	Method
Chloride, Cl	14.6	mg/L		0.04	0.01	CRJ	06/18/2019 00:18	EPA 300.1-1997, Rev. 1.0
Fluoride, F	0.15	mg/L		0.06	0.01	CRJ	06/18/2019 00:18	EPA 300.1-1997, Rev. 1.0
Sulfate, SO4	52.8	mg/L		0.4	0.06	CRJ	06/18/2019 00:18	EPA 300.1-1997, Rev. 1.0

ATTACHMENT D

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 Welsh Bottom Ash Storage Pond 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

BETH ANN GROSS
79864

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

9/2/19
Date

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
J. Robert Welsh Power Plant

Landfill CCR Management Unit

1187 Country Road 4865
Titus County
Pittsburg, 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), Welsh 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 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Semi-annual Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- No statistically significant levels (SSLs) were identified;
- Statistically significant increases (SSIs) remain without alternate source demonstrations, keeping the unit in assessment monitoring.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared in accordance with 40 CFR 257.93 and certified. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).
- This CCR Unit remained in assessment monitoring throughout 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;
- Statistical reports are located in Appendix II

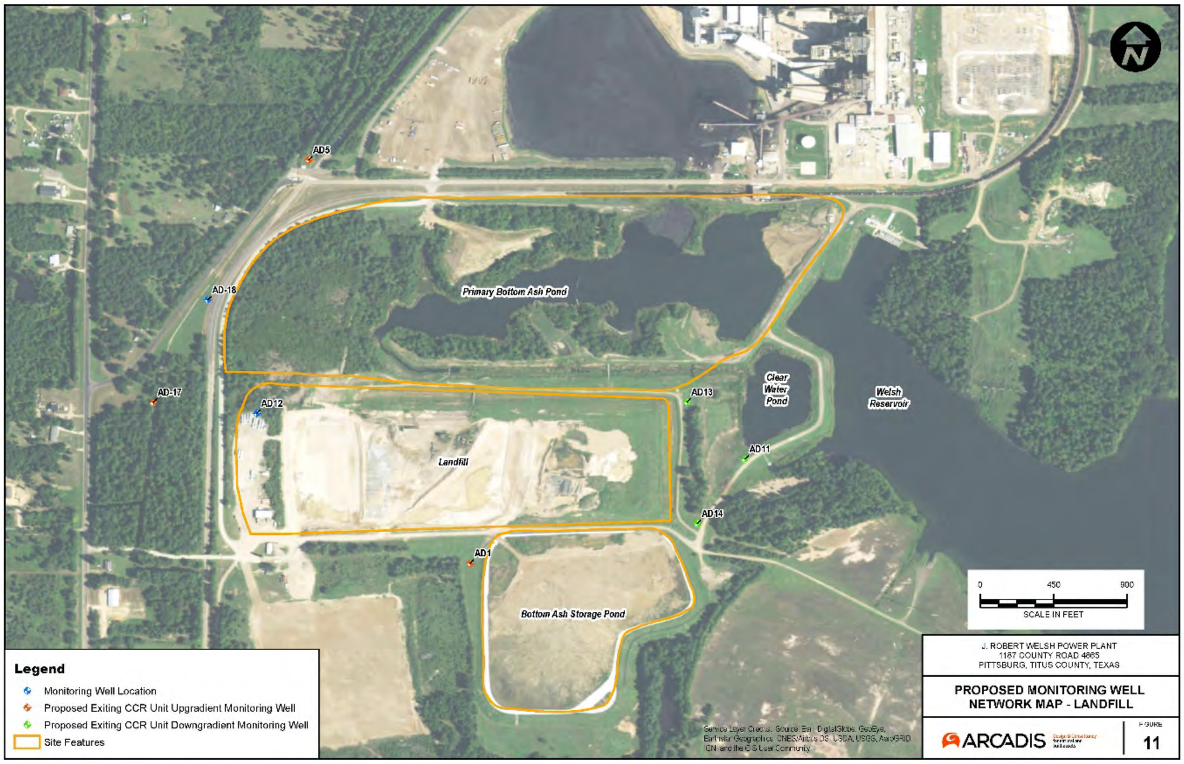
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over 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-1	AD-11
AD-5	AD-13
AD-17	AD-14



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\Dec2017Update\fig 11 - proposed wells_v2.mxd

III. Monitoring Wells Installed or Decommissioned

During 2019, no monitoring wells were installed or decommissioned during this time period.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data obtained under 40 CFR 257.90 through 275.9. 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.

The sampling event conducted 5/30/19 satisfies the requirement of 257.95(b).

V. Statistical Evaluations completed in 2019

During the 2nd semi-annual 2018 event the following SSIs were determined:

- Boron concentrations exceeded the interwell UPL of 0.77 mg/L at AD-11 (1.84 mg/L), AD-13 (1.49 mg/L), and AD-14 (1.51 mg/L).
- Chloride concentrations exceeded the intrawell UPLs of 12.6 mg/L at AD-11 (15.0 mg/L) and 6.45 mg/L at AD-14 (12.00 mg/L).
- pH value was below the interwell LPL of 4.29 SU at AD-14 (4.27 SU).
- Sulfate concentration exceeded the intrawell UPL of 131 mg/L at AD-14 (204 mg/L).
- TDS concentration exceeded the intrawell UPL of 325 mg/L at AD-14 (384 mg/L).

SSLs were not determined for the landfill during 2nd semi-annual 2018 event.

During the 1st semi-annual 2019 event, the following SSIs were determined:

- Boron concentrations exceeded the interwell UPL of 0.775 mg/L at AD-11 (1.63 mg/L and 1.34 mg/L) and AD-14 (1.20 mg/L and 1.04 mg/L).

SSLs were not determined for the landfill during the 1st semi-annual 2019 event.

During the 2nd semi-annual 2019 event, the following SSIs were determined:

- Boron concentrations exceeded the interwell UPL of 0.700 mg/L at AD-11 (1.56 mg/L), AD-13 (0.780 mg/L), and AD-14 (1.25 mg/L).
- TDS concentration at AD-14 exceeded the intrawell UPL of 369 mg/L at AD-14 (440 mg/L).

SSLs were not determined for the landfill during the 2nd semi-annual 2019 event.

These SSIs cause the unit to remain in assessment monitoring.

The statistical reports completed in 2019 are found in Appendix II

VI. Alternate Source Demonstrations completed in 2019

No ASDs were conducted for the landfill's SSIs.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

This unit remains in assessment monitoring.

VIII. Other Information Required

As required by the CCR assessment monitoring rules in 40 CFR 257.95 (b) and (d 1), sampling all CCR wells for the required Appendix III and IV parameters was completed in 2019. Statistical comparison of Appendix III and IV parameters to the GWPSs was completed in 2019.

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 will continue;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for SSIs as well as 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 Well
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- CCR Units

Notes

- Monitoring well coordinates and water level data (collected on February 20-21, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

500 250 0 500
Feet

Groundwater Potentiometric Map
February 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
1

Columbus, Ohio
2020/01/22

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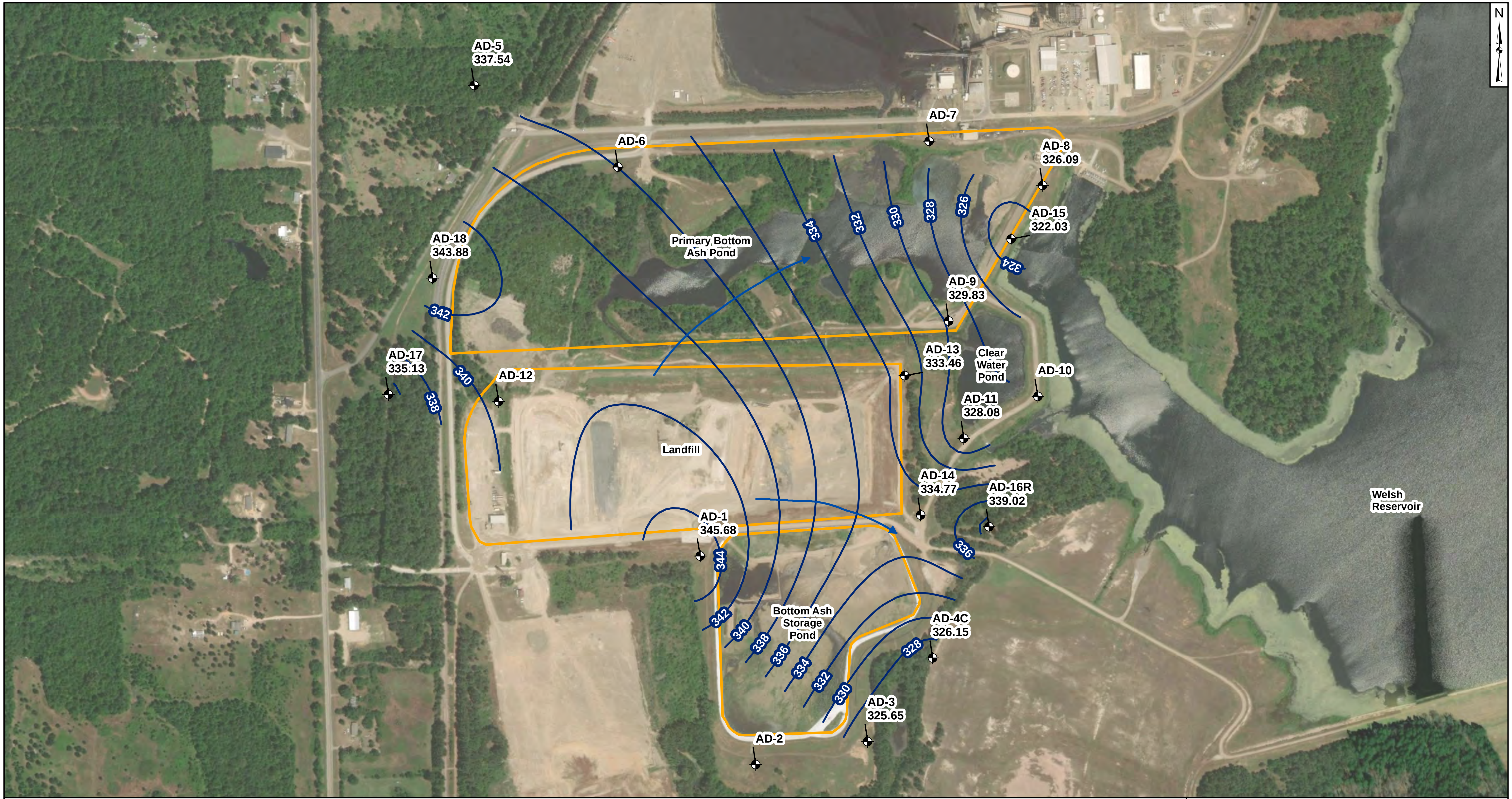

Legend
- ⌖ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- ▭ CCR Units

Notes
- Monitoring well coordinates and water level data (collected on May 29-30, 2019) provided by AEP.
- AD-10, AD-6, AD-7, AD-2, and AD-12 were not gauged during this event
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- AD-16 was replaced with AD-16R on 4/12/2017.

750 375 0 750
Feet

Groundwater Potentiometric Map
May 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Columbus, Ohio
2019/12/12

Figure
2

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Legend
- ⯐ Groundwater Monitoring Well
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)
- ▭ CCR Units

Notes
- Monitoring well coordinates and water level data (collected on July 23-24, 2019) provided by AEP.
-AD-12 and AD-6 were not gauged during this event.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016).
- Groundwater elevation units are feet above mean sea level.
- Inferred groundwater contours were ectrapolated from topographic and hydrographic information as well as previous monitoring events.

750 375 0 750
Feet

Groundwater Potentiometric Map
July 2019

AEP Welsh Power Plant
Cason, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio
2020/01/22

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Welsh\2019\AEP-Welsh_GW_2019-07July.mxd. ARevezzo. 1/22/2020. CHA8423/14/08.

Table 1: Residence Time Calculation Summary
Welsh Landfill

			2019-02		2019-05		2019-07	
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)
Landfill	AD-5 [1]	2.0	1.5	40.2	2.4	25.4	2.1	29.2
	AD-11 [2]	2.0	5.3	11.4	7.4	8.2	4.4	13.9
	AD-13 [2]	0.0	2.5	24.7	4.8	12.8	3.8	15.8
	AD-14 [2]	0.0	3.5	17.2	1.9	32.2	1.9	32.9
	AD-1 [1]	2.0	2.7	22.4	5.3	11.5	4.1	14.9
	AD-17 [1]	2.0	8.9	6.9	4.7	13.0	3.5	17.5

Notes:

[1] - Upgradient Well

[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-1
Welsh - LF
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
5/26/2016	Background	0.346	36.5	5	<0.083 U	5.9	252	42
7/29/2016	Background	0.35	39.6	4	<0.083 U	5.3	239	36
9/30/2016	Background	0.332	15	5	<0.083 U	5.4	173	35
10/21/2016	Background	0.398	19.1	4	<0.083 U	5.2	192	42
12/14/2016	Background	0.394	8.74	4	<0.083 U	5.2	200	40
1/20/2017	Background	0.656	129	4	<0.083 U	7.1	538	68
2/24/2017	Background	0.7	147	9	<0.083 U	6.9	612	68
6/8/2017	Background	0.449	15.1	4	<0.083 U	5.1	176	42
10/6/2017	Detection	0.453	14.3	4	<0.083 U	5.3	160	40
5/24/2018	Assessment	0.345	10.2	4	<0.083 U	2.2	150	43
8/14/2018	Assessment	0.443	5.95	5	<0.083 U	5.2	160	44
2/20/2019	Assessment	0.504	142	2.82	0.24	7.3	522	49.2
5/30/2019	Assessment	0.689	138	1.59	0.29	6.7	588	43.3
7/24/2019	Assessment	0.644	62.7	2	0.106 J	6.0	180	58

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-1
Welsh - LF
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
5/26/2016	Background	<0.93 U	1.39361 J	191	0.271453 J	0.213294 J	0.240267 J	1.15339 J	1.184	<0.083 U	<0.68 U	0.01	0.033	0.53149 J	1.74922 J	0.959865 J
7/29/2016	Background	<0.93 U	<1.05 U	191	0.315631 J	0.0940357 J	<0.23 U	0.615933 J	0.9952	<0.083 U	<0.68 U	0.019	0.00793 J	<0.29 U	1.81763 J	<0.86 U
9/30/2016	Background	<0.93 U	2.96797 J	141	0.382874 J	<0.07 U	5	0.850408 J	1.38	<0.083 U	3.38434 J	0.014	0.01773 J	<0.29 U	1.02629 J	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	114	0.311247 J	<0.07 U	0.412131 J	0.649606 J	1.141	<0.083 U	<0.68 U	0.008	0.00534 J	1.39872 J	2.03168 J	1.25062 J
12/14/2016	Background	<0.93 U	<1.05 U	72	0.34133 J	<0.07 U	<0.23 U	0.424105 J	0.719	<0.083 U	<0.68 U	0.008	0.01521 J	<0.29 U	1.85825 J	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	410	0.0366913 J	<0.07 U	<0.23 U	0.480125 J	3.009	<0.083 U	<0.68 U	0.000275956 J	<0.005 U	<0.29 U	4.04737 J	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	488	<0.02 U	<0.07 U	<0.23 U	0.765099 J	4.309	<0.083 U	<0.68 U	0.001	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	1.14 J	93.46	0.37 J	<0.07 U	0.66 J	0.77 J	0.676	<0.083 U	<0.68 U	0.00902	0.007 J	<0.29 U	2.1 J	<0.86 U
5/24/2018	Assessment	3.17 J	<1.05 U	79.9	0.39 J	<0.07 U	<0.23 U	0.35 J	1.983	<0.083 U	<0.68 U	0.00814	0.006 J	<0.29 U	1.38 J	<0.86 U
8/14/2018	Assessment	0.03 J	0.21	63	0.482	0.02	- -	- -	1.102	<0.083 U	0.238	0.00708	0.013 J	0.210	1.7	0.03 J
2/20/2019	Assessment	0.16	0.46	457	0.09 J	0.01 J	0.306	0.399	3.159	0.24	0.124	0.00155	<0.005 U	1 J	0.7	<0.1 U
5/30/2019	Assessment	0.16	0.60	512	0.244	0.01 J	0.1 J	0.756	2.717	0.29	0.197	<0.009 U	<0.005 U	2.43	1.4	<0.1 U
7/24/2019	Assessment	0.08 J	0.39	245	0.54	0.02 J	0.1 J	0.789	1.819	0.106 J	0.1 J	0.00557	<0.005 U	2 J	3.4	<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-5
Welsh - LF
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
5/31/2016	Background	0.03	36.9	15	0.3469 J	6.4	337	123
7/29/2016	Background	0.04	44.7	16	<0.083 U	5.4	360	163
9/30/2016	Background	0.04	46.3	15	0.2436 J	5.3	416	190
10/21/2016	Background	0.05	50.7	14	<0.083 U	5.9	448	267
12/14/2016	Background	0.05	49.6	13	<0.083 U	6.2	484	233
1/20/2017	Background	0.04	49.8	14	<0.083 U	6.3	438	234
2/24/2017	Background	0.04	33	15	<0.083 U	5.5	286	127
6/8/2017	Background	0.05281	49.7	14	<0.083 U	6.0	300	82
10/6/2017	Detection	0.04322	33.1	16	<0.083 U	5.6	258	82
5/24/2018	Assessment	0.05007	28.1	22	<0.083 U	6.2	242	60
8/15/2018	Assessment	0.05	40.5	19	<0.083 U	6.2	428	240
2/21/2019	Assessment	0.033	33.9	24.7	0.21	5.4	220	46.5
5/30/2019	Assessment	0.03 J	30.0	22.3	0.29	6.3	238	51.3
7/24/2019	Assessment	0.04 J	41.1	18	0.112 J	6.3	354	90

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-5
Welsh - LF
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
5/31/2016	Background	<0.93 U	<1.05 U	57	0.149801 J	0.0765156 J	0.555038 J	14	1.634	0.3469 J	<0.68 U	0.135	0.01135 J	<0.29 U	<0.99 U	<0.86 U
7/29/2016	Background	2.05116 J	2.90819 J	93	0.518653 J	0.502155 J	0.411466 J	15	4.75	<0.083 U	<0.68 U	0.191	0.01516 J	<0.29 U	1.08901 J	<0.86 U
9/30/2016	Background	<0.93 U	4.7609 J	87	0.251584 J	<0.07 U	0.90676 J	14	3.33	0.2436 J	<0.68 U	0.186	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	70	0.08781 J	0.107488 J	0.248085 J	9	2.319	<0.083 U	<0.68 U	0.225	<0.005 U	1.36984 J	<0.99 U	<0.86 U
12/14/2016	Background	<0.93 U	1.15381 J	53	0.164529 J	0.203546 J	0.747921 J	13	2.182	<0.083 U	<0.68 U	0.199	0.00802 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	47	0.0574718 J	0.180502 J	<0.23 U	12	1.023	<0.083 U	<0.68 U	0.239	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	42	0.0306858 J	<0.07 U	<0.23 U	13	1.788	<0.083 U	<0.68 U	0.166	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	3.85 J	87.7	0.08 J	0.39 J	0.28 J	11.93	2.32	<0.083 U	<0.68 U	0.124	<0.005 U	<0.29 U	<0.99 U	<0.86 U
5/24/2018	Assessment	<0.93 U	<1.05 U	71.16	<0.02 U	0.23 J	0.8 J	14.24	1.946	<0.083 U	<0.68 U	0.121	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/15/2018	Assessment	0.01 J	1.69	63.7	0.055	0.008 J	0.072	11.4	0.316	<0.083 U	0.079	0.147	<0.005 U	0.13	0.08 J	<0.01 U
2/21/2019	Assessment	0.02 J	1.59	69.4	0.08 J	<0.01 U	0.432	8.58	1.267	0.21	0.147	0.0807	<0.005 U	<0.4 U	0.1 J	<0.1 U
5/30/2019	Assessment	<0.02 U	3.05	60.5	0.08 J	<0.01 U	0.06 J	11.8	1.431	0.29	0.05 J	0.104	0.006 J	<0.4 U	0.05 J	<0.1 U
7/24/2019	Assessment	<0.02 U	2.48	77.4	0.05 J	<0.01 U	0.05 J	8.38	2.533	0.112 J	<0.05 U	0.108	<0.005 U	<0.4 U	0.06 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-11
Welsh - LF
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
5/31/2016	Background	2.47	8.47	9	2	5.2	388	518
7/29/2016	Background	2.83	8.88	10	2	3.8	1000	596
9/30/2016	Background	3.4	10.7	12	2	4.1	1065	683
10/21/2016	Background	3.77	8.78	11	3	3.7	1024	706
12/14/2016	Background	3.36	8.98	10	2	3.8	1044	548
1/20/2017	Background	2.81	10.3	11	2	4.4	1048	760
2/24/2017	Background	2.88	9.31	10	2	4.3	876	558
6/8/2017	Background	2.79	9.93	10	1.366	3.9	960	556
10/6/2017	Detection	2.58	6.99	10	<0.083 U	4.4	752	527
1/18/2018	Detection	1.9	- -	- -	- -	4.5	564	377
5/23/2018	Assessment	- -	- -	- -	<0.083 U	4.1	- -	- -
8/15/2018	Assessment	- -	- -	- -	<0.083 U	4.7	- -	- -
9/17/2018	Assessment	1.84	6.61	15	- -	- -	720	410
2/5/2019	Assessment	1.47	4.56	9.47	0.47	4.3	- -	225
2/21/2019	Assessment	1.63	19.1	9.23	0.41	4.9	542	306
4/30/2019	Assessment	1.34	7.53	- -	- -	5.3	- -	- -
5/29/2019	Assessment	1.40	5.78	6.96	0.47	4.2	680	367
7/23/2019	Assessment	1.56	7.19	6	0.338 J	4.5	700	342

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-11
Welsh - LF
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
5/31/2016	Background	<0.93 U	<1.05 U	14	4	0.325877 J	3	26	1.773	2	<0.68 U	0.032	0.02258 J	<0.29 U	1.54658 J	<0.86 U
7/29/2016	Background	<0.93 U	<1.05 U	12	4	0.453906 J	0.581828 J	26	2.23	2	<0.68 U	0.047	0.00624 J	<0.29 U	1.63477 J	1.31673 J
9/30/2016	Background	<0.93 U	1.77308 J	52	5	0.579196 J	7	30	3.92	2	4.25302 J	0.047	0.01924 J	<0.29 U	2.09096 J	1.07034 J
10/21/2016	Background	<0.93 U	<1.05 U	20	5	0.515668 J	2	27	2.56	3	<0.68 U	0.047	0.0156 J	1.51918 J	<0.99 U	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	13	4	0.366319 J	0.365212 J	25	1.569	2	<0.68 U	0.041	0.01212 J	<0.29 U	1.57203 J	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	13	4	0.394925 J	0.749253 J	25	1.082	2	<0.68 U	0.046	<0.005 U	<0.29 U	<0.99 U	1.23139 J
2/24/2017	Background	<0.93 U	<1.05 U	19	4	0.430668 J	2	24	1.45	2	1.18289 J	0.035	0.01613 J	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	1.23 J	10.12	2.79	0.41 J	0.32 J	22.16	1.902	1.366	<0.68 U	0.03654	<0.005 U	<0.29 U	<0.99 U	<0.86 U
5/23/2018	Assessment	<0.93 U	2.6 J	16.27	0.89 J	0.18 J	0.8 J	8.63	1.912	<0.083 U	<0.68 U	0.01875	0.007 J	<0.29 U	1.34 J	46
8/15/2018	Assessment	0.02 J	1.05	11.9	1.18	0.37	0.257	15.3	2.568	<0.083 U	1.42	0.0175	<0.005 U	0.05 J	2.4	0.2
2/21/2019	Assessment	0.03 J	0.51	40.3	0.824	0.19	0.259	8.58	1.506	0.41	0.523	0.0157	<0.005 U	<0.4 U	1.5	0.1 J
5/29/2019	Assessment	<0.02 U	0.78	19.1	1.05	0.20	0.369	9.82	1.473	0.47	0.847	0.02 J	<0.005 U	<0.4 U	2.2	0.1 J
7/23/2019	Assessment	<0.02 U	0.59	16.4	0.987	0.24	0.413	10.5	2.246	0.338 J	0.976	0.0153	<0.005 U	<0.4 U	1.0	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-13
Welsh - LF
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
5/31/2016	Background	1.19	8.02	12	0.4948 J	6.1	900	177
7/29/2016	Background	1.23	3.7	15	0.7416 J	4.5	404	187
9/30/2016	Background	1.37	2.7	17	0.6464 J	4.6	431	207
10/21/2016	Background	1.67	3.66	19	1.1263	4.3	482	226
12/14/2016	Background	1.96	3.77	18	0.4149 J	4.8	596	287
1/20/2017	Background	0.402	33.5	7	<0.083 U	5.4	222	90
2/24/2017	Background	1.27	10.3	13	<0.083 U	5.1	392	183
6/8/2017	Background	1.68	3.03	15	0.6679 J	4.2	494	244
10/6/2017	Detection	2.23	5.11	13	<0.083 U	4.6	564	345
1/18/2018	Detection	2.13	- -	- -	- -	4.7	588	383
5/23/2018	Assessment	- -	- -	- -	0.6534 J	4.5	- -	- -
8/14/2018	Assessment	- -	- -	- -	0.7442 J	4.8	- -	- -
9/17/2018	Assessment	1.49	10.1	18	- -	- -	620	316
2/5/2019	Assessment	0.656	5.85	5.43	0.39	4.5	- -	130
2/20/2019	Assessment	0.484	17.7	3.95	0.28	4.9	234	96.3
4/30/2019	Assessment	0.483	- -	- -	- -	4.9	- -	- -
5/30/2019	Assessment	0.477	9.88	3.60	0.53	5.2	196	94.0
7/23/2019	Assessment	0.78	6.16	5	0.169 J	4.8	334	146

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
Welsh - LF
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
5/31/2016	Background	<0.93 U	<1.05 U	62	0.682114 J	<0.07 U	0.690428 J	4.11633 J	1.223	0.4948 J	<0.68 U	0.011	0.01797 J	<0.29 U	1.4772 J	<0.86 U
7/29/2016	Background	<0.93 U	<1.05 U	36	0.922975 J	0.0850015 J	<0.23 U	4.46011 J	1.601	0.7416 J	<0.68 U	0.026	0.00515 J	<0.29 U	2.00998 J	<0.86 U
9/30/2016	Background	<0.93 U	<1.05 U	40	0.827513 J	0.0965393 J	0.77177 J	4.59287 J	2.213	0.6464 J	<0.68 U	0.020	<0.005 U	<0.29 U	1.03137 J	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	30	0.934335 J	0.0913657 J	0.581648 J	4.91926 J	3.662	1.1263	<0.68 U	0.022	<0.005 U	0.870491 J	1.03637 J	0.97358 J
12/14/2016	Background	<0.93 U	3.69546 J	51	1	0.185393 J	7	7	2.27	0.4149 J	1.09698 J	0.025	0.01565 J	0.353324 J	1.64297 J	<0.86 U
1/20/2017	Background	<0.93 U	6.00	112	0.198035 J	<0.07 U	4	1.76949 J	2.228	<0.083 U	2.72659 J	0.004	0.00673 J	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	41	0.612394 J	<0.07 U	<0.23 U	4.55541 J	1.556	<0.083 U	<0.68 U	0.015	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	1.53 J	<1.05 U	17.12	0.89 J	0.14 J	<0.23 U	6.24	1.565	0.6679 J	<0.68 U	0.02082	<0.005 U	<0.29 U	1.03 J	<0.86 U
5/23/2018	Assessment	<0.93 U	<1.05 U	26.53	0.87 J	<0.07 U	0.73 J	9.37	2.16	0.6534 J	<0.68 U	0.0291	0.008 J	<0.29 U	<0.99 U	<0.86 U
8/14/2018	Assessment	0.03 J	1.37	16.9	0.971	0.31	0.503	13.1	4.037	0.7442 J	1	0.0321	<0.005 U	0.06 J	1.7	0.277
2/20/2019	Assessment	0.02 J	0.380	55.2	0.302	0.05	0.2 J	2.35	2.534	0.28	0.05 J	0.0094	<0.005 U	<0.4 U	0.4	<0.1 U
5/30/2019	Assessment	0.03 J	0.320	60.9	0.385	0.07	0.310	3.15	3.15	0.53	0.05 J	0.009 J	<0.005 U	<0.4 U	0.4	<0.1 U
7/23/2019	Assessment	0.02 J	0.370	23.6	0.443	0.09	0.283	3.82	1.748	0.169 J	0.204	0.0175	<0.005 U	<0.4 U	0.3	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-14
Welsh - LF
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
5/31/2016	Background	1.28	2.88	4	<0.083 U	4.8	285	115
7/29/2016	Background	1.14	2.51	5	<0.083 U	4.2	267	111
9/30/2016	Background	1.14	1.19	5	<0.083 U	4.2	252	111
10/21/2016	Background	1.25	2.48	4	<0.083 U	3.9	276	118
12/14/2016	Background	1.25	2.41	5	<0.083 U	4.1	296	101
1/20/2017	Background	0.915	10.3	4	<0.083 U	6.1	254	92
2/24/2017	Background	1.06	9.48	4	<0.083 U	5.4	212	90
6/8/2017	Background	1.26	7.69	6	<0.083 U	4.8	256	108
10/6/2017	Detection	1.63	3.55	10	<0.083 U	4.6	288	143
1/18/2018	Detection	1.57	- -	6.43	- -	5.7	- -	- -
5/23/2018	Assessment	- -	- -	- -	<0.083 U	4.2	- -	- -
8/14/2018	Assessment	- -	- -	- -	<0.083 U	4.3	- -	- -
9/17/2018	Assessment	1.51	4.51	12	- -	- -	384	204
2/5/2019	Assessment	1.1	4.13	3.13	0.15	4.3	- -	99.9
2/20/2019	Assessment	1.2	10.3	2.2	0.14	4.3	236	90.4
4/30/2019	Assessment	1.04	- -	- -	- -	4.4	- -	- -
5/29/2019	Assessment	1.21	9.80	3.65	0.19	4.5	274	122
7/23/2019	Assessment	1.25	9.93	8	0.162 J	5.5	440	171

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-14
Welsh - LF
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**
5/31/2016	Background	<0.93 U	1.89384 J	31	0.65845 J	0.99504 J	0.536293 J	10	0.871	<0.083 U	<0.68 U	0.012	0.03	<0.29 U	2.91711 J	<0.86 U
7/29/2016	Background	<0.93 U	<1.05 U	84	0.653837 J	0.976466 J	1	9	1.487	<0.083 U	<0.68 U	0.024	0.02159 J	<0.29 U	1.93417 J	<0.86 U
9/30/2016	Background	<0.93 U	1.45308 J	30	0.473938 J	0.975306 J	0.775009 J	9	4.817	<0.083 U	<0.68 U	0.015	0.02217 J	<0.29 U	2.73939 J	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	39	0.543258 J	1	0.640984 J	9	1.972	<0.083 U	<0.68 U	0.014	0.02024 J	0.49697 J	2.46916 J	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	47	0.536415 J	1	1	9	1.271	<0.083 U	<0.68 U	0.013	0.037	<0.29 U	3.32013 J	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	38	0.215525 J	0.226476 J	0.700394 J	2.91252 J	1.825	<0.083 U	<0.68 U	0.013	0.01863 J	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	42	0.286071 J	0.187588 J	<0.23 U	3.50056 J	0.512	<0.083 U	<0.68 U	0.012	0.01443 J	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	<1.05 U	44.83	0.38 J	0.67 J	1.27	6.78	1.138	<0.083 U	<0.68 U	0.0127	0.021 J	<0.29 U	2.61 J	<0.86 U
5/23/2018	Assessment	<0.93 U	<1.05 U	28.17	0.78 J	1.61	<0.23 U	14.34	1.601	<0.083 U	<0.68 U	0.0152	0.145	<0.29 U	3.62 J	<0.86 U
8/14/2018	Assessment	0.01 J	0.39	24	0.854	1.99	0.276	17.6	1.502	<0.083 U	0.174	0.011	0.181	0.03 J	3.7	0.242
2/20/2019	Assessment	0.03 J	0.34	41.2	0.387	0.35	0.247	4.37	1.172	0.14	0.09 J	0.0114	<0.005 U	<0.4 U	0.8	<0.1 U
5/29/2019	Assessment	0.03 J	0.4	44.8	0.556	0.81	0.2 J	7.82	1.946	0.19	0.137	0.02 J	0.181	<0.4 U	2	<0.1 U
7/23/2019	Assessment	<0.02 U	0.43	36.2	0.934	2.49	0.286	18.5	2.731	0.162 J	0.2	0.0155	0.123	<0.4 U	2.7	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-17
Welsh - LF
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
5/26/2016	Background	0.121	200	43	0.4023 J	7.2	1810	1166
7/29/2016	Background	0.119	195	32	0.4135 J	5.7	1576	1005
9/30/2016	Background	0.111	191	36	0.3055 J	6.2	1663	1055
10/21/2016	Background	0.124	194	32	0.583 J	6.1	1612	1163
12/14/2016	Background	0.135	196	31	0.5399 J	6.0	1560	1096
1/20/2017	Background	0.101	196	33	<0.083 U	5.9	1686	1445
2/24/2017	Background	0.135	189	30	<0.083 U	5.7	1628	1055
6/8/2017	Background	0.121	188	30	<0.083 U	5.8	1578	1105
10/6/2017	Detection	0.183	183	31	<0.083 U	5.9	1548	1090
5/24/2018	Assessment	0.239	193	39	<0.083 U	6.3	1836	1067
8/15/2018	Assessment	0.118	187	40	<0.083 U	5.6	1748	1168
2/21/2019	Assessment	0.151	207	43.2	0.18	6.9	1722	1060
5/30/2019	Assessment	0.158	202	41.7	<0.04 U	6.1	1546	1120
7/24/2019	Assessment	0.113	216	37	0.085 J	6.0	1864	1127

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
Welsh - LF
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**
5/26/2016	Background	<0.93 U	1.37501 J	21	0.173275 J	2	1	63	1.525	0.4023 J	<0.68 U	0.37	0.032	<0.29 U	<0.99 U	<0.86 U
7/29/2016	Background	1.13716 J	<1.05 U	20	0.307264 J	4	1	68	2.78	0.4135 J	<0.68 U	0.374	0.02133 J	1.04115 J	4.56733 J	<0.86 U
9/30/2016	Background	<0.93 U	<1.05 U	31	0.175474 J	0.848199 J	3	58	2.358	0.3055 J	<0.68 U	0.354	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/21/2016	Background	<0.93 U	<1.05 U	34	0.200656 J	2	4	65	2.224	0.583 J	<0.68 U	0.394	<0.005 U	0.322249 J	3.34422 J	<0.86 U
12/14/2016	Background	<0.93 U	<1.05 U	17	0.0498325 J	3	0.816224 J	68	2.384	0.5399 J	<0.68 U	0.323	0.01485 J	<0.29 U	<0.99 U	<0.86 U
1/20/2017	Background	<0.93 U	<1.05 U	14	0.0319852 J	3	68	68	2.436	<0.083 U	<0.68 U	0.341	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/24/2017	Background	<0.93 U	<1.05 U	20	0.0665729 J	2	1	73	2.288	<0.083 U	<0.68 U	0.331	<0.005 U	<0.29 U	<0.99 U	<0.86 U
6/8/2017	Background	<0.93 U	<1.05 U	10.3	<0.02 U	6.06	<0.23 U	74.8	1.598	<0.083 U	<0.68 U	0.329	0.013 J	<0.29 U	<0.99 U	<0.86 U
5/24/2018	Assessment	<0.93 U	<1.05 U	9.65	<0.02 U	6.46	<0.23 U	71.73	1.939	<0.083 U	<0.68 U	0.308	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/15/2018	Assessment	0.02 J	1.83	12.8	0.069	0.25	0.604	43.5	2.35	<0.083 U	1.1	0.243	0.011 J	0.35	0.3	0.074
2/21/2019	Assessment	0.08 J	2.51	120	0.240	0.27	3.34	64.5	2.657	0.18	2.49	0.268	0.007 J	0.7 J	0.8	<0.1 U
5/30/2019	Assessment	<0.02 U	0.410	19.6	0.02 J	0.03 J	0.246	51.1	2.508	<0.04 U	0.03 J	0.341	<0.005 U	<0.4 U	0.06 J	<0.1 U
7/24/2019	Assessment	<0.02 U	1.07	14.3	0.13	0.03 J	0.228	57.7	3.45	0.085 J	0.263	0.283	<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

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
J. Robert Welsh Plant
Pittsburg, Texas

Submitted to

AMERICAN
ELECTRIC
POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

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January 8, 2019

CHA8473

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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 Welsh Power Plant located in Pittsburg, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, total dissolved solids (TDS), and sulfate at the LF. An alternate source was not identified at the time, so three assessment monitoring events were conducted at the LF in 2018, in accordance with 40 CFR 257.95.

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 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. No SSLs were identified, but Appendix III concentrations for boron, chloride, TDS, and sulfate remained above background. Thus, the unit will 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, samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) and 257.95(d)(1). Samples collected from background wells for the May and August 2018 sampling events were analyzed for both Appendix III and Appendix IV parameters, whereas samples collected from downgradient wells were analyzed for Appendix IV parameters only. Lead and molybdenum values for the August 2018 are not reported as they were not detected in any wells during the first event. Additional samples were collected from downgradient wells for Appendix III parameters in September 2018. A summary of data collected during assessment monitoring 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.9.5 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(b) and 257.95(d)(1) were screened for potential outliers. The reported chromium value of 0.068 milligrams per liter (mg/L) for the January 20, 2017 sampling event at background well AD-17 was removed as an outlier. The reported lithium value of 0.024 mg/L for the July 29, 2016 sampling event at compliance well AD-14 was also removed as an outlier.

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 regional screening level (RSL) 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. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for barium, beryllium, and combined radium. Non-parametric tolerance limits were calculated for arsenic, chromium, cobalt, lithium, mercury, molybdenum, and selenium due to apparent non-normal distributions; for antimony, fluoride, lead, and thallium due to a high non-detect frequency; and for cadmium 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.

No SSLs were identified at the Welsh LF.

2.2.3 Evaluation of Potential Appendix III SSIs

The CCR rule allows CCR units to move from assessment monitoring to detection monitoring if all Appendix III and Appendix IV parameters were at or below background levels for two consecutive sampling events [40 CFR 257.95(e)]. Since no Appendix IV SSLs were identified, Appendix III results were analyzed 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, chloride, and pH, whereas interwell tests were used to evaluate potential SSIs for boron, fluoride, TDS, and sulfate.

Wells AD-1 and AD-17 were added to the monitoring well network following completion of the background statistics. Thus, the prediction limits were recalculated using both the background data from AD-1 and AD-17 and the data collected during the 2018 assessment monitoring events. Intrawell tests were selected for calcium, chloride, TDS, and sulfate, whereas interwell tests were selected for boron, fluoride and pH.

Data collected from each compliance well were compared to the prediction limits to evaluate SSIs. The results from this event and the prediction limits are summarized in Table 3. While the prediction limits were calculated assuming a 1-of-2 testing procedures, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the lower prediction limit (LPL) or the upper prediction limit (UPL) based on results from previously unsuccessful alternative source demonstrations (ASDs). The following exceedances of the LPLs/UPLs were noted:

- Boron concentrations exceeded the interwell UPL of 0.77 mg/L at AD-11 (1.84 mg/L), AD-13 (1.49 mg/L), and AD-14 (1.51 mg/L).
- Chloride concentrations exceeded the intrawell UPLs of 12.6 mg/L at AD-11 (15.0 mg/L), and 6.45 mg/L at AD-14 (12.00 mg/L).
- The pH value was below the interwell LPL of 4.29 SU at AD-14 (4.27 SU).
- The sulfate concentration exceeded the intrawell UPL of 131 mg/L at AD-14 (204 mg/L).
- The TDS concentration exceeded the intrawell UPL of 325 mg/L at AD-14 (384 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Welsh LF during assessment monitoring. As a result, the Welsh LF CCR unit will remain in assessment monitoring.

2.3 Conclusions

Three assessment monitoring events were conducted in 2018 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 2018 data. GWPSs were 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. No SSLs were identified.

The Appendix III results were evaluated to assess whether concentrations of Appendix III parameters exceeded background levels. The prediction limits were recalculated using data from additional background wells and the 2018 sampling events. Intrawell tests were used to evaluate for calcium, chloride, TDS, and sulfate exeedances, whereas interwell tests were used to evaluate for boron, fluoride and pH exceedances. Boron, chloride, pH, sulfate, and TDS results exceeded background levels.

Based on this evaluation, the Welsh LF CCR unit will remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Welsh Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Landfill, J. Robert Welsh Plant, Pittsburg, Texas. January 15, 2018.

TABLES

Table 1 – Groundwater Data Summary
Welsh – Landfill

Parameter	Unit	AD-1		AD-5		AD-11			AD-13			AD-14			AD-17	
		5/24/2018	8/14/2018	5/24/2018	8/15/2018	5/23/2018	8/15/2018	9/17/2018	5/23/2018	8/14/2018	9/17/2018	5/23/2018	8/14/2018	9/17/2018	5/24/2018	8/15/2018
Antimony	mg/L	0.00317 J	0.0000300 J	0.005 U	0.0000100 J	0.005 U	0.0000200 J	-	0.005 U	0.0000300 J	-	0.005 U	0.0000100 J	-	0.005 U	0.0000200 J
Arsenic	mg/L	0.005 U	0.000210	0.005 U	0.00169	0.00260 J	0.00105	-	0.005 U	0.00137	-	0.005 U	0.000390	-	0.005 U	0.00183
Barium	mg/L	0.0799	0.0630	0.0712	0.0637	0.0163	0.0119	-	0.0265	0.0169	-	0.0282	0.0240	-	0.00965	0.0128
Beryllium	mg/L	0.000390 J	0.000482	0.001 U	0.0000550	0.000890 J	0.00118	-	0.000870 J	0.000971	-	0.000780 J	0.000854	-	0.001 U	0.0000690
Boron	mg/L	0.345	0.443	0.0501	0.0500	-	-	1.84	-	-	1.49	-	-	1.51	0.239	0.118
Cadmium	mg/L	0.001 U	0.0000200	0.000230 J	0.00000800 J	0.000180 J	0.000370	-	0.001 U	0.000310	-	0.00161	0.00199	-	0.00646	0.000250
Calcium	mg/L	10.2	5.95	28.1	40.5	-	-	6.61	-	-	10.1	-	-	4.51	193	187
Chloride	mg/L	4.00	5.00	22.0	19.0	-	-	15.0	-	-	18.0	-	-	12.0	39.0	40.0
Chromium	mg/L	0.001 U	0.00016	0.000800 J	0.0000720	0.000800 J	0.000257	-	0.000730 J	0.000503	-	0.001 U	0.000276	-	0.001 U	0.000604
Cobalt	mg/L	0.000350 J	0.000797	0.0142	0.0114	0.00863	0.0153	-	0.00937	0.0131	-	0.0143	0.0176	-	0.0717	0.0435
Combined Radium	pCi/L	1.98	1.10	1.95	0.316	1.91	2.57	-	2.16	4.07*	-	1.60	1.50*	-	1.94	2.35
Fluoride	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	-	0.653 J	0.7442 J	-	1 U	1 U	-	1 U	1 U
Lead	mg/L	0.005 U	NR	0.005 U	NR	0.005 U	0.00142	-	0.005 U	0.00100	-	0.005 U	0.000174	-	0.005 U	0.00110
Lithium	mg/L	0.00814	0.00708	0.121	0.147	0.0188	0.0175	-	0.0291	0.0321	-	0.0152	0.0110	-	0.308	0.243
Mercury	mg/L	0.00000600 J	0.0000130 J	0.000025 U	0.000025 U	0.00000700 J	0.000025 U	-	0.00000800 J	0.000025 U	-	0.000145	0.000181	-	0.000025 U	0.0000110 J
Molybdenum	mg/L	0.005 U	NR	0.005 U	NR	0.005 U	0.0000500 J	-	0.005 U	0.0000600 J	-	0.005 U	0.0000300 J	-	0.005 U	0.000350
Selenium	mg/L	0.00138 J	0.00170	0.005 U	0.0000800 J	0.00134 J	0.00240	-	0.005 U	0.00170	-	0.00362 J	0.00370	-	0.005 U	0.000300
Total Dissolved Solids	mg/L	150	160	242	428	-	-	720	-	-	620	-	-	384	1840	1750
Sulfate	mg/L	43.0	44.0	60.0	240	-	-	410	-	-	316	-	-	204	1070	1170
Thallium	mg/L	0.002 U	0.0000300 J	0.002 U	0.01 U	0.0460	0.000200	-	0.002 U	0.000277	-	0.002 U	0.000242	-	0.002 U	0.000074
pH	SU	2.19	5.18	6.22	6.23	4.05	4.73	-	4.52	4.82	-	4.17	4.27	-	6.28	5.60

Notes:
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
-: Not sampled
NR: Values are not reported as this parameter was not detected during the May 2018 event at any wells
*Sample collected on 8/15/2018
The fluoride values collected in August 2018 were also used in Appendix III analyses.

Table 2: Groundwater Protection Standards
Welsh Plant - Landfill

Constituent Name	MCL	RSL	Background Limit
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.36
Beryllium, Total (mg/L)	0.004		0.00077
Cadmium, Total (mg/L)	0.005		0.0065
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.075
Combined Radium, Total (pCi/L)	5		4.21
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.39
Mercury, Total (mg/L)	0.002		0.000033
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 (Upper Tolerance Limit) is higher than MCL.

MCL = Maximum Contaminant Level

RSL = Regional Screening Level

Calculated UTL represents site-specific background values.

The higher of the calculated UTL or MCL/RSL is used as the GWPS.

Table 3: Appendix III Data Evaluation
Welsh Plant - Landfill

Parameter	Units	Description	AD-11	AD-13	AD-14
			9/17/2018	9/17/2018	9/17/2018
Boron	mg/L	Interwell Background Value (UPL)	0.77		
	mg/L	Assessment Monitoring Result	**1.84**	**1.49**	**1.51**
Calcium	mg/L	Intrawell Background Value (UPL)	11.4	38.5	13.9
	mg/L	Assessment Monitoring Result	6.61	10.1	4.51
Chloride	mg/L	Intrawell Background Value (UPL)	12.6	24.0	6.45
	mg/L	Assessment Monitoring Result	**15**	18	**12**
Fluoride	mg/L	Interwell Background Value (UPL)	1.0		
	mg/L	Assessment Monitoring Result	<0.083	0.744	<0.83
pH	SU	Interwell Background Value (UPL)	7.05		
	SU	Interwell Background Value (LPL)	4.29		
	SU	Assessment Monitoring Result	4.73	4.82	**4.27**
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	1224	974	325
	mg/L	Assessment Monitoring Result	720	620	**384**
Sulfate	mg/L	Intrawell Background Value (UPL)	833	342	131
	mg/L	Assessment Monitoring Result	410	316	**204**

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

Fluoride and pH analyzed on 8/14-8/15/2018

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 Welsh 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

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

01.08.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

January 5, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Welsh Landfill
Assessment Monitoring Event 2018

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the September 2018 data for American Electric Power Inc.’s Welsh 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, consists of the following:

- **Upgradient wells:** AD-1, AD-5, and AD-17; and
- **Downgradient wells:** AD-11, AD-13 and AD-14

Data were sent electronically to Groundwater Stats Consulting, 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 Groundwater Stats Consulting.

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 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). Data were screened for trends and outliers during December 2017 and the results of those findings were submitted with that report. A summary of flagged values follows this report (Figure C). Values previously flagged as outliers may also be seen in a lighter font and disconnected symbol on the time series graphs. Since the original background screening, upgradient wells AD-1 and AD-17 were approved during 2018 for use as background wells at the Welsh Landfill. These data were previously evaluated during the November 2017 background screening as part of the Welsh PBAP monitoring well network, and no additional adjustments were required to the data sets. Data were, however, re-evaluated to determine the most appropriate statistical method, as described below, with the addition of the data from these upgradient wells.

Determination of Statistical Method

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 (Figure D). 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 variation for the following Appendix III parameters: boron, calcium, chloride, sulfate and TDS suggesting intrawell methods should be considered. No differences were noted for fluoride and pH; therefore, these parameters are eligible for interwell prediction limits. Boron, calcium, chloride, sulfate and TDS data were further evaluated as described below 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 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 the upgradient well. 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 the upgradient well, 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 upgradient well data for each of the Appendix III parameters (Figure E). 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 (Figure F). 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 all parameters except boron. Therefore, intrawell methods are recommended for calcium, chloride, sulfate and TDS; and interwell methods are initially recommended for boron, fluoride and pH. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through June 2017 at each well were used to establish intrawell background limits for the parameters identified above based on a 1-of-2 resample plan that will be used for future comparisons (Figure G). Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells AD-1, AD-5 and AD-17 (Figure H). 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 included in background when a minimum of 2 new samples are available. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points 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.

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, fluoride, and pH. Intrawell limits combined with a 1-of-2 verification strategy were constructed for calcium, chloride, sulfate and TDS.

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.

When upgradient wells exceed their background limits, it may be an indication that groundwater is changing naturally upgradient of the facility. Concentrations will continue to be monitored over the next sampling events. 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 I). Upgradient wells are included in the trend analyses to identify whether similar patters 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 well/parameter pairs. A Trend Test summary table follows this letter.

Evaluation of Appendix IV Parameters

Parametric tolerance limits were used to calculate background limits from pooled upgradient well data for Appendix IV parameters with a target of 95% confidence and 95% coverage to determine the Alternate Contaminant Level (ACL) (Figure J). 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 Regional Screening Levels (RSLs) 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 K).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, RSL, or ACL as discussed above (Figure L). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence intervals exceedances were found for any of the downgradient wells. 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 Welsh Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

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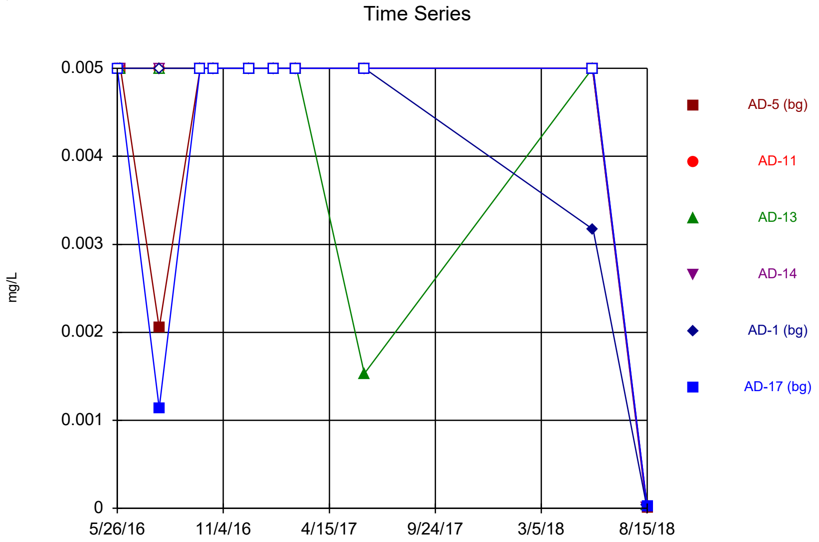
Hollow symbols indicate censored values.



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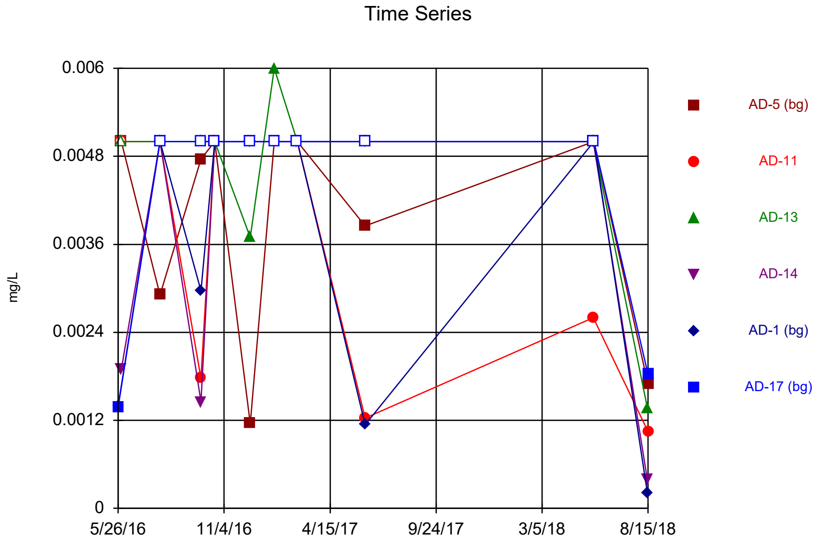

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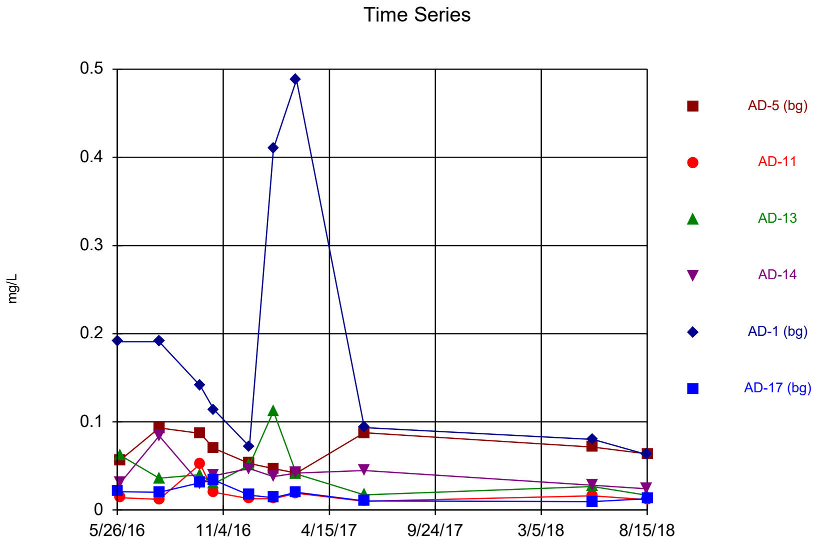

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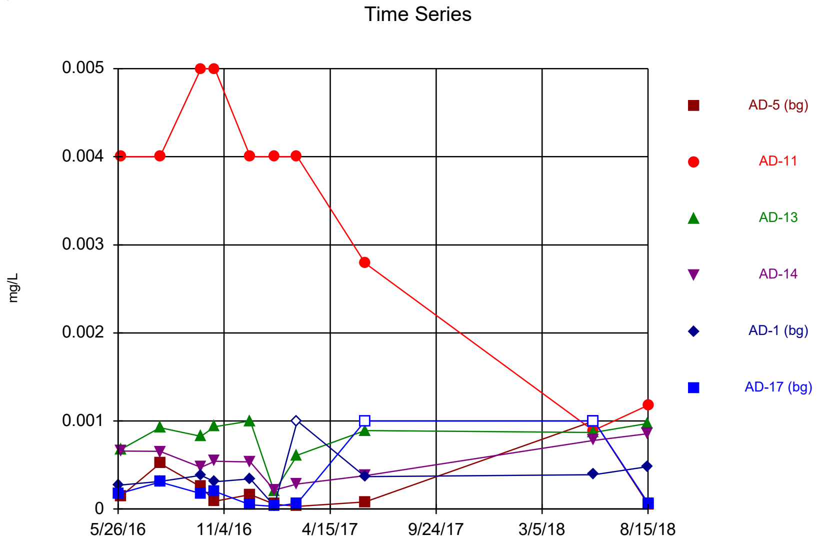

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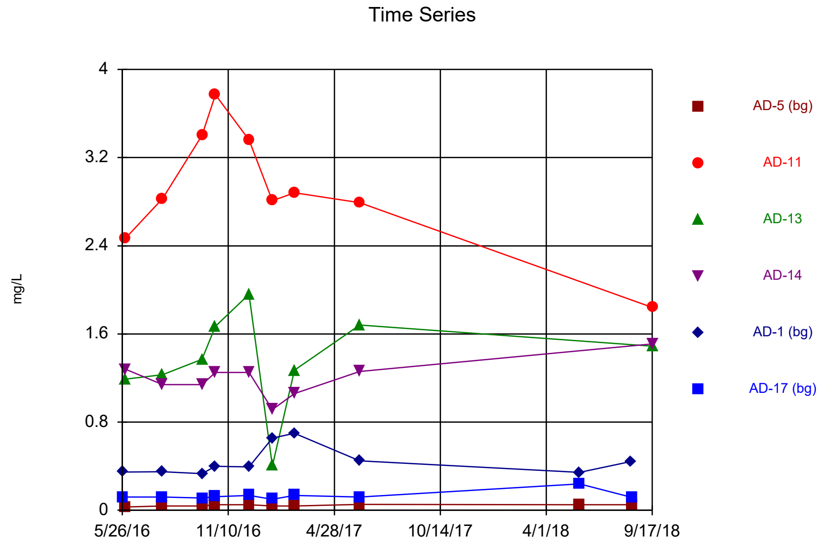

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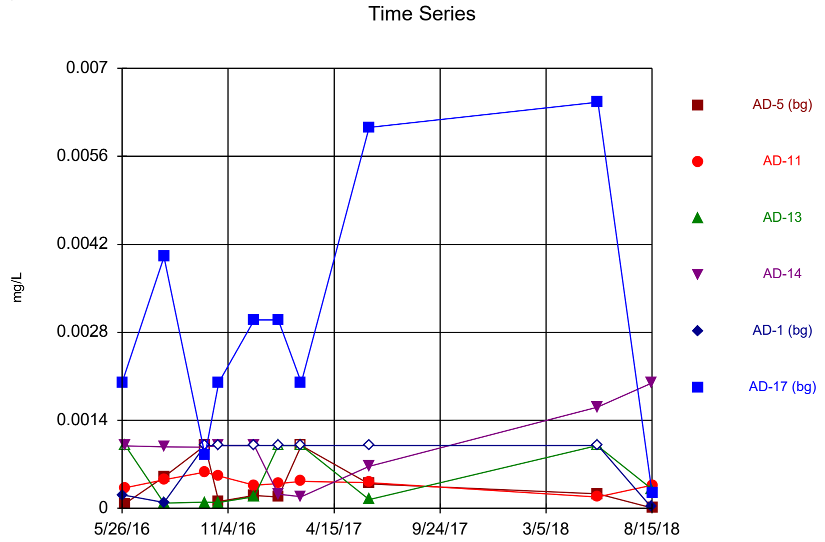

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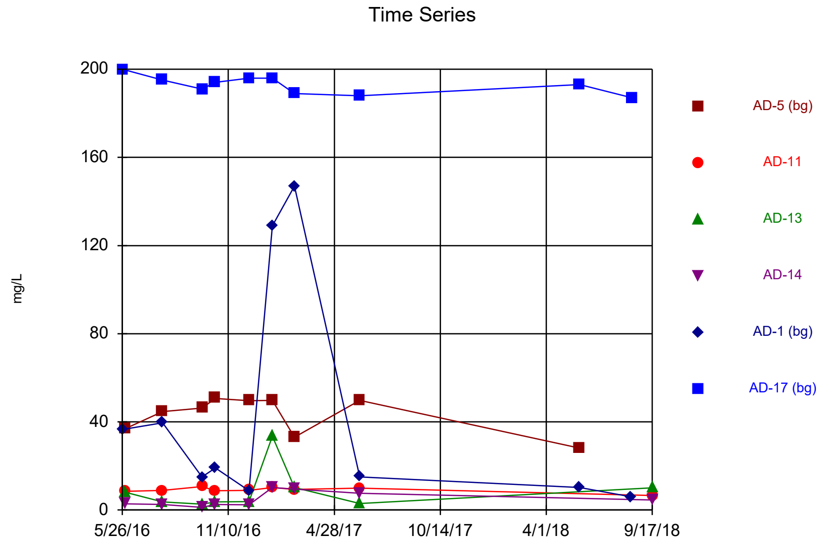

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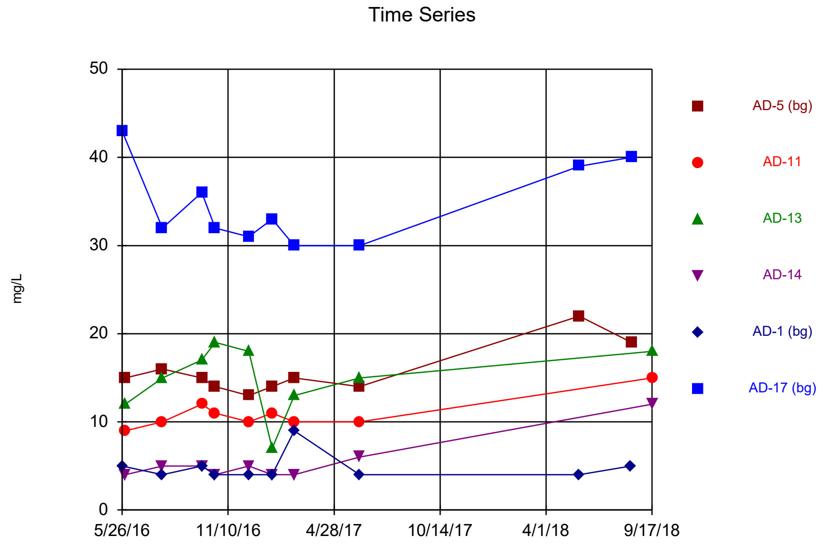

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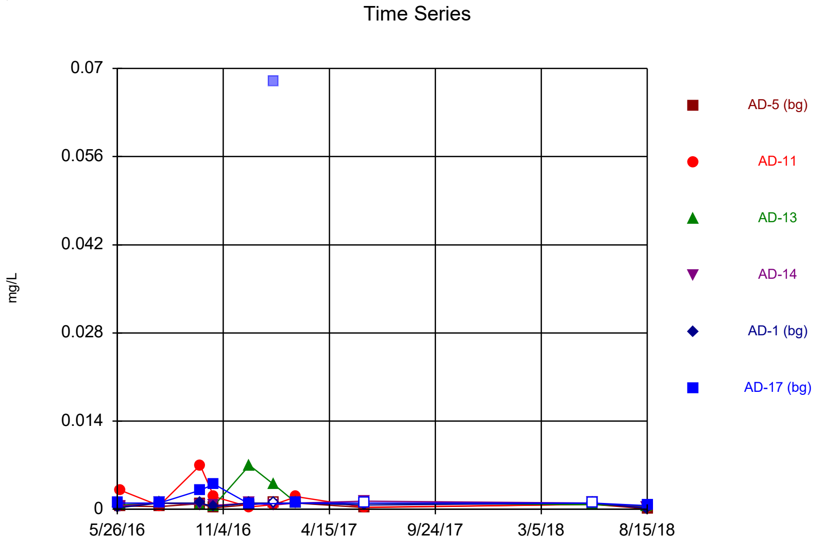

Constituent: Chromium, total   Analysis Run 12/24/2018 8:54 AM   View: Descriptive
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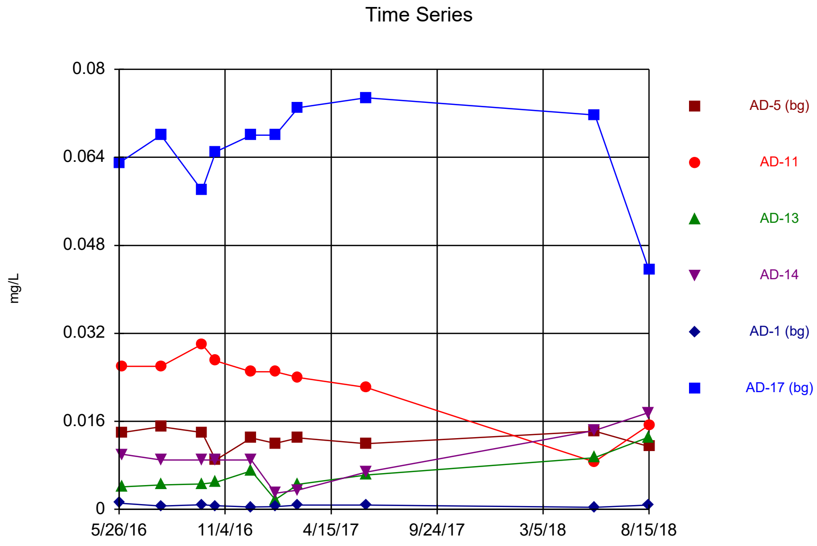

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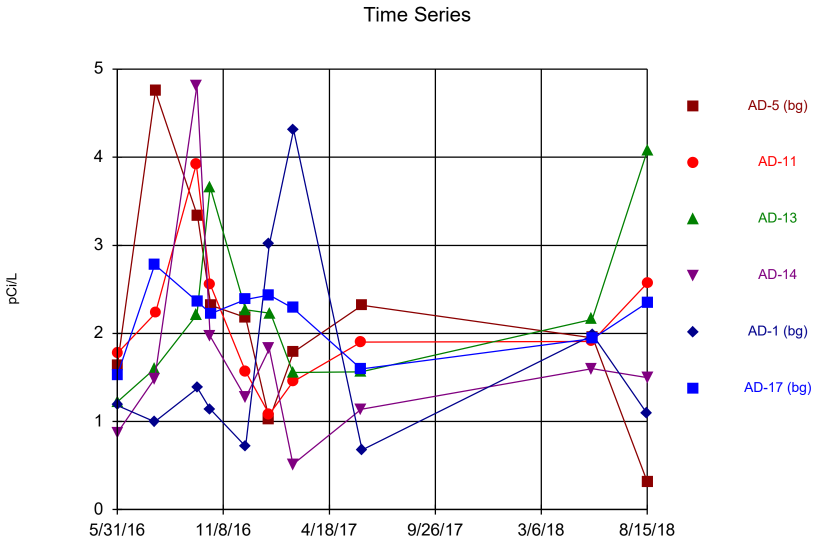

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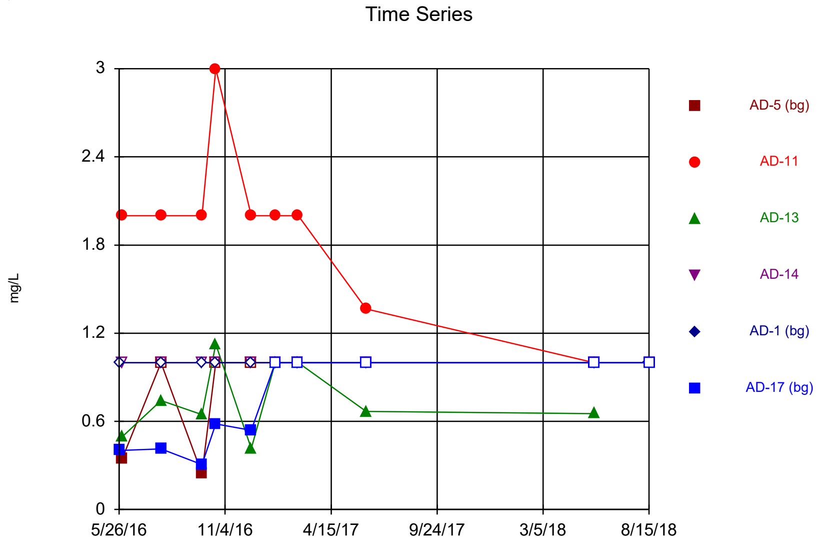

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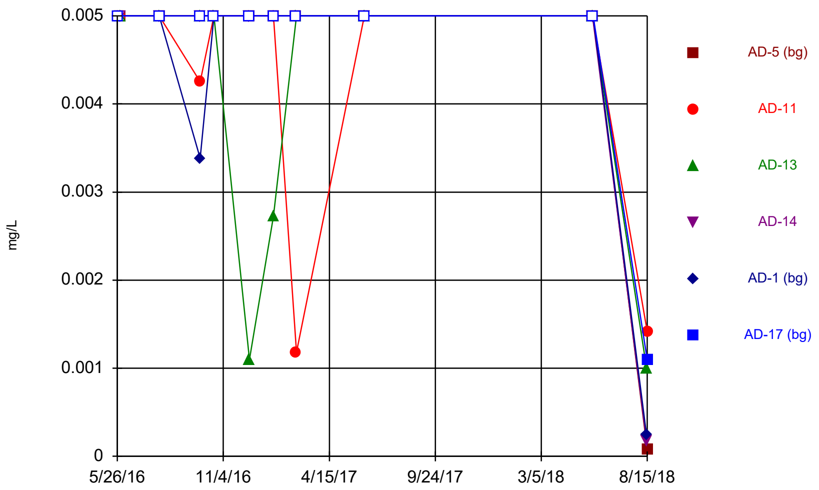
Hollow symbols indicate censored values.

Time Series



Constituent: Lead, total   Analysis Run 12/24/2018 8:55 AM   View: Descriptive
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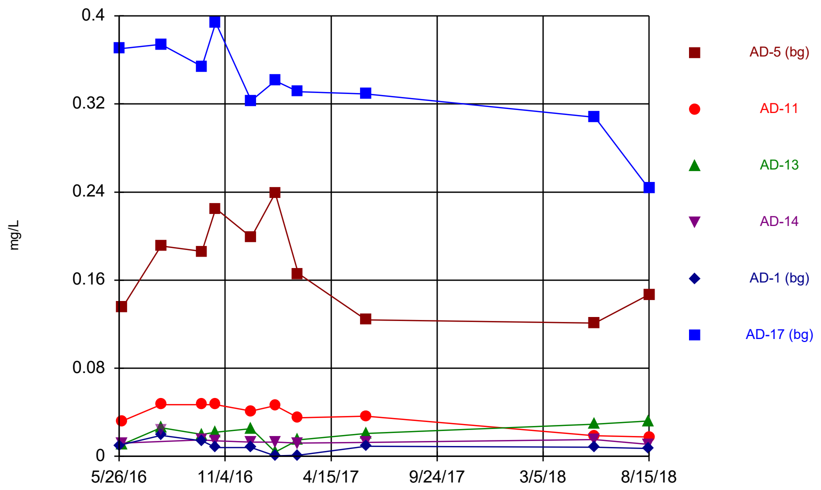
Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



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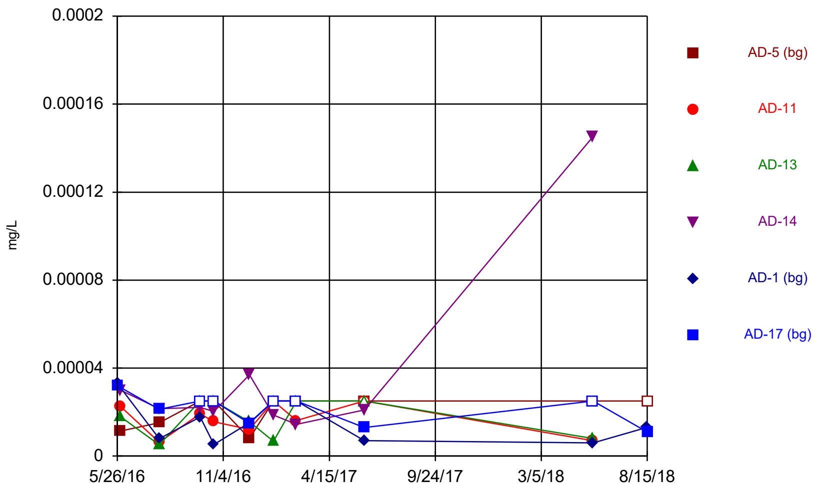

Constituent: Mercury, total   Analysis Run 12/24/2018 8:55 AM   View: Descriptive
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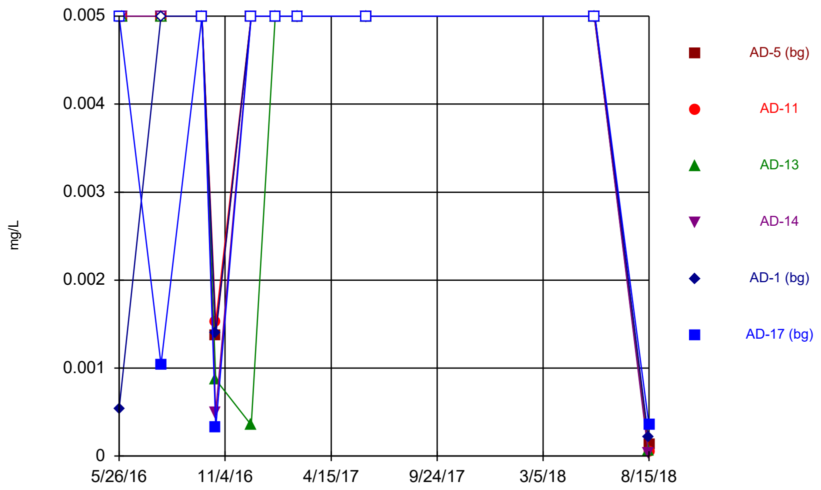
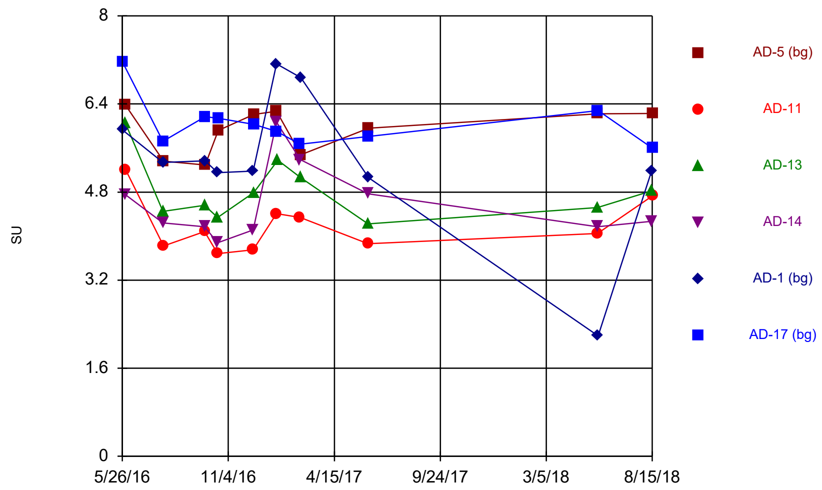


Constituent: Molybdenum, total   Analysis Run 12/24/2018 8:55 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

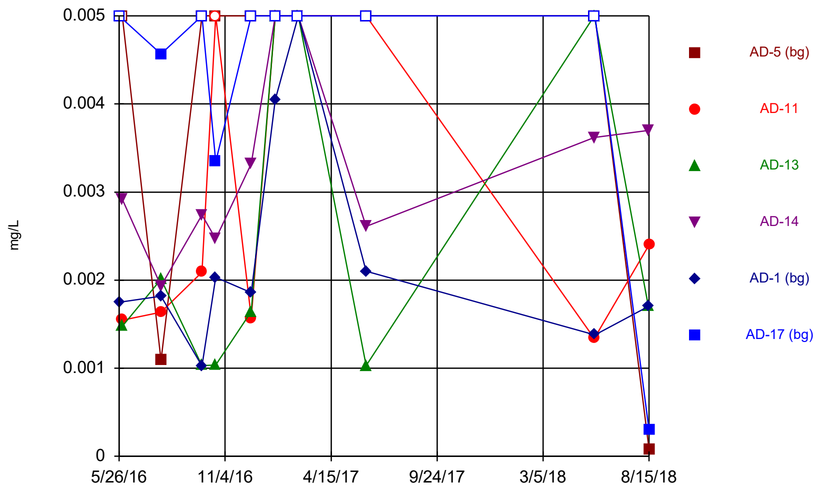
Time Series



Constituent: pH, field Analysis Run 12/24/2018 8:55 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

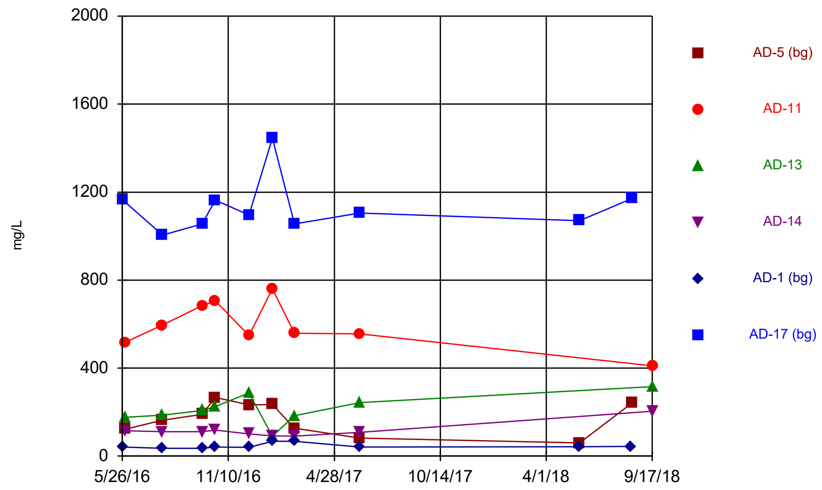
Time Series



Constituent: Selenium, total Analysis Run 12/24/2018 8:55 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

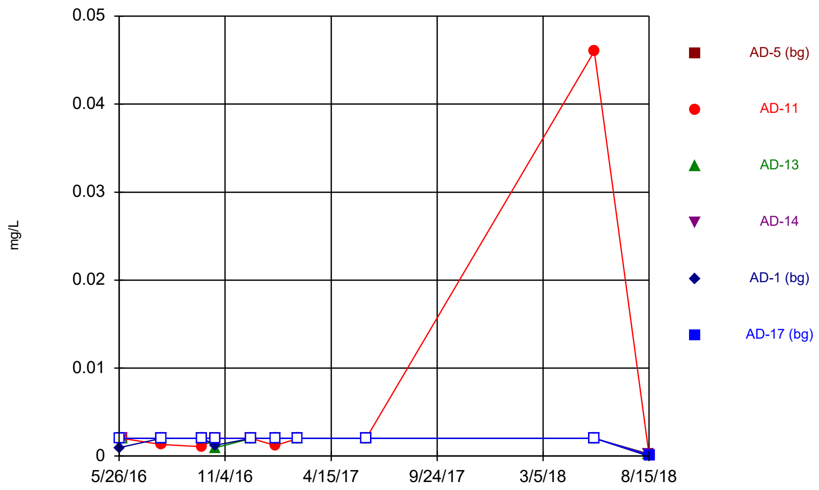
Time Series



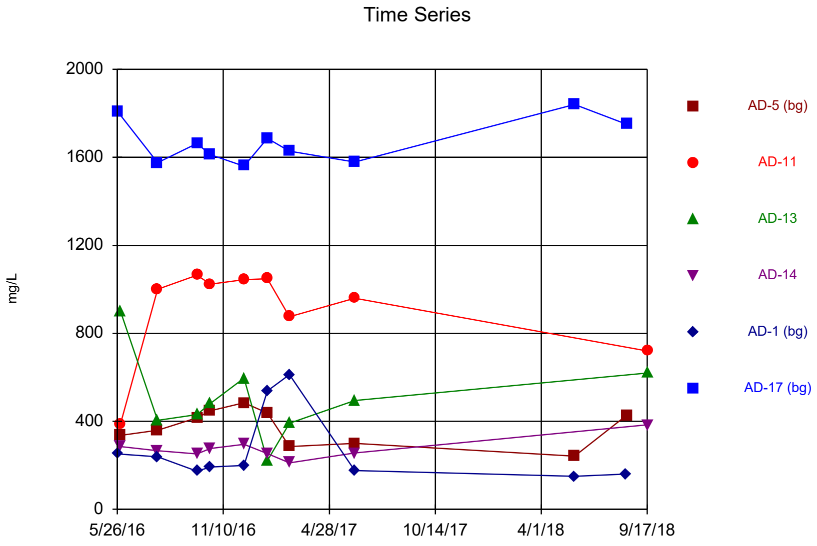
Constituent: Sulfate, total Analysis Run 12/24/2018 8:55 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series

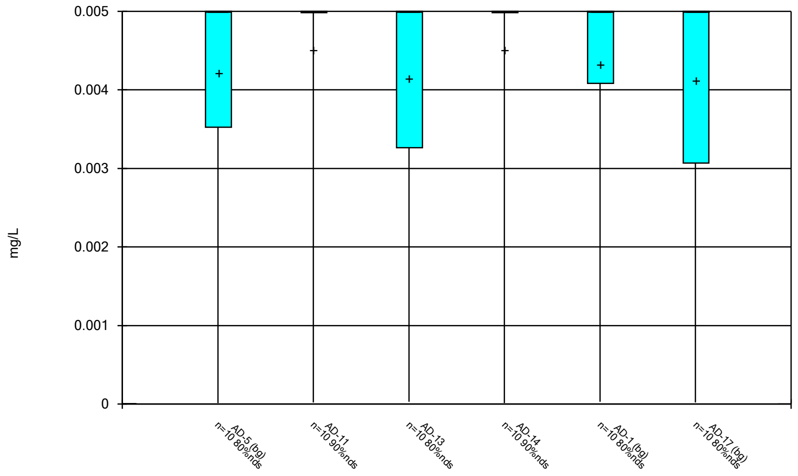


Constituent: Thallium, total Analysis Run 12/24/2018 8:55 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF



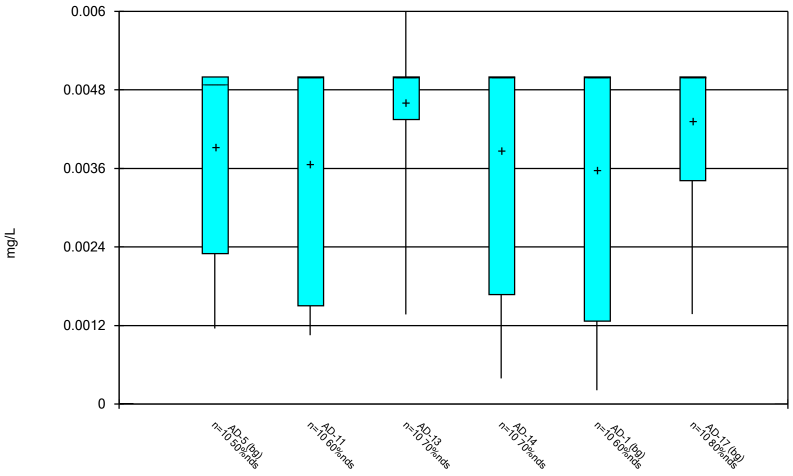
Constituent: Total Dissolved Solids Analysis Run 12/24/2018 8:55 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG


Box & Whiskers Plot

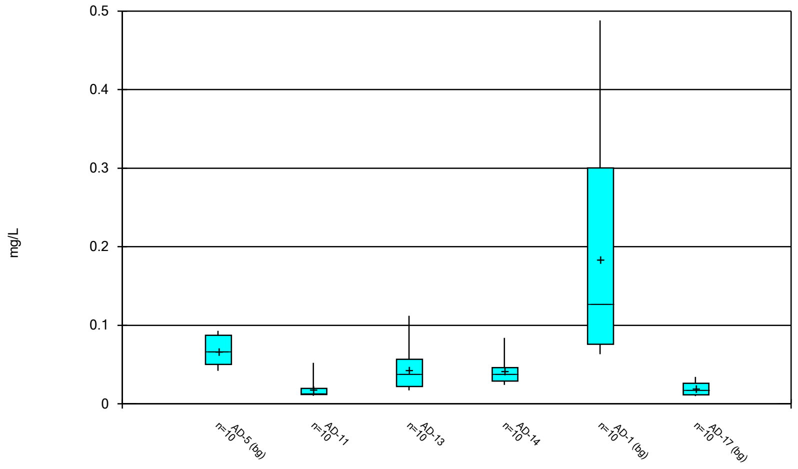
Constituent: Antimony, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG


Box & Whiskers Plot

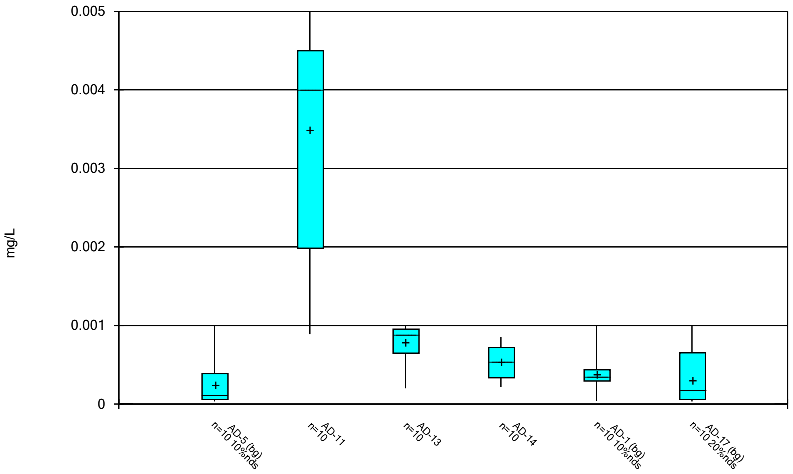
Constituent: Arsenic, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG


Box & Whiskers Plot

Constituent: Barium, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

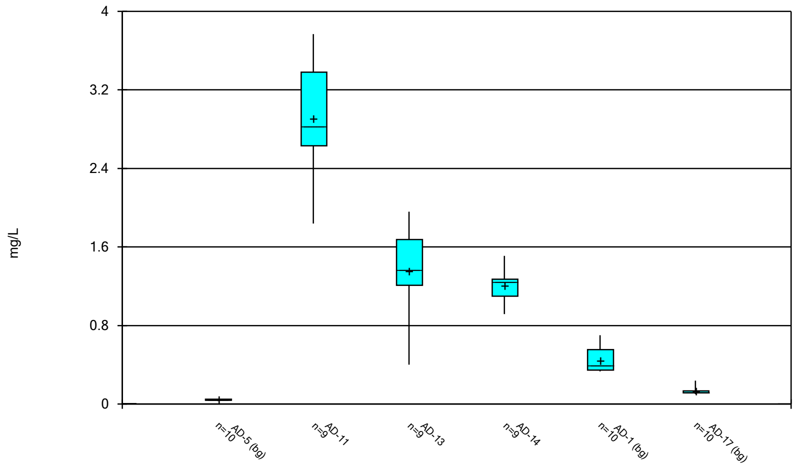
Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG


Box & Whiskers Plot

Constituent: Beryllium, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

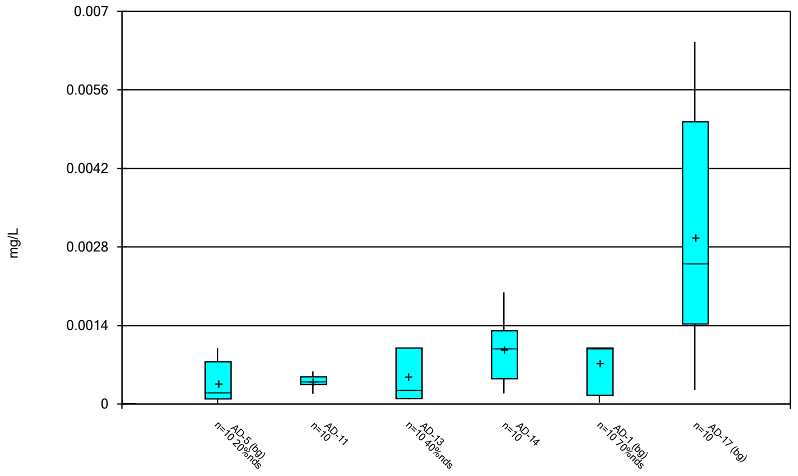
Box & Whiskers Plot



Constituent: Boron, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

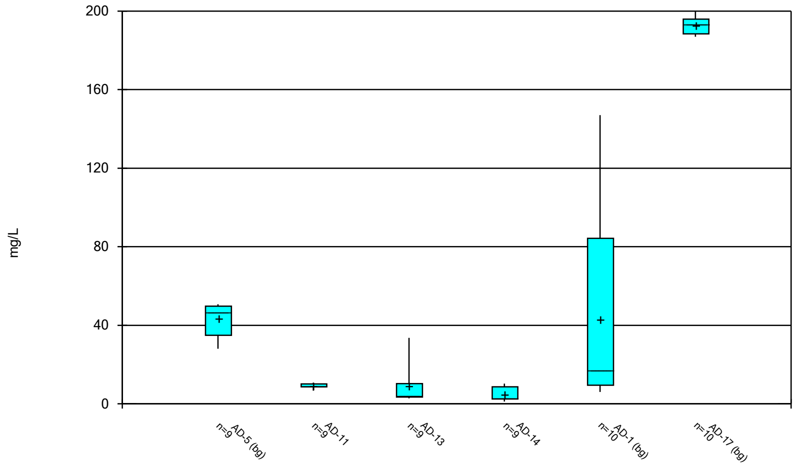
Box & Whiskers Plot



Constituent: Cadmium, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

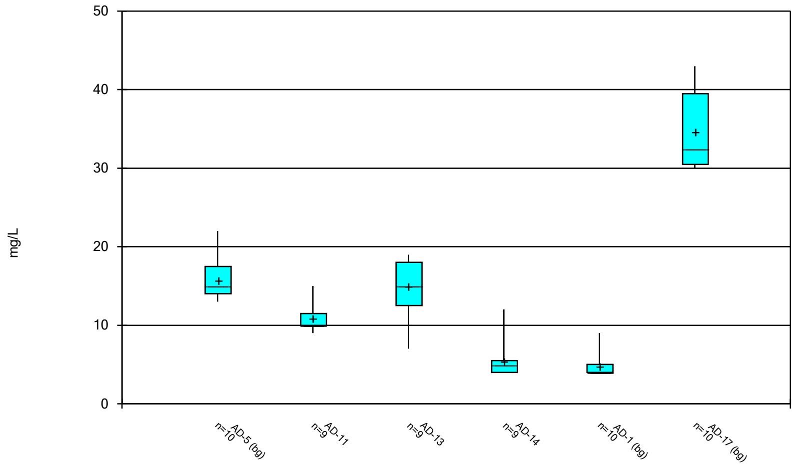
Box & Whiskers Plot



Constituent: Calcium, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

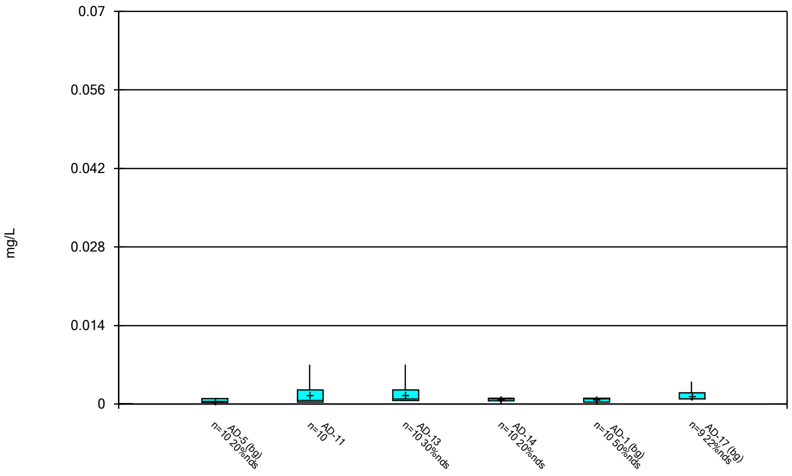
Box & Whiskers Plot



Constituent: Chloride, total Analysis Run 12/24/2018 8:56 AM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

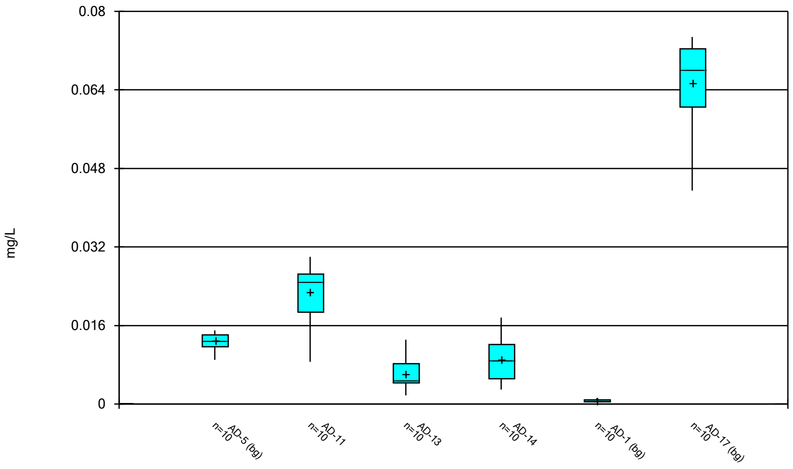
Box & Whiskers Plot



Constituent: Chromium, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

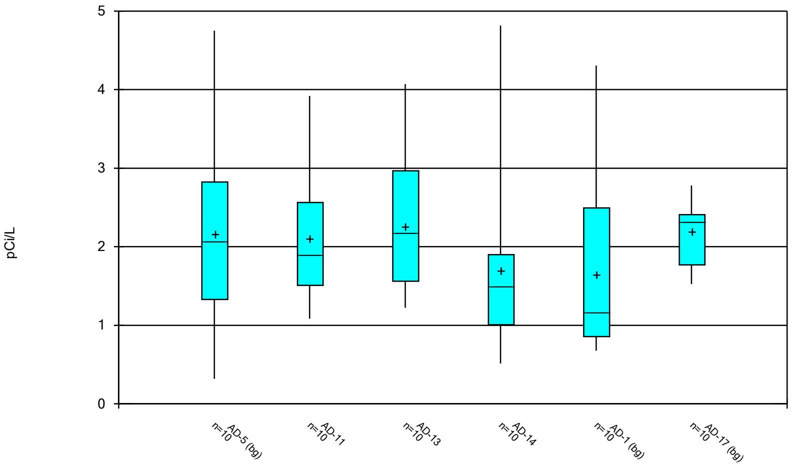
Box & Whiskers Plot



Constituent: Cobalt, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

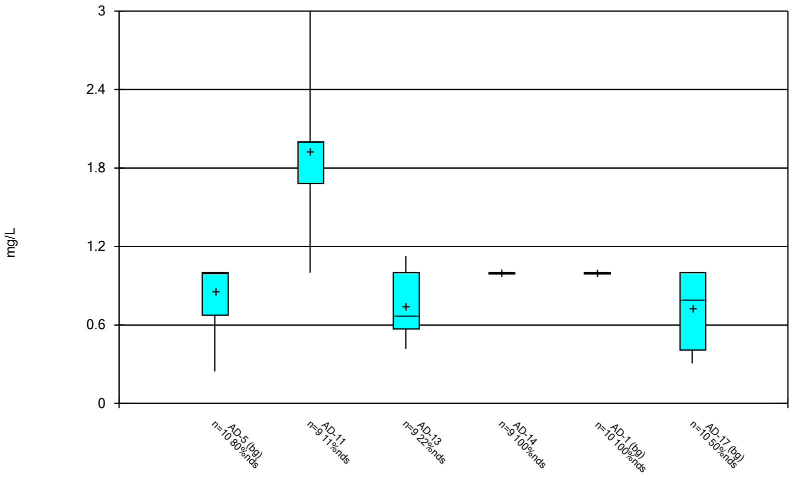
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

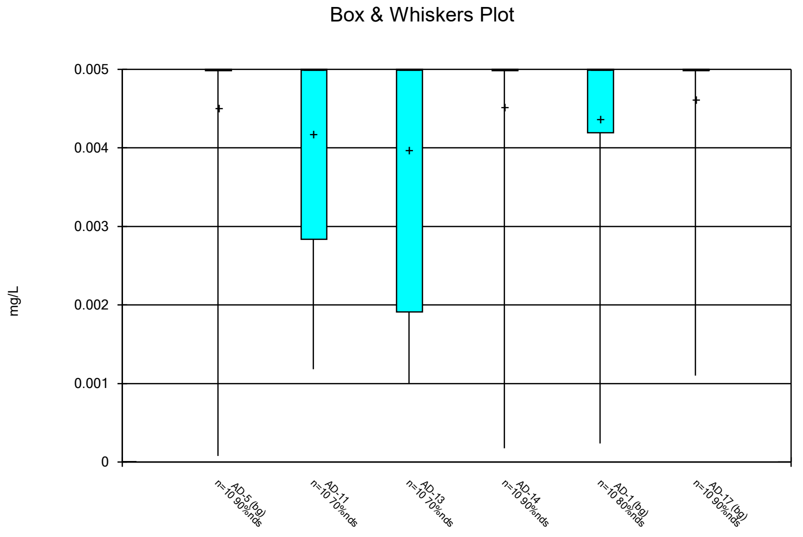
Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Box & Whiskers Plot



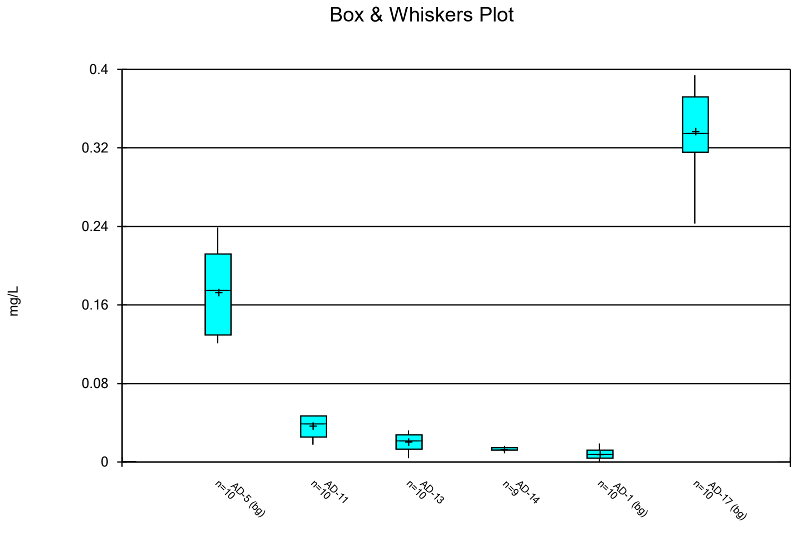
Constituent: Fluoride, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



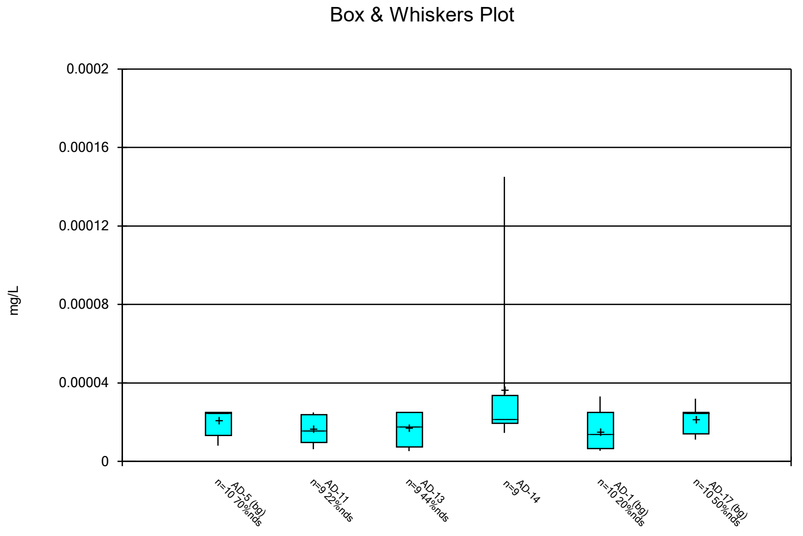
Constituent: Lead, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



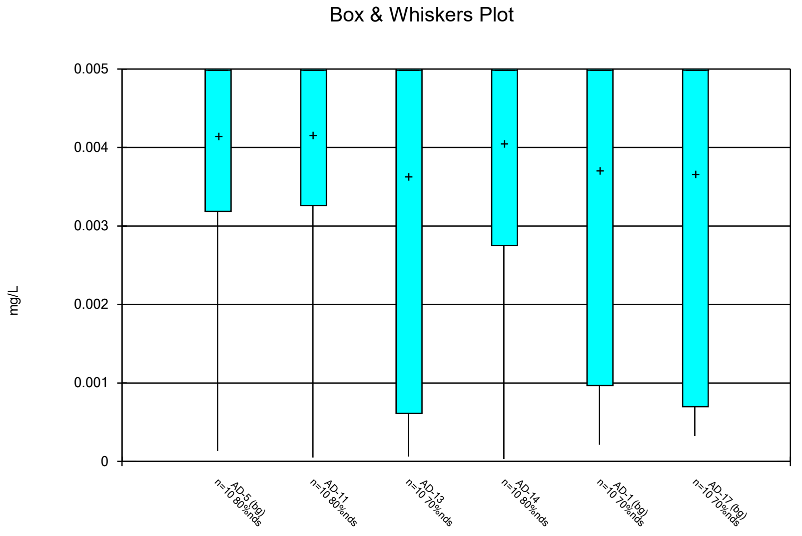
Constituent: Lithium, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Mercury, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

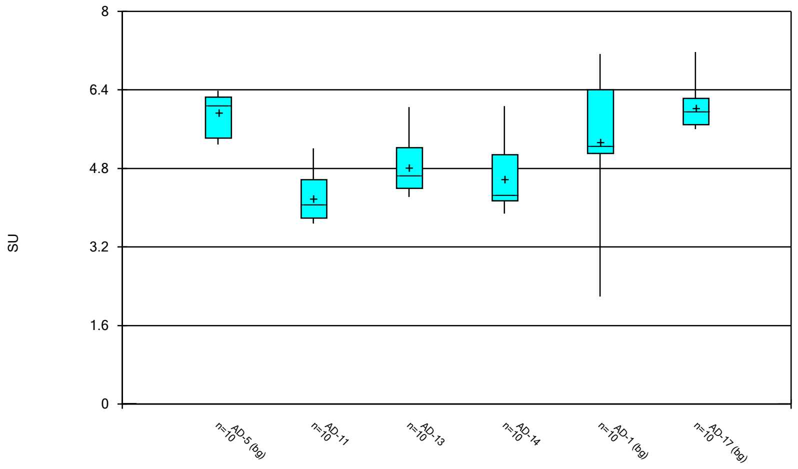
Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Molybdenum, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

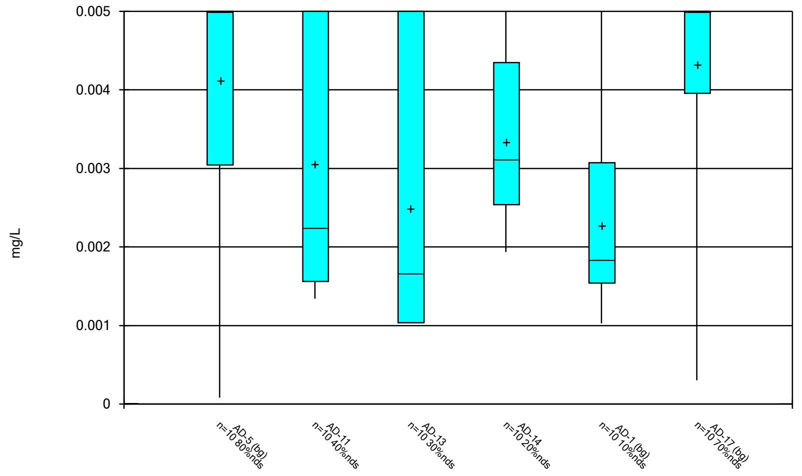
Box & Whiskers Plot



Constituent: pH, field   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

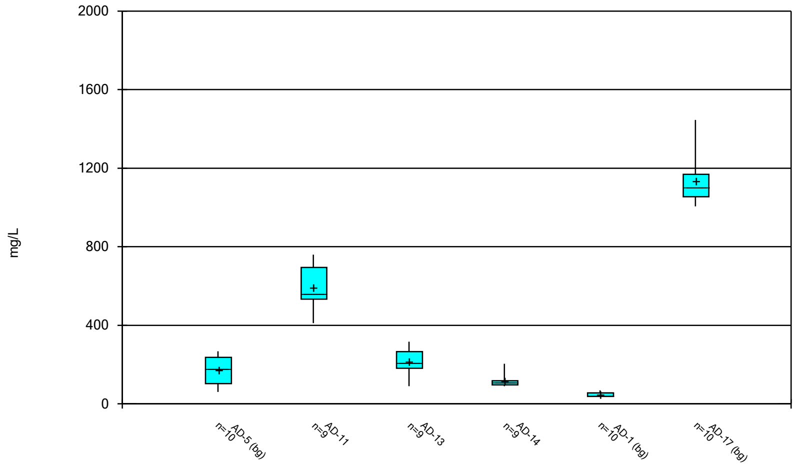
Box & Whiskers Plot



Constituent: Selenium, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

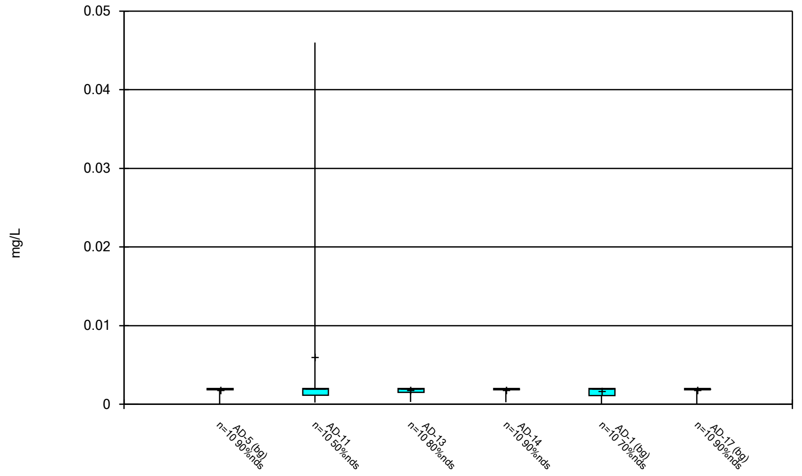
Box & Whiskers Plot



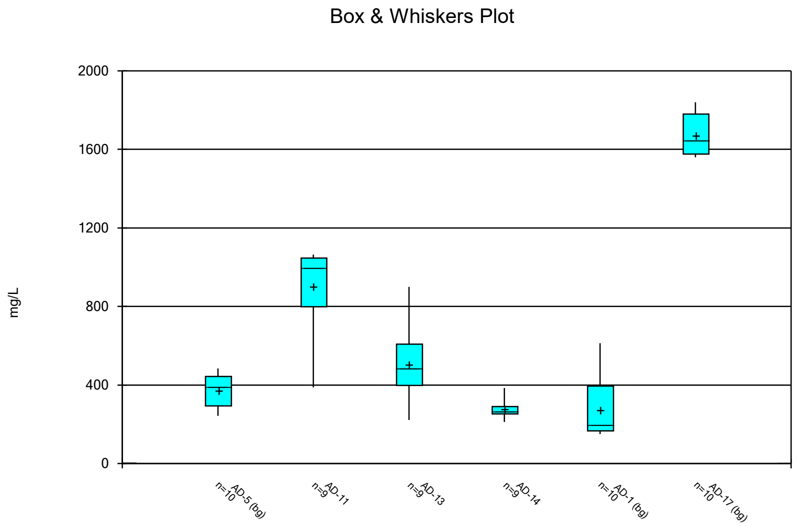
Constituent: Sulfate, total   Analysis Run 12/24/2018 8:56 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total   Analysis Run 12/24/2018 8:57 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF



Constituent: Total Dissolved Solids   Analysis Run 12/24/2018 8:57 AM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Outlier Summary

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 12/10/2018, 3:33 PM

	AD-17 Chromium, total (mg/L)	AD-14 Lithium, total (mg/L)
7/29/2016		0.024 (o)
1/20/2017	0.068 (O)	

Analysis of Variance

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 12/24/2018, 8:59 AM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Boron, total (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Calcium, total (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Chloride, total (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Fluoride, total (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
pH, field (SU)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Sulfate, total (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)

Parametric ANOVA

Constituent: Boron, total Analysis Run 12/24/2018 8:59 AM View: ANOVA
Welsh LF Client: Geosyntec Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 248.8

Tabulated F statistic = 3.35 with 2 and 27 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	1.521	2	0.7604	8.064
Error Within Groups	2.546	27	0.09429	
Total	4.067	29		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9013, critical = 0.9. Levene's Equality of Variance test passed. Calculated = 0.5384, tabulated = 3.35.

Non-Parametric ANOVA

Constituent: Calcium, total   Analysis Run 12/24/2018 8:59 AM   View: ANOVA
Welsh LF   Client: Geosyntec   Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 20.41

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 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) = 20.41
Adjusted Kruskal-Wallis statistic (H') = 20.41

Non-Parametric ANOVA

Constituent: Chloride, total Analysis Run 12/24/2018 8:59 AM View: ANOVA
Welsh LF Client: Geosyntec Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 26.09

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 6 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) = 25.81
Adjusted Kruskal-Wallis statistic (H') = 26.09

Non-Parametric ANOVA

Constituent: Fluoride, total   Analysis Run 12/24/2018 8:59 AM   View: ANOVA
Welsh LF   Client: Geosyntec   Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 5.92

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 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) = 3.254
Adjusted Kruskal-Wallis statistic (H') = 5.92

Non-Parametric ANOVA

Constituent: pH, field Analysis Run 12/24/2018 8:59 AM View: ANOVA
Welsh LF Client: Geosyntec Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.842

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 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) = 4.841
Adjusted Kruskal-Wallis statistic (H') = 4.842

Non-Parametric ANOVA

Constituent: Sulfate, total   Analysis Run 12/24/2018 8:59 AM   View: ANOVA
Welsh LF   Client: Geosyntec   Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 25.33

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 3 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) = 25.3
Adjusted Kruskal-Wallis statistic (H') = 25.33

Non-Parametric ANOVA

Constituent: Total Dissolved Solids Analysis Run 12/24/2018 8:59 AM View: ANOVA
Welsh LF Client: Geosyntec Data: Welsh LF

For observations made between 5/26/2016 and 8/15/2018, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 21.53

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 0 groups of ties in the data, so no adjustment to the Kruskal-Wallis statistic (H) was necessary.

Upper Tolerance Limits - Appendix III

Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/10/2018, 4:12 PM

Constituent	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	200	n/a	29	n/a	n/a	0	n/a	n/a	0.2259	NP Inter(normality)
Chloride, total (mg/L)	43	n/a	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Fluoride, total (mg/L)	1	n/a	30	n/a	n/a	76.67	n/a	n/a	0.2146	NP Inter(NDs)
pH, field (SU)	7.672	3.051	30	34.08	8.719	0	None	x^2	0.01	Inter
Sulfate, total (mg/L)	1445	n/a	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Total Dissolved Solids (mg/L)	1840	n/a	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Boron, total (mg/L)	0.7	n/a	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter

Confidence Intervals Appendix III - Significant Results

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 12/10/2018, 4:15 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Boron, total (mg/L)	**AD-11**	**3.451**	**2.36**	**0.7**	**Yes**	**9**	**0**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-13**	**1.787**	**0.9379**	**0.7**	**Yes**	**9**	**0**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-14**	**1.36**	**1.041**	**0.7**	**Yes**	**9**	**0**	**No**	**0.01**	**Param.**

Confidence Intervals Appendix III - All Results

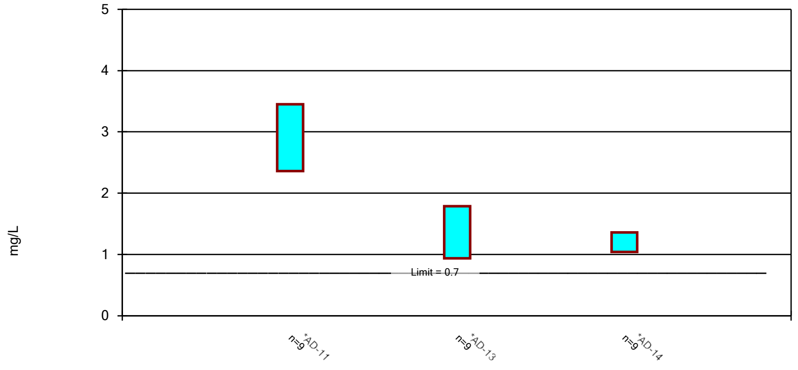
Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/10/2018, 4:15 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Boron, total (mg/L)	**AD-11**	**3.451**	**2.36**	**0.7**	**Yes**	**9**	**0**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-13**	**1.787**	**0.9379**	**0.7**	**Yes**	**9**	**0**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-14**	**1.36**	**1.041**	**0.7**	**Yes**	**9**	**0**	**No**	**0.01**	**Param.**
Calcium, total (mg/L)	AD-11	10.26	7.949	200	No	9	0	No	0.01	Param.
Calcium, total (mg/L)	AD-13	33.5	2.7	200	No	9	0	No	0.002	NP (normality)
Calcium, total (mg/L)	AD-14	7.913	1.793	200	No	9	0	sqrt(x)	0.01	Param.
Chloride, total (mg/L)	AD-11	15	9	43	No	9	0	No	0.002	NP (normality)
Chloride, total (mg/L)	AD-13	18.55	11.23	43	No	9	0	No	0.01	Param.
Chloride, total (mg/L)	AD-14	12	4	43	No	9	0	No	0.002	NP (normality)
Fluoride, total (mg/L)	AD-11	3	0.5	4	No	9	11.11	No	0.002	NP (normality)
Fluoride, total (mg/L)	AD-13	1.126	0.4149	4	No	9	22.22	No	0.002	NP (Cohens/xfrm)
Fluoride, total (mg/L)	AD-14	0.5	0.5	4	No	9	100	No	0.002	NP (NDs)
pH, field (SU)	AD-11	4.693	3.693	7.67	No	10	0	No	0.005	Param.
pH, field (SU)	AD-13	5.389	4.249	7.67	No	10	0	No	0.005	Param.
pH, field (SU)	AD-14	5.262	3.909	7.67	No	10	0	sqrt(x)	0.005	Param.
Sulfate, total (mg/L)	AD-11	696.6	489	1445	No	9	0	No	0.01	Param.
Sulfate, total (mg/L)	AD-13	277.1	148.9	1445	No	9	0	No	0.01	Param.
Sulfate, total (mg/L)	AD-14	204	90	1445	No	9	0	No	0.002	NP (normality)
Total Dissolved Solids (mg/L)	AD-11	1061	796.3	1840	No	9	0	x^4	0.01	Param.
Total Dissolved Solids (mg/L)	AD-13	687.3	321.8	1840	No	9	0	No	0.01	Param.
Total Dissolved Solids (mg/L)	AD-14	319.6	232.1	1840	No	9	0	sqrt(x)	0.01	Param.

Sanitas™ v.9.6.11 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.

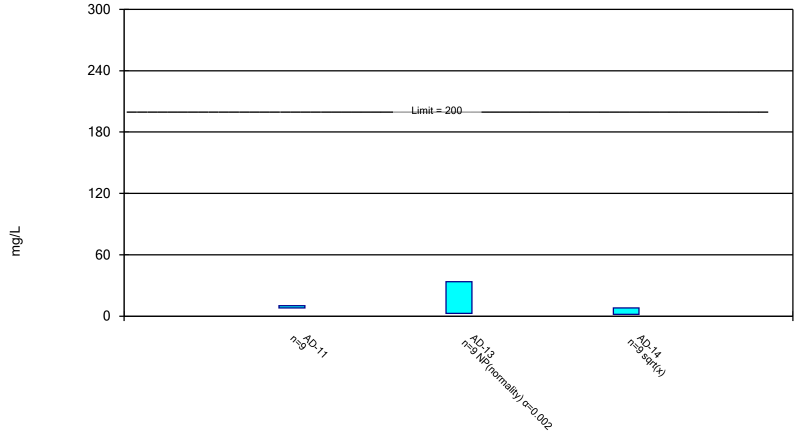


Constituent: Boron, total Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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.

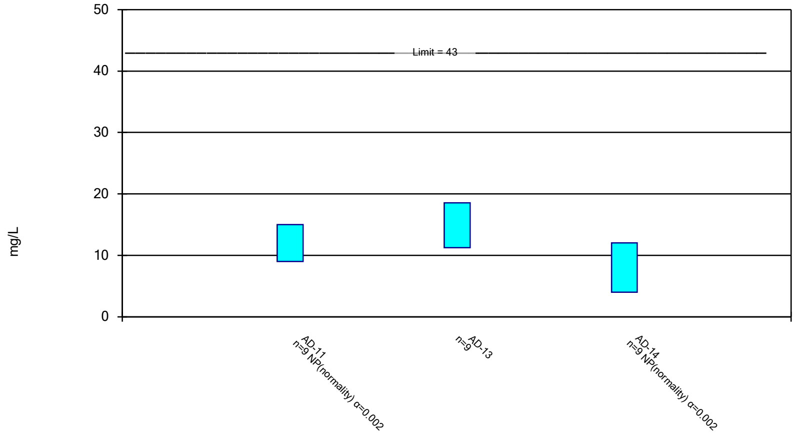


Constituent: Calcium, total Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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.

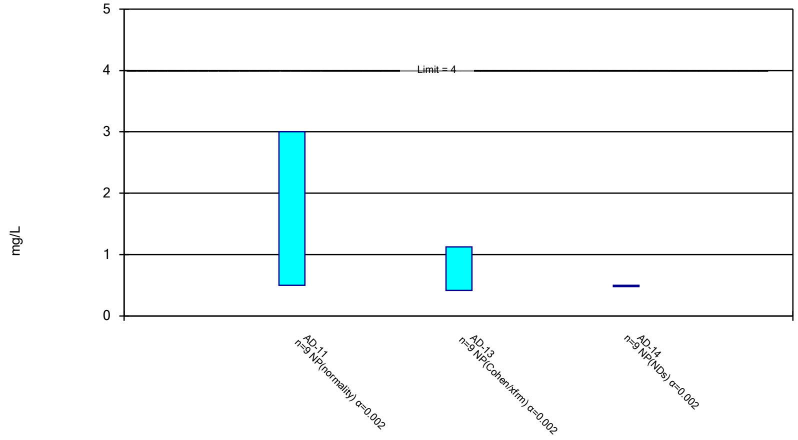


Constituent: Chloride, total Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

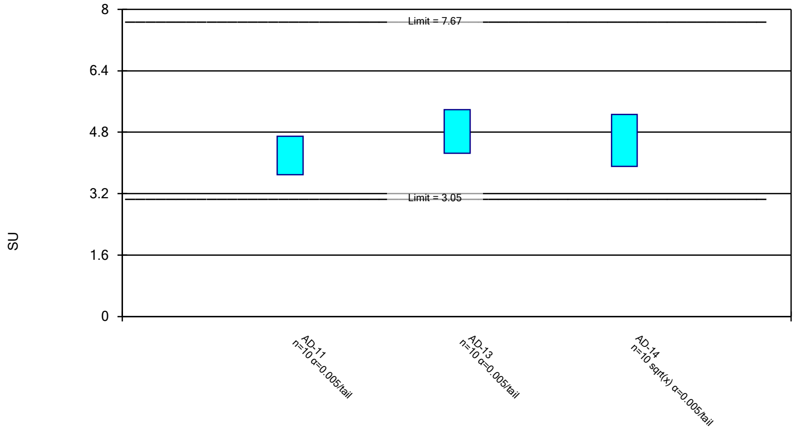


Constituent: Fluoride, total Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Normality Test: Shapiro Wilk, alpha based on n.

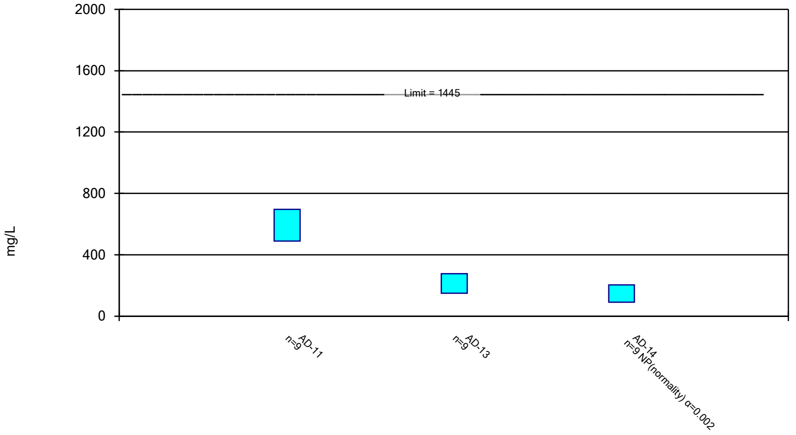


Constituent: pH, field Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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.

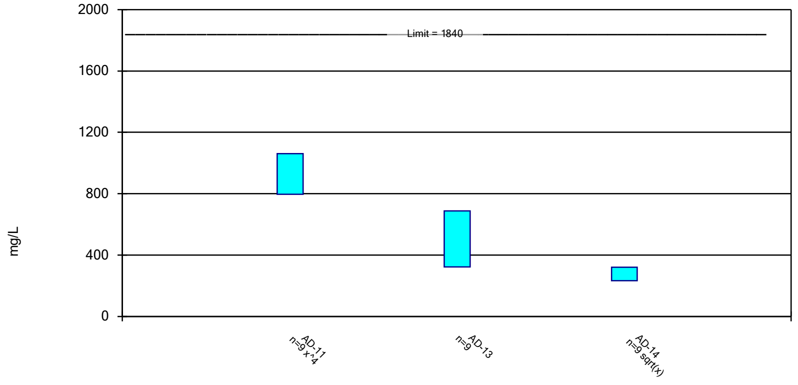


Constituent: Sulfate, total Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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: Total Dissolved Solids Analysis Run 12/10/2018 4:14 PM View: Confidence Intervals - App III
Welsh LF Client: Geosyntec Data: Welsh LF

Intrawell Prediction Limit Summary Table - Significant Results

Welsh LF Client: Geosyntec Data: Welsh LF Printed 1/5/2019, 11:10 AM

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-5**	**16.78**	**n/a**	**8/15/2018**	**19**	**Yes**	**8**	**14.5**	**0.9258**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-11**	**12.63**	**n/a**	**9/17/2018**	**15**	**Yes**	**8**	**10.38**	**0.9161**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-14**	**6.454**	**n/a**	**9/17/2018**	**12**	**Yes**	**8**	**4.625**	**0.744**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Sulfate, total (mg/L)	**AD-14**	**131.3**	**n/a**	**9/17/2018**	**204**	**Yes**	**8**	**105.8**	**10.39**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Total Dissolved Solids (mg/L)	**AD-14**	**325.3**	**n/a**	**9/17/2018**	**384**	**Yes**	**8**	**262.3**	**25.65**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**

Intrawell Prediction Limit Summary Table - All Results

Welsh LF Client: Geosyntec Data: Welsh LF Printed 1/5/2019, 11:10 AM

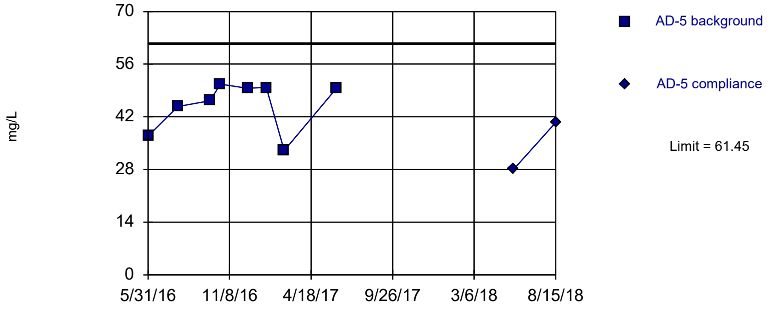
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj	Transform	Alpha	Method
Calcium, total (mg/L)	AD-5	61.45	n/a	8/15/2018	40.5	No	8	45.09	6.656	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-11	11.39	n/a	9/17/2018	6.61	No	8	9.419	0.8002	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-13	38.48	n/a	9/17/2018	10.1	No	8	1.861	0.6165	0	None	x^(1/3)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-14	13.85	n/a	9/17/2018	4.51	No	8	4.868	3.655	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-1	224.6	n/a	8/14/2018	5.95	No	8	6.363	3.508	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	203.5	n/a	8/15/2018	187	No	8	193.6	4.033	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	**AD-5**	**16.78**	**n/a**	**8/15/2018**	**19**	**Yes**	**8**	**14.5**	**0.9258**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-11**	**12.63**	**n/a**	**9/17/2018**	**15**	**Yes**	**8**	**10.38**	**0.9161**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	AD-13	23.97	n/a	9/17/2018	18	No	8	14.5	3.854	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	**AD-14**	**6.454**	**n/a**	**9/17/2018**	**12**	**Yes**	**8**	**4.625**	**0.744**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	AD-1	9	n/a	8/14/2018	5	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) ...
Chloride, total (mg/L)	AD-17	44.04	n/a	8/15/2018	40	No	8	33.38	4.34	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-5	336.4	n/a	8/15/2018	240	No	8	177.4	64.69	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-11	833.3	n/a	9/17/2018	410	No	8	615.6	88.57	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-13	342	n/a	9/17/2018	316	No	8	200.1	57.71	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	**AD-14**	**131.3**	**n/a**	**9/17/2018**	**204**	**Yes**	**8**	**105.8**	**10.39**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Sulfate, total (mg/L)	AD-1	82.3	n/a	8/14/2018	44	No	8	6.772	0.9358	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	1471	n/a	8/15/2018	1170	No	8	1136	136.3	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-5	563.5	n/a	8/15/2018	428	No	8	383.6	73.17	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-11	1224	n/a	9/17/2018	720	No	8	9.0e8	3.8e8	0	None	x^3	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-13	974.4	n/a	9/17/2018	620	No	8	490.1	197	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	**AD-14**	**325.3**	**n/a**	**9/17/2018**	**384**	**Yes**	**8**	**262.3**	**25.65**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Total Dissolved Solids (mg/L)	AD-1	784.8	n/a	8/14/2018	160	No	8	16.71	4.598	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1840	n/a	8/15/2018	1750	No	8	1639	81.77	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=45.09, Std. Dev.=6.656, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8101, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

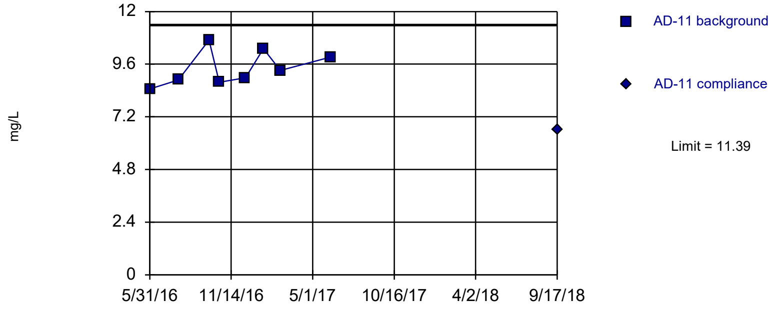
Constituent: Calcium, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.419, Std. Dev.=0.8002, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9212, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

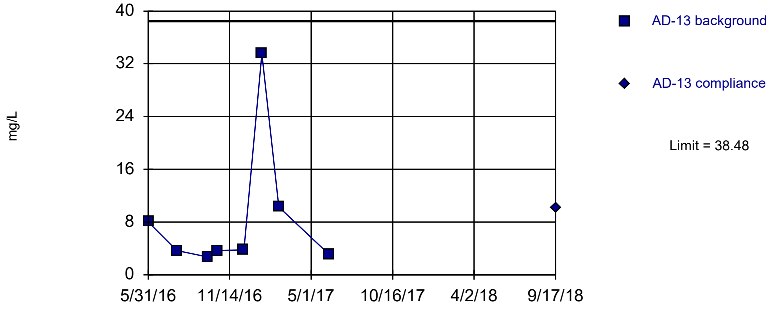
Constituent: Calcium, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on cube root transformation): Mean=1.861, Std. Dev.=0.6165, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7575, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

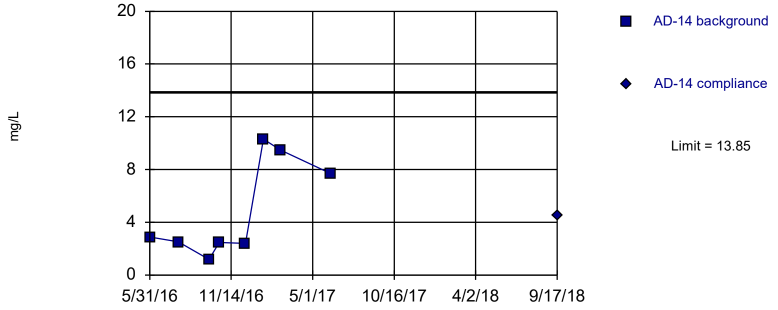
Constituent: Calcium, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.868, Std. Dev.=3.655, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8054, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

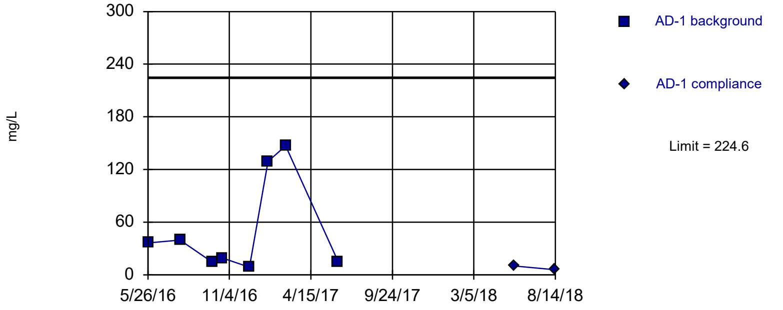
Constituent: Calcium, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=6.363, Std. Dev.=3.508, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8248, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

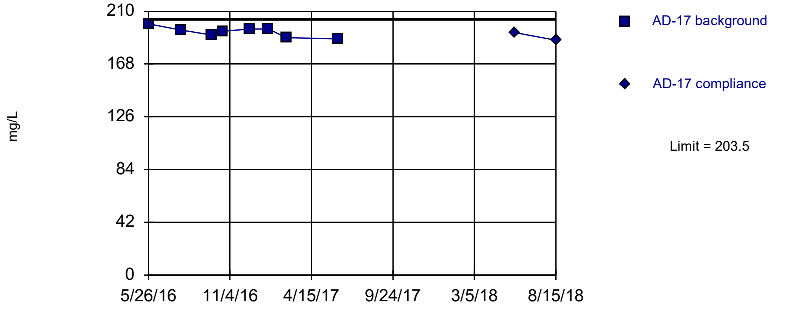
Constituent: Calcium, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=193.6, Std. Dev.=4.033, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9507, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

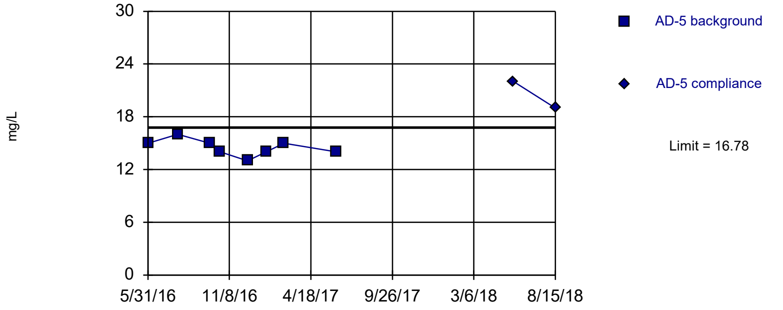
Constituent: Calcium, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=14.5, Std. Dev.=0.9258, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9302, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

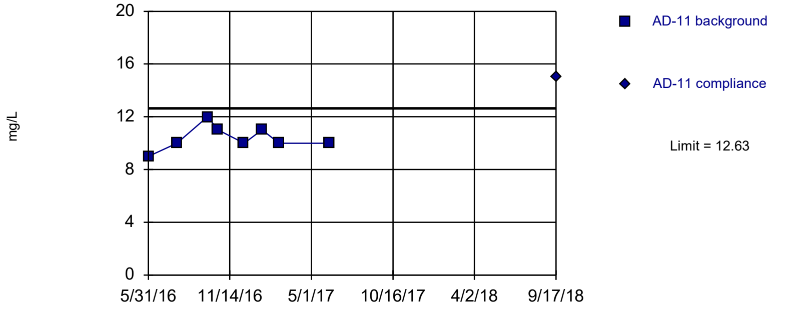
Constituent: Chloride, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=10.38, Std. Dev.=0.9161, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9054, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

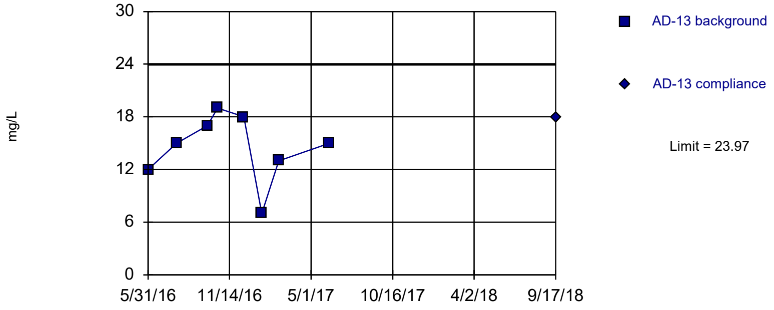
Constituent: Chloride, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=14.5, Std. Dev.=3.854, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9344, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

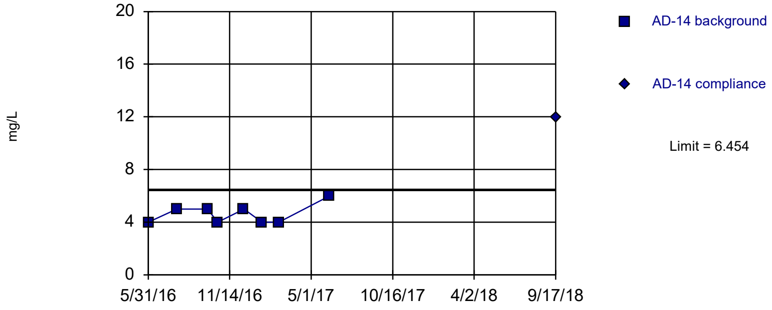
Constituent: Chloride, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.625, 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.

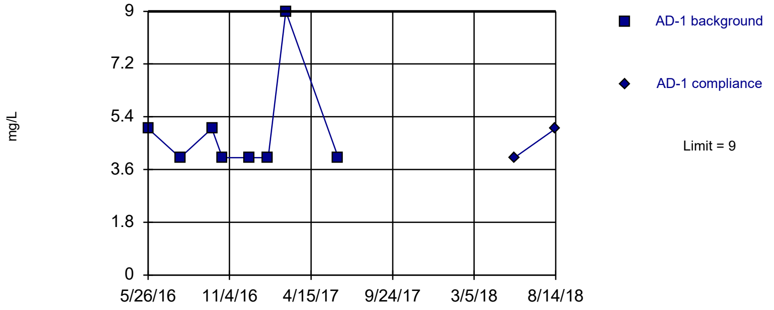
Constituent: Chloride, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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).

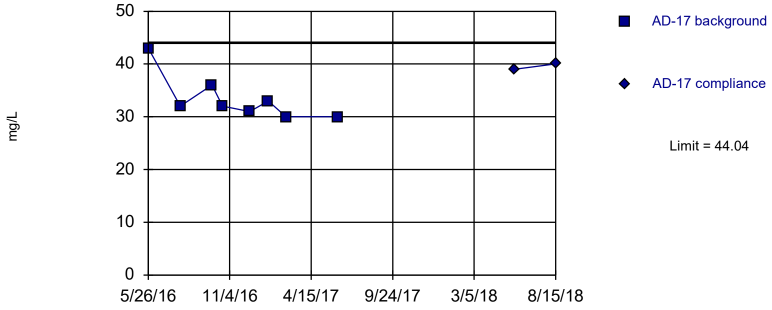
Constituent: Chloride, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=33.38, Std. Dev.=4.34, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

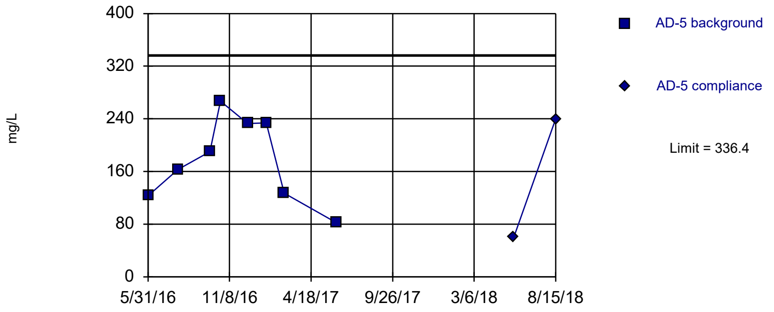
Constituent: Chloride, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=177.4, Std. Dev.=64.69, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.953, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

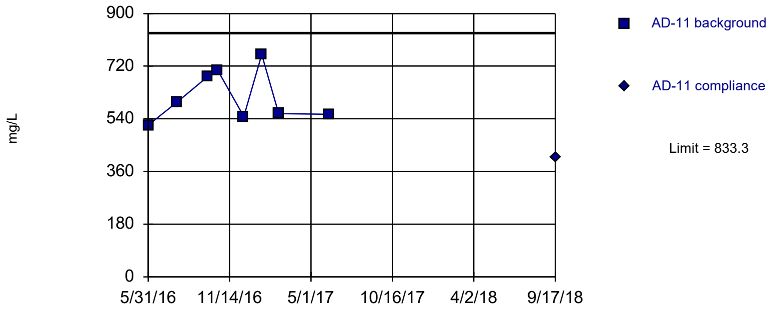
Constituent: Sulfate, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=615.6, Std. Dev.=88.57, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8871, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

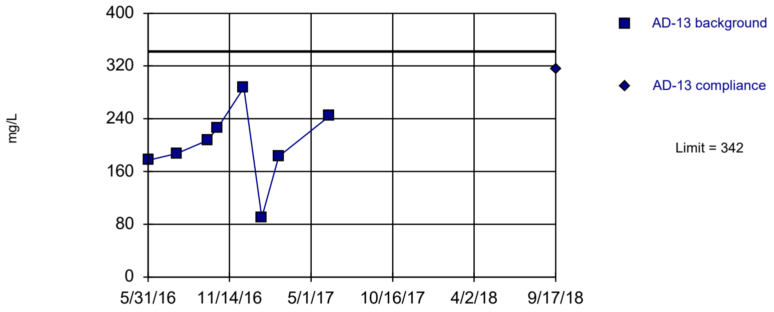
Constituent: Sulfate, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=200.1, Std. Dev.=57.71, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9527, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

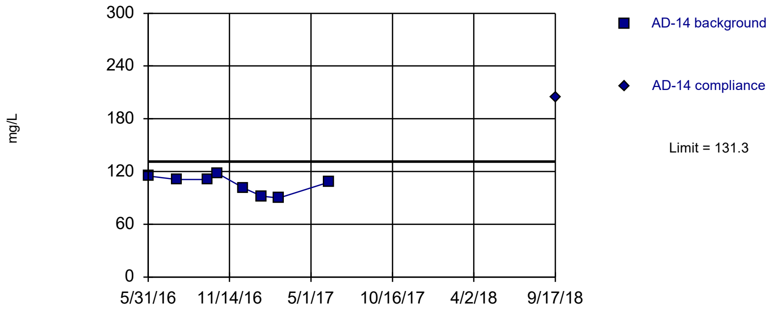
Constituent: Sulfate, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=105.8, Std. Dev.=10.39, 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.

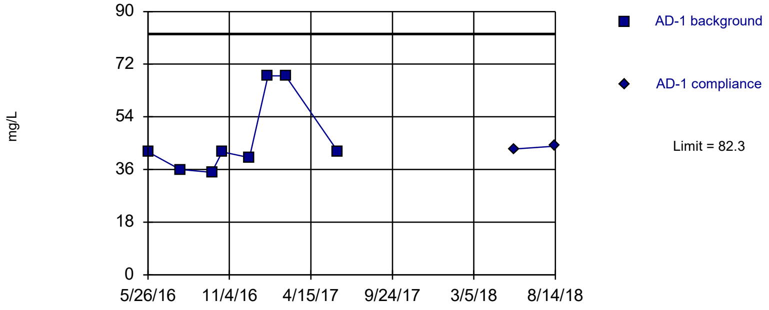
Constituent: Sulfate, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=6.772, Std. Dev.=0.9358, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7528, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

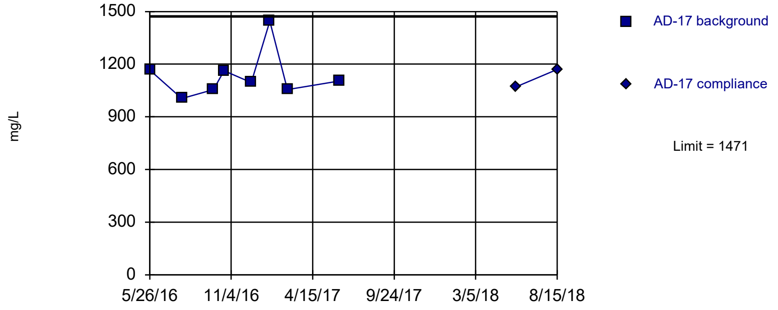
Constituent: Sulfate, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1136, Std. Dev.=136.3, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7916, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

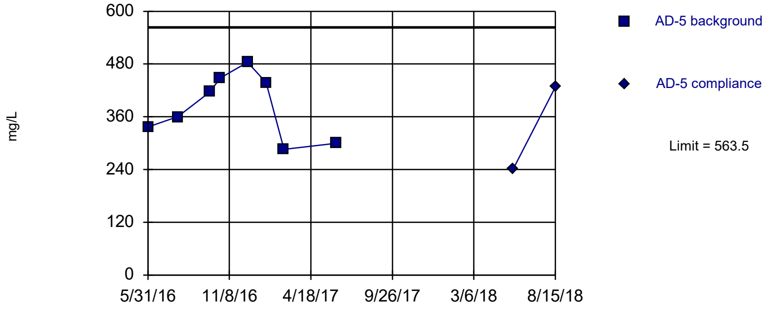
Constituent: Sulfate, total Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=383.6, Std. Dev.=73.17, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.937, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

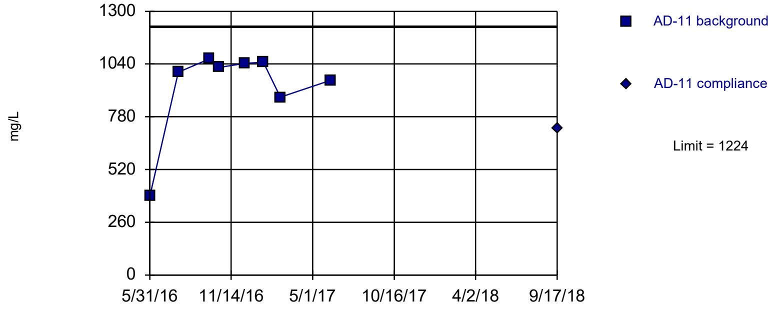
Constituent: Total Dissolved Solids Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on cube transformation): Mean=9.0e8, Std. Dev.=3.8e8, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.79, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

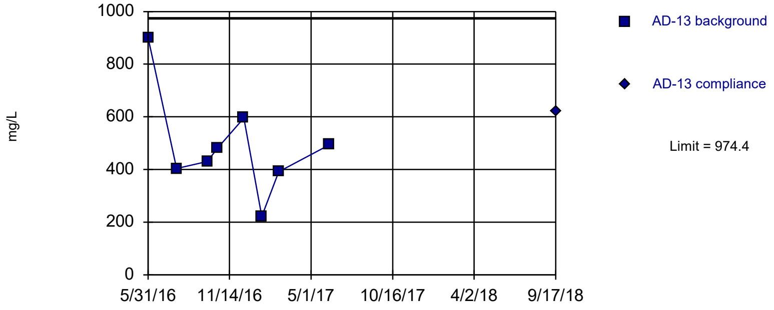
Constituent: Total Dissolved Solids Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=490.1, Std. Dev.=197, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.896, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

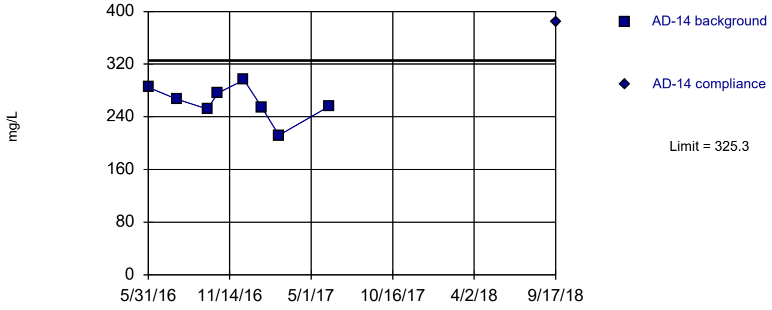
Constituent: Total Dissolved Solids Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=262.3, Std. Dev.=25.65, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9381, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

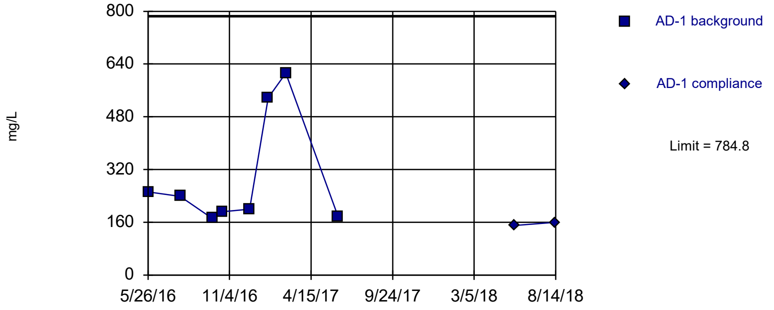
Constituent: Total Dissolved Solids Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=16.71, Std. Dev.=4.598, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.756, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

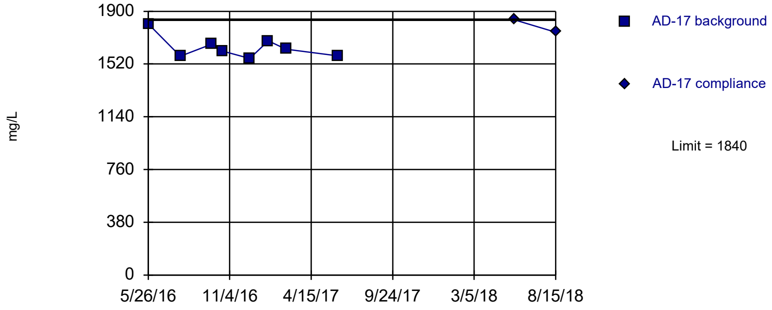
Constituent: Total Dissolved Solids Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1639, Std. Dev.=81.77, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8702, 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 Analysis Run 1/5/2019 11:06 AM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Interwell Prediction Limit Summary Table - Significant Results

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 1/5/2019, 11:13 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-11**	**0.765**	**n/a**	**9/17/2018**	**1.84**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	Param 1 of 2
Boron, total (mg/L)	**AD-13**	**0.765**	**n/a**	**9/17/2018**	**1.49**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	Param 1 of 2
Boron, total (mg/L)	**AD-14**	**0.765**	**n/a**	**9/17/2018**	**1.51**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	Param 1 of 2
pH, field (SU)	**AD-14**	**7.051**	**4.294**	**8/14/2018**	**4.27**	**Yes**	**30**	**34.08**	**8.719**	**0**	**None**	**x^2**	**0.001253**	Param 1 of 2

Interwell Prediction Limit Summary Table - All Results

Welsh LF Client: Geosyntec Data: Welsh LF Printed 1/5/2019, 11:13 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-11**	**0.765**	**n/a**	**9/17/2018**	**1.84**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	Param 1 of 2
Boron, total (mg/L)	**AD-13**	**0.765**	**n/a**	**9/17/2018**	**1.49**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	Param 1 of 2
Boron, total (mg/L)	**AD-14**	**0.765**	**n/a**	**9/17/2018**	**1.51**	**Yes**	**30**	**-2.011**	**0.9717**	**0**	**None**	**ln(x)**	**0.002505**	Param 1 of 2
Fluoride, total (mg/L)	AD-11	1	n/a	8/15/2018	1ND	No	30	n/a	n/a	76.67	n/a	n/a	0.00197	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-13	1	n/a	8/14/2018	0.7442	No	30	n/a	n/a	76.67	n/a	n/a	0.00197	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-14	1	n/a	8/14/2018	1ND	No	30	n/a	n/a	76.67	n/a	n/a	0.00197	NP (NDs) 1 of 2
pH, field (SU)	AD-11	7.051	4.294	8/15/2018	4.73	No	30	34.08	8.719	0	None	x^2	0.001253	Param 1 of 2
pH, field (SU)	AD-13	7.051	4.294	8/14/2018	4.82	No	30	34.08	8.719	0	None	x^2	0.001253	Param 1 of 2
pH, field (SU)	**AD-14**	**7.051**	**4.294**	**8/14/2018**	**4.27**	**Yes**	**30**	**34.08**	**8.719**	**0**	**None**	**x^2**	**0.001253**	Param 1 of 2

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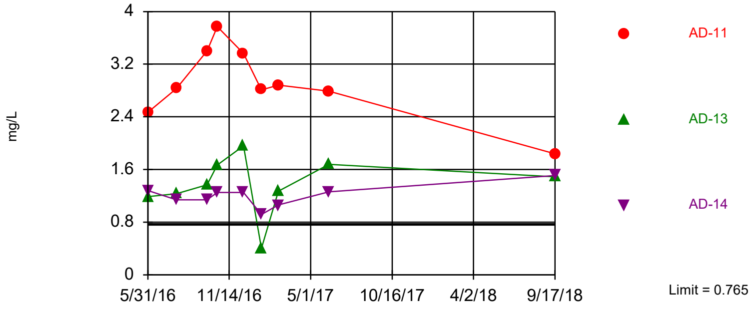
Exceeds Limit: AD-11, AD-13, AD-14

Prediction Limit

Interwell Parametric



Background Data Summary (based on natural log transformation): Mean=-2.011, Std. Dev.=0.9717, n=30. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9108, critical = 0.9. Kappa = 1.794 (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.

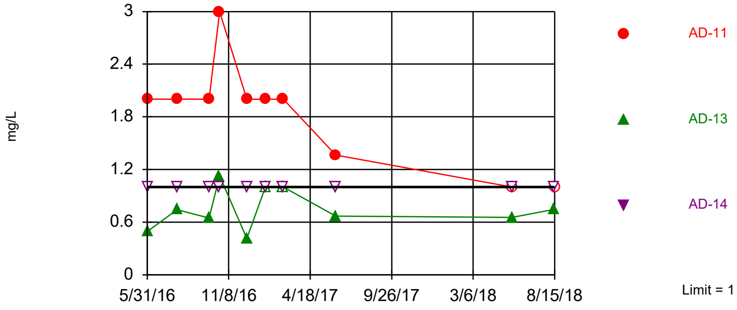
Constituent: Boron, total Analysis Run 1/5/2019 11:11 AM View: PL's - Interwell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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 30 background values. 76.67% NDs. Annual per-constituent alpha = 0.01176. Individual comparison alpha = 0.00197 (1 of 2). Comparing 3 points to limit.

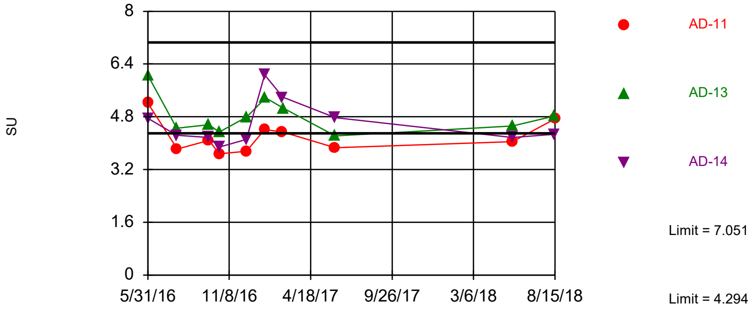
Constituent: Fluoride, total Analysis Run 1/5/2019 11:11 AM View: PL's - Interwell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits: AD-14

Prediction Limit

Interwell Parametric



Background Data Summary (based on square transformation): Mean=34.08, Std. Dev.=8.719, n=30. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9102, critical = 0.9. Kappa = 1.794 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 3 points to limit.

Constituent: pH, field Analysis Run 1/5/2019 11:11 AM View: PL's - Interwell
Welsh LF Client: Geosyntec Data: Welsh LF

Prediction Limit

Constituent: Boron, total (mg/L)   Analysis Run 1/5/2019 11:13 AM   View: PL's - Interwell

Welsh LF   Client: Geosyntec   Data: Welsh LF

	AD-17 (bg)	AD-1 (bg)	AD-5 (bg)	AD-13	AD-11	AD-14
5/26/2016	0.121	0.346				
5/31/2016			0.03	1.19	2.47	1.28
7/29/2016	0.119	0.35	0.04	1.23	2.83	1.14
9/30/2016	0.111	0.332	0.04	1.37	3.4	1.14
10/21/2016	0.124	0.398	0.05	1.67	3.77	1.25
12/14/2016	0.135	0.394	0.05	1.96	3.36	1.25
1/20/2017	0.101	0.656	0.04	0.402	2.81	0.915
2/24/2017	0.135	0.7	0.04	1.27	2.88	1.06
6/8/2017	0.121	0.449	0.05281	1.68	2.79	1.26
5/24/2018	0.239	0.345	0.0501			
8/14/2018		0.443				
8/15/2018	0.118		0.05			
9/17/2018				1.49	1.84	1.51

Trend Test Summary Table - All Results (No Significant Results)

Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/11/2018, 5:00 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-5 (bg)	0.005828	22	30	No	10	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-11	-0.295	-10	-25	No	9	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-13	0.1357	12	25	No	9	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-14	0.0183	4	25	No	9	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-1 (bg)	0.08093	15	30	No	10	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-17 (bg)	0.007399	7	30	No	10	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-5 (bg)	0	5	30	No	10	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-11	1.168	9	25	No	9	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-14	1.308	11	25	No	9	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-1 (bg)	0	-1	-30	No	10	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-17 (bg)	-2.005	-5	-30	No	10	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-5 (bg)	0.1885	11	30	No	10	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-14	0.01464	2	30	No	10	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-1 (bg)	-0.4232	-14	-30	No	10	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-17 (bg)	-0.4462	-19	-30	No	10	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-5 (bg)	-14.86	-1	-30	No	10	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-14	-9.409	-7	-25	No	9	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-1 (bg)	2.401	19	30	No	10	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-17 (bg)	12.06	8	30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	AD-5 (bg)	-33.56	-5	-30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	AD-14	-3.767	0	25	No	9	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	AD-1 (bg)	-26.43	-13	-30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	AD-17 (bg)	40.84	7	30	No	10	0	n/a	n/a	0.01	NP

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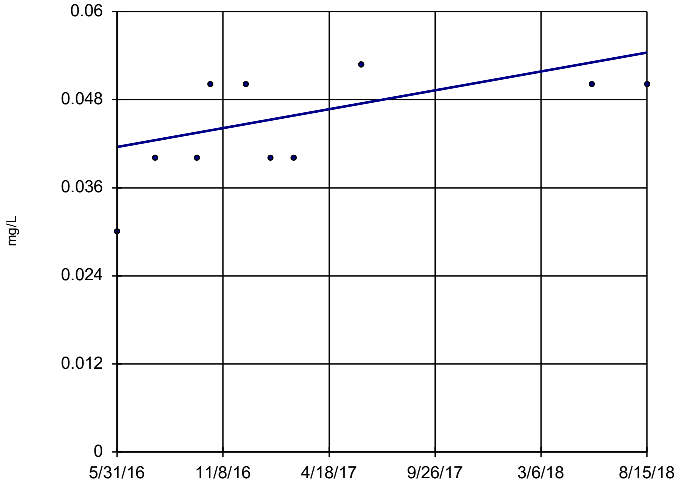
Sen's Slope Estimator

AD-5 (bg)



n = 10

Slope = 0.005828 units per year.

Mann-Kendall statistic = 22 critical = 30

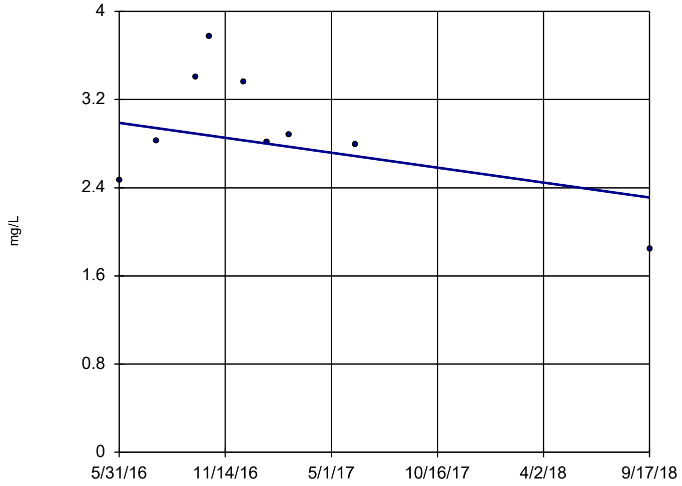
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-11



n = 9

Slope = -0.295 units per year.

Mann-Kendall statistic = -10 critical = -25

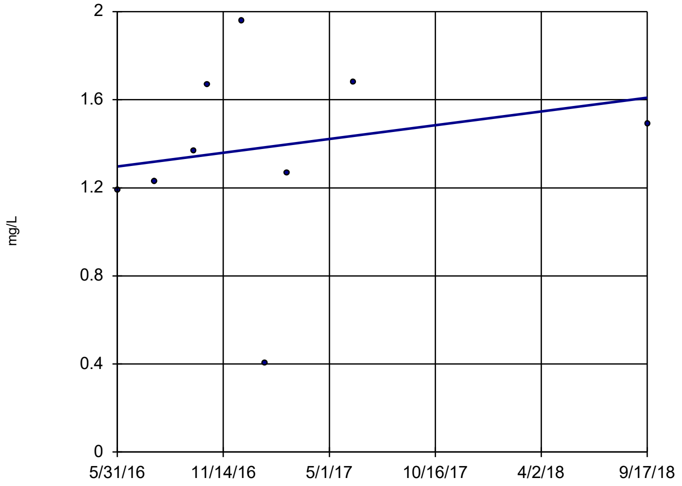
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13



n = 9

Slope = 0.1357 units per year.

Mann-Kendall statistic = 12 critical = 25

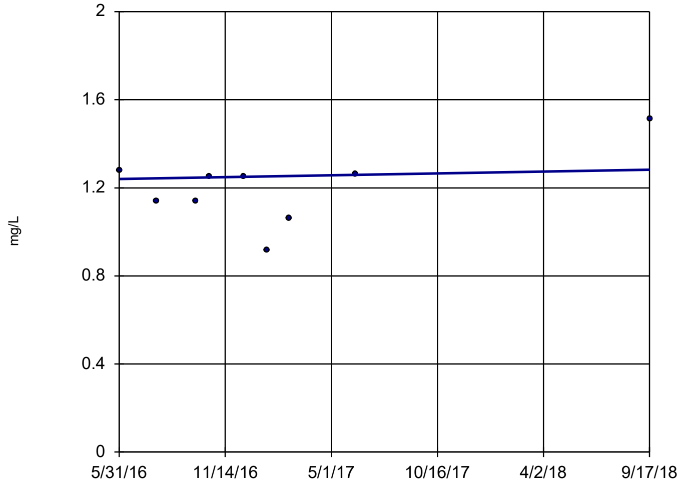
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-14



n = 9

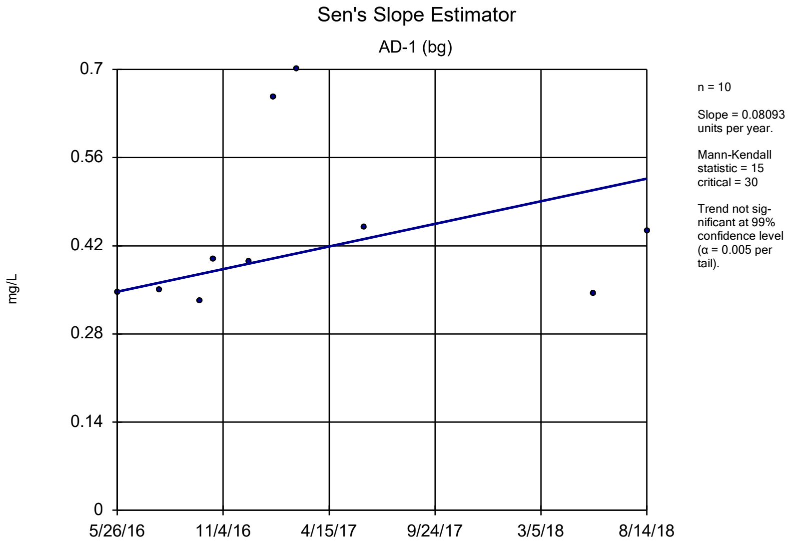
Slope = 0.0183 units per year.

Mann-Kendall statistic = 4 critical = 25

Trend not significant at 99% confidence level (α = 0.005 per tail).

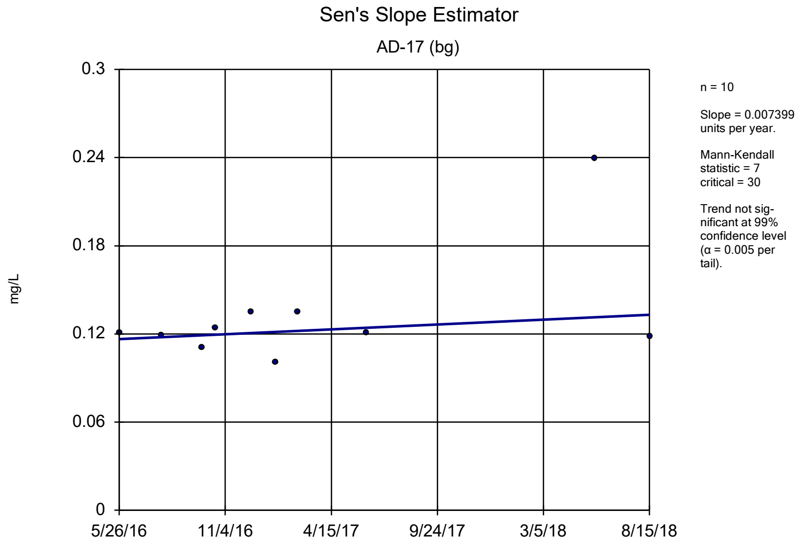
Constituent: Boron, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



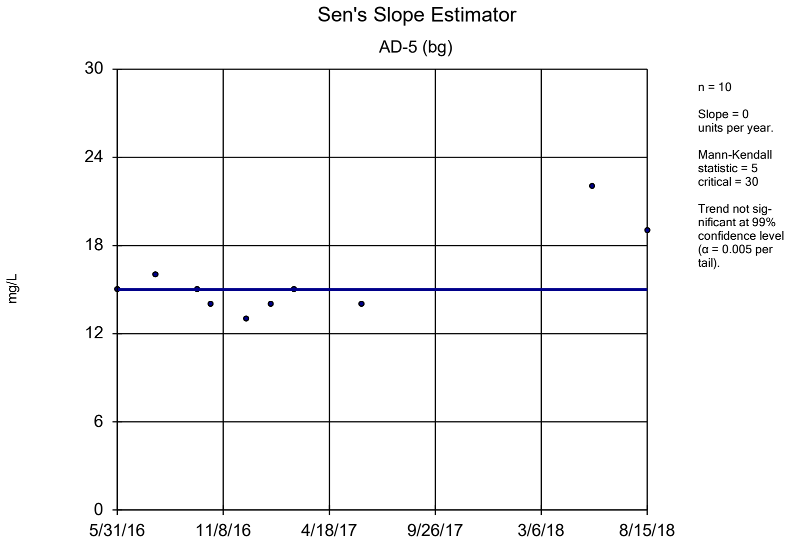
Constituent: Boron, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



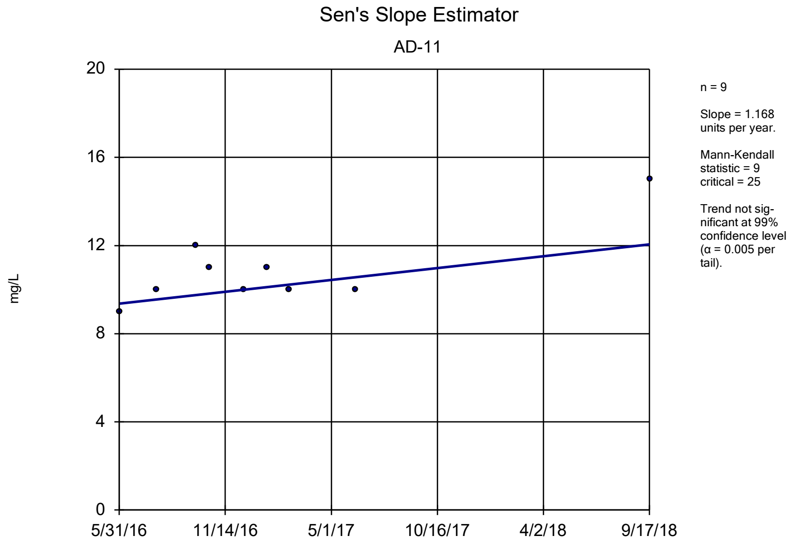
Constituent: Boron, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Chloride, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

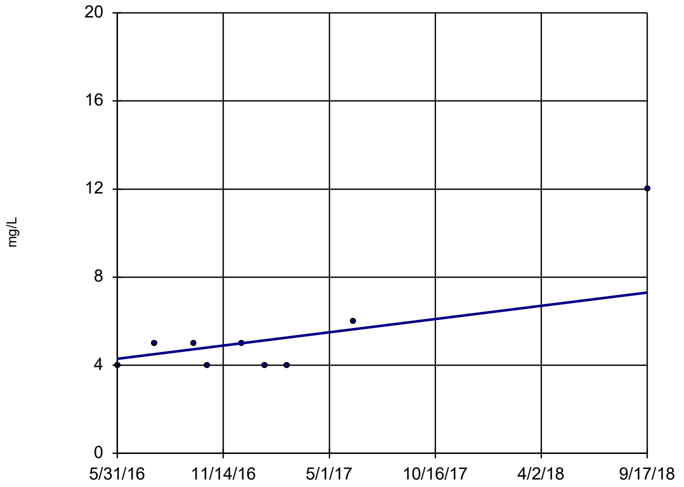


Constituent: Chloride, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-14



n = 9

Slope = 1.308
units per year.

Mann-Kendall
statistic = 11
critical = 25

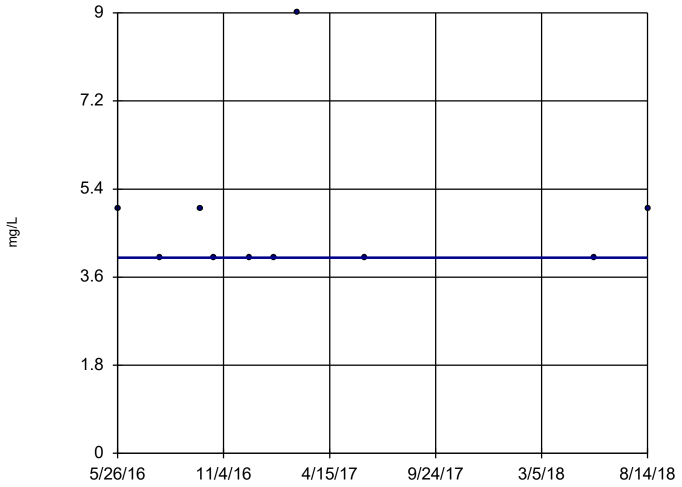
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-1 (bg)



n = 10

Slope = 0
units per year.

Mann-Kendall
statistic = -1
critical = -30

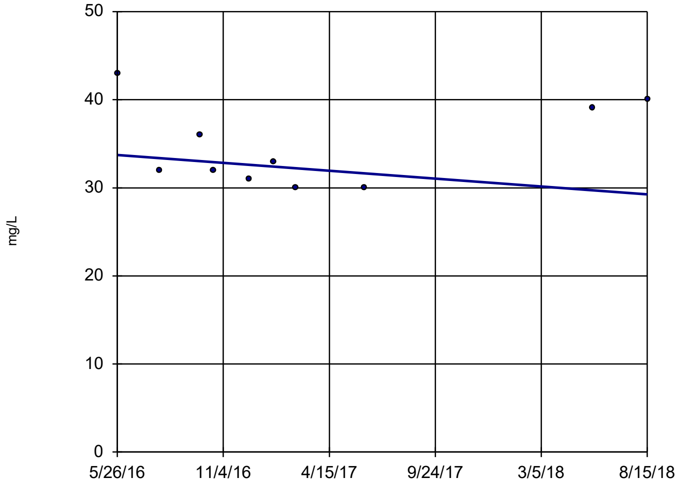
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-17 (bg)



n = 10

Slope = -2.005
units per year.

Mann-Kendall
statistic = -5
critical = -30

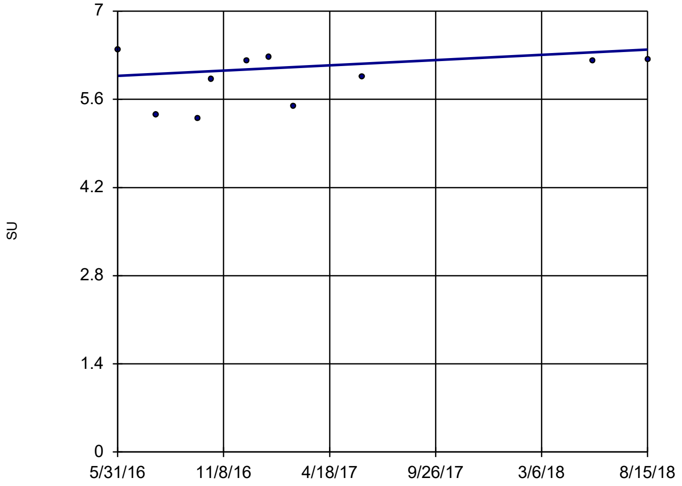
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-5 (bg)



n = 10

Slope = 0.1885
units per year.

Mann-Kendall
statistic = 11
critical = 30

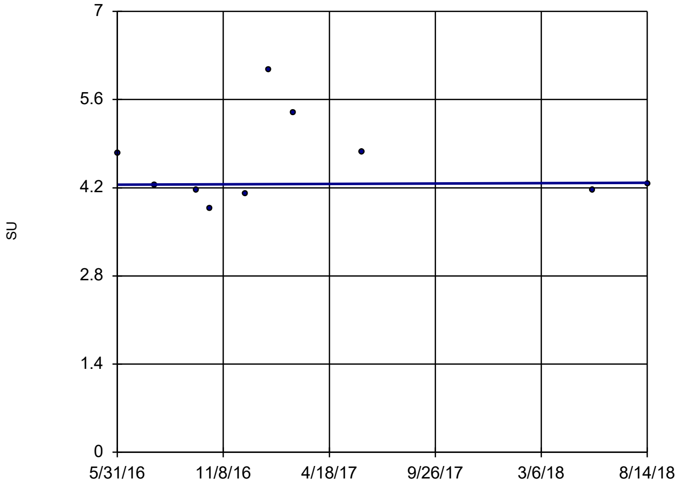
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-14



n = 10

Slope = 0.01464 units per year.

Mann-Kendall statistic = 2 critical = 30

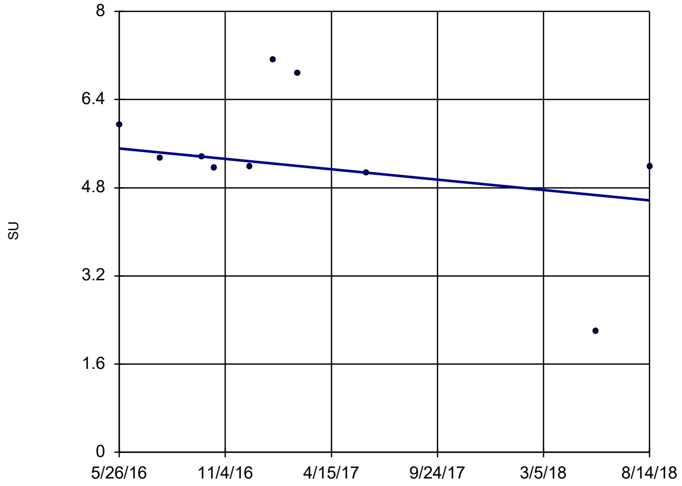
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-1 (bg)



n = 10

Slope = -0.4232 units per year.

Mann-Kendall statistic = -14 critical = -30

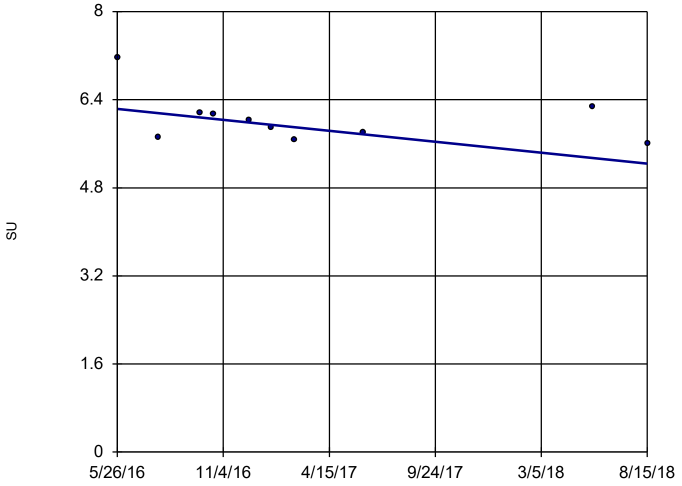
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-17 (bg)



n = 10

Slope = -0.4462 units per year.

Mann-Kendall statistic = -19 critical = -30

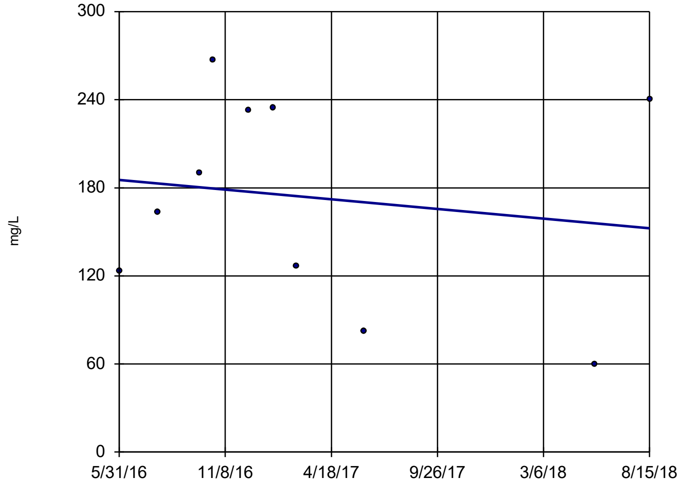
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-5 (bg)



n = 10

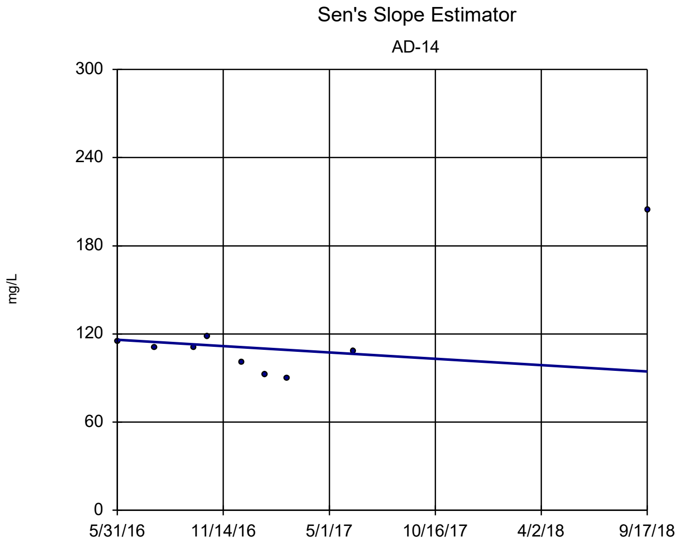
Slope = -14.86 units per year.

Mann-Kendall statistic = -1 critical = -30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-14

n = 9

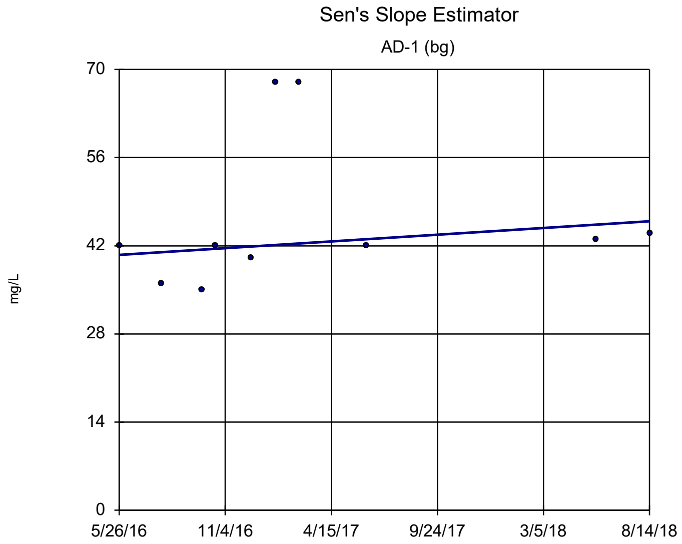
Slope = -9.409
units per year.

Mann-Kendall
statistic = -7
critical = -25

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 12/11/2018 4:59 AM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-1 (bg)

n = 10

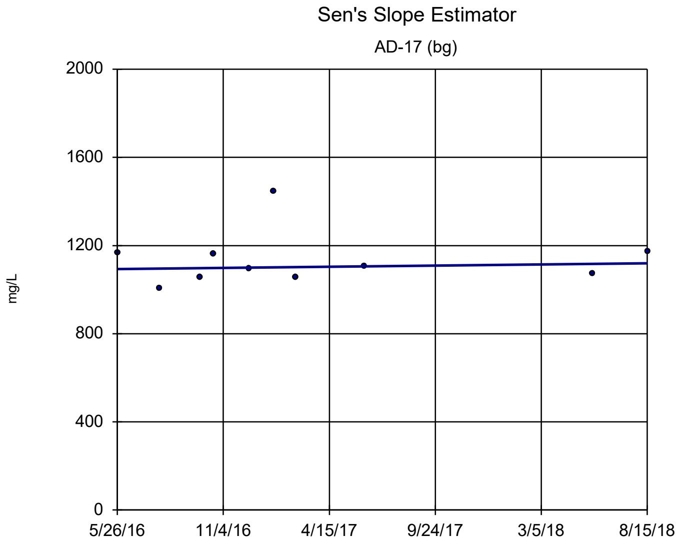
Slope = 2.401
units per year.

Mann-Kendall
statistic = 19
critical = 30

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 12/11/2018 4:59 AM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-17 (bg)

n = 10

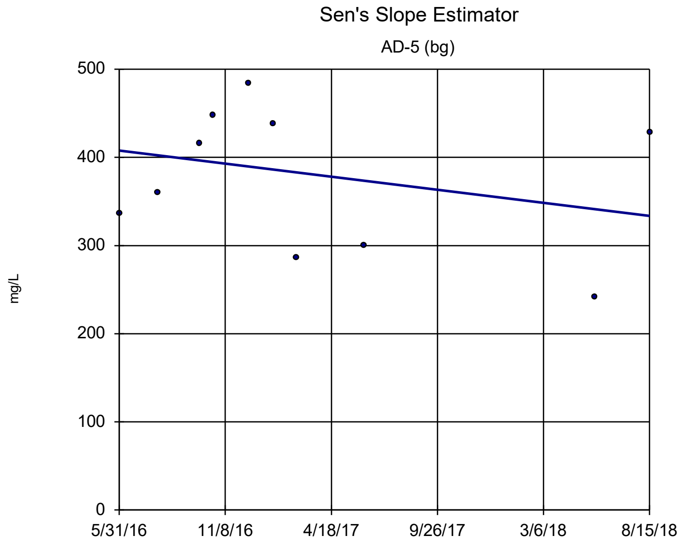
Slope = 12.06
units per year.

Mann-Kendall
statistic = 8
critical = 30

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 12/11/2018 4:59 AM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-5 (bg)

n = 10

Slope = -33.56
units per year.

Mann-Kendall
statistic = -5
critical = -30

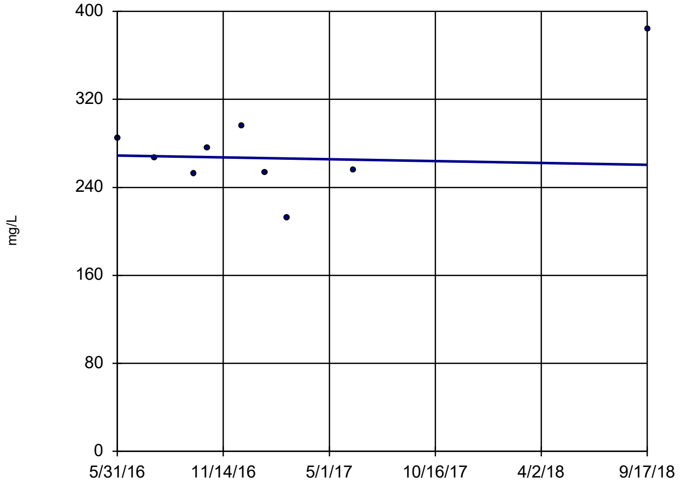
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Total Dissolved Solids   Analysis Run 12/11/2018 4:59 AM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-14



n = 9

Slope = -3.767 units per year.

Mann-Kendall statistic = 0 critical = 25

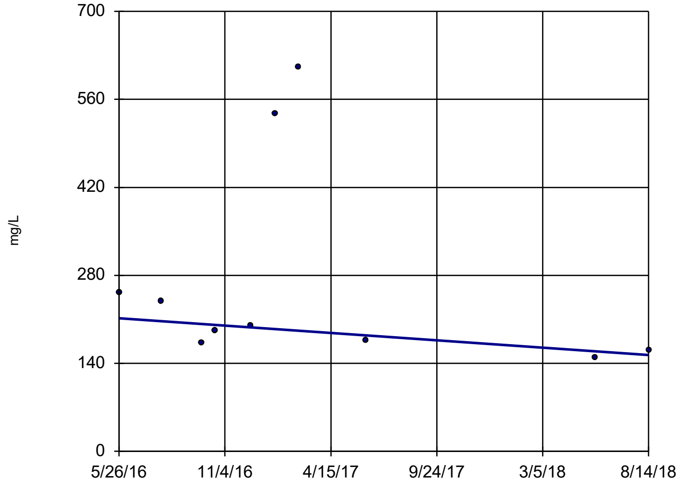
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-1 (bg)



n = 10

Slope = -26.43 units per year.

Mann-Kendall statistic = -13 critical = -30

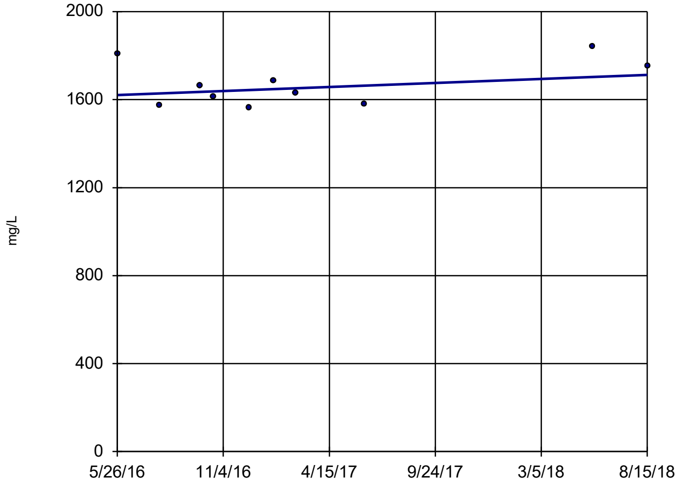
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-17 (bg)



n = 10

Slope = 40.84 units per year.

Mann-Kendall statistic = 7 critical = 30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids Analysis Run 12/11/2018 4:59 AM View: Trend Testing
Welsh LF Client: Geosyntec Data: Welsh LF

Upper Tolerance Limits - Appendix IV

Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/10/2018, 1:51 PM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	30	n/a	n/a	80	n/a	n/a	0.2146	NP Inter(NDs)
Arsenic, total (mg/L)	0.005	30	n/a	n/a	63.33	n/a	n/a	0.2146	NP Inter(normality)
Barium, total (mg/L)	0.362	30	0.4014	0.1402	0	None	x^(1/3)	0.05	Inter
Beryllium, total (mg/L)	0.0007706	30	0.01454	0.005955	13.33	None	sqrt(x)	0.05	Inter
Cadmium, total (mg/L)	0.00646	30	n/a	n/a	30	n/a	n/a	0.2146	NP Inter(Cohens/xform)
Chromium, total (mg/L)	0.004	29	n/a	n/a	31.03	n/a	n/a	0.2259	NP Inter(normality)
Cobalt, total (mg/L)	0.0748	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	4.205	30	2	0.9933	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	30	n/a	n/a	76.67	n/a	n/a	0.2146	NP Inter(NDs)
Lead, total (mg/L)	0.005	30	n/a	n/a	86.67	n/a	n/a	0.2146	NP Inter(NDs)
Lithium, total (mg/L)	0.394	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Mercury, total (mg/L)	0.000033	30	n/a	n/a	46.67	n/a	n/a	0.2146	NP Inter(normality)
Molybdenum, total (mg/L)	0.005	30	n/a	n/a	73.33	n/a	n/a	0.2146	NP Inter(normality)
Selenium, total (mg/L)	0.005	30	n/a	n/a	53.33	n/a	n/a	0.2146	NP Inter(normality)
Thallium, total (mg/L)	0.002	30	n/a	n/a	83.33	n/a	n/a	0.2146	NP Inter(NDs)

Confidence Interval Summary Table - All Appendix IV (No Significant Results)

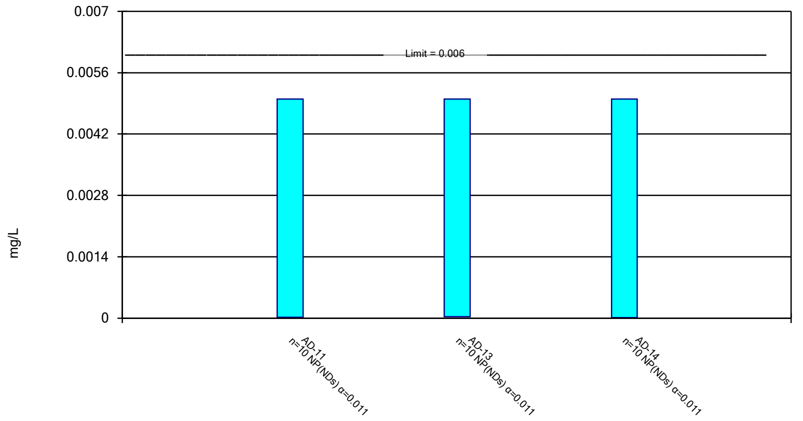
Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 1/5/2019, 11:18 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-11	0.005	0.00002	0.006	No	10	90	No	0.011	NP (NDs)
Antimony, total (mg/L)	AD-13	0.005	0.00003	0.006	No	10	80	No	0.011	NP (NDs)
Antimony, total (mg/L)	AD-14	0.005	0.00001	0.006	No	10	90	No	0.011	NP (NDs)
Arsenic, total (mg/L)	AD-11	0.005	0.00105	0.01	No	10	60	No	0.011	NP (normality)
Arsenic, total (mg/L)	AD-13	0.005	0.00137	0.01	No	10	70	No	0.011	NP (normality)
Arsenic, total (mg/L)	AD-14	0.005	0.00039	0.01	No	10	70	No	0.011	NP (normality)
Barium, total (mg/L)	AD-11	0.02	0.01012	2	No	10	0	No	0.011	NP (normality)
Barium, total (mg/L)	AD-13	0.0645	0.02124	2	No	10	0	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-14	0.05407	0.02723	2	No	10	0	sqrt(x)	0.01	Param.
Beryllium, total (mg/L)	AD-11	0.004635	0.002551	0.004	No	10	0	x^2	0.01	Param.
Beryllium, total (mg/L)	AD-13	0.0009722	0.0006411	0.004	No	10	0	x^2	0.01	Param.
Beryllium, total (mg/L)	AD-14	0.0007222	0.0003541	0.004	No	10	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-11	0.0004992	0.0003061	0.005	No	10	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-13	0.001	0.000085	0.005	No	10	40	No	0.011	NP (normality)
Cadmium, total (mg/L)	AD-14	0.001452	0.0004738	0.005	No	10	0	No	0.01	Param.
Chromium, total (mg/L)	AD-11	0.003028	0.0002928	0.1	No	10	0	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-13	0.004	0.000503	0.1	No	10	30	No	0.011	NP (normality)
Chromium, total (mg/L)	AD-14	0.001171	0.0005606	0.1	No	10	20	No	0.01	Param.
Cobalt, total (mg/L)	AD-11	0.02786	0.01857	0.075	No	10	0	x^2	0.01	Param.
Cobalt, total (mg/L)	AD-13	0.008863	0.003162	0.075	No	10	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-14	0.01305	0.005173	0.075	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-11	2.806	1.388	5	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-13	3.082	1.427	5	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-14	2.552	0.8154	5	No	10	0	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-11	2	0.083	4	No	10	20	No	0.011	NP (normality)
Fluoride, total (mg/L)	AD-13	0.8623	0.1958	4	No	10	20	No	0.01	Param.
Fluoride, total (mg/L)	AD-14	0.083	0.083	4	No	10	100	No	0.011	NP (NDs)
Lead, total (mg/L)	AD-11	0.005	0.001183	0.015	No	10	70	No	0.011	NP (normality)
Lead, total (mg/L)	AD-13	0.005	0.001	0.015	No	10	70	No	0.011	NP (normality)
Lead, total (mg/L)	AD-14	0.005	0.000174	0.015	No	10	90	No	0.011	NP (NDs)
Lithium, total (mg/L)	AD-11	0.04681	0.02675	0.39	No	10	0	No	0.01	Param.
Lithium, total (mg/L)	AD-13	0.02811	0.01289	0.39	No	10	0	No	0.01	Param.
Lithium, total (mg/L)	AD-14	0.01446	0.01174	0.39	No	9	0	No	0.01	Param.
Mercury, total (mg/L)	AD-11	0.00001756	0.000001904	0.002	No	10	30	No	0.01	Param.
Mercury, total (mg/L)	AD-13	0.00001565	0.000005	0.002	No	10	50	No	0.011	NP (normality)
Mercury, total (mg/L)	AD-14	0.000145	0.00001443	0.002	No	10	0	No	0.011	NP (normality)
Molybdenum, total (mg/L)	AD-11	0.005	0.00005	0.1	No	10	80	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-13	0.005	0.00006	0.1	No	10	70	No	0.011	NP (normality)
Molybdenum, total (mg/L)	AD-14	0.005	0.00003	0.1	No	10	80	No	0.011	NP (NDs)
Selenium, total (mg/L)	AD-11	0.005	0.00134	0.05	No	10	40	No	0.011	NP (normality)
Selenium, total (mg/L)	AD-13	0.005	0.00103	0.05	No	10	30	No	0.011	NP (normality)
Selenium, total (mg/L)	AD-14	0.00453	0.002362	0.05	No	10	20	No	0.01	Param.
Thallium, total (mg/L)	AD-11	0.002	0.0002	0.002	No	10	50	No	0.011	NP (normality)
Thallium, total (mg/L)	AD-13	0.002	0.000277	0.002	No	10	80	No	0.011	NP (NDs)
Thallium, total (mg/L)	AD-14	0.002	0.000242	0.002	No	10	90	No	0.011	NP (NDs)

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

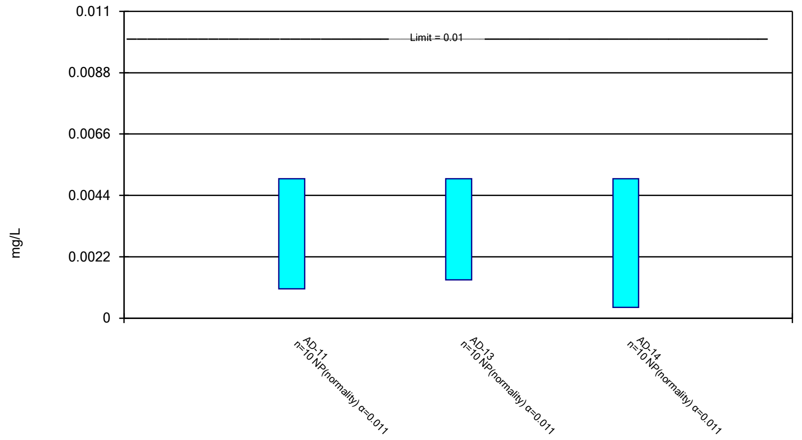


Constituent: Antimony, total   Analysis Run 1/5/2019 11:15 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

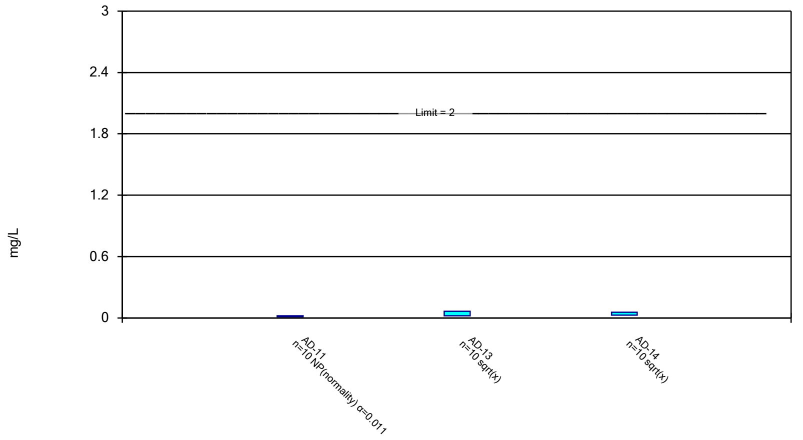


Constituent: Arsenic, total   Analysis Run 1/5/2019 11:15 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

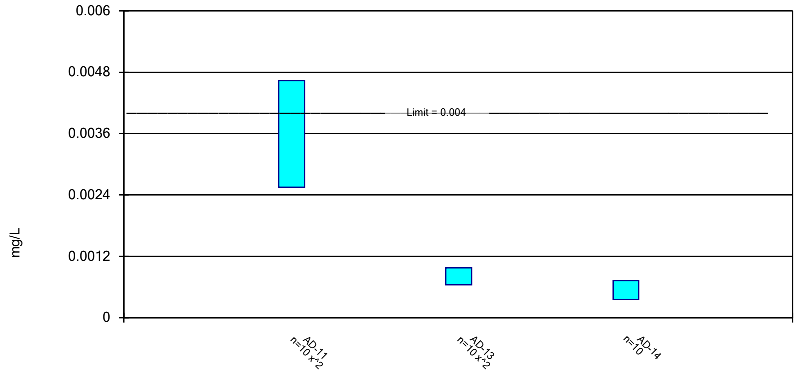


Constituent: Barium, total   Analysis Run 1/5/2019 11:15 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

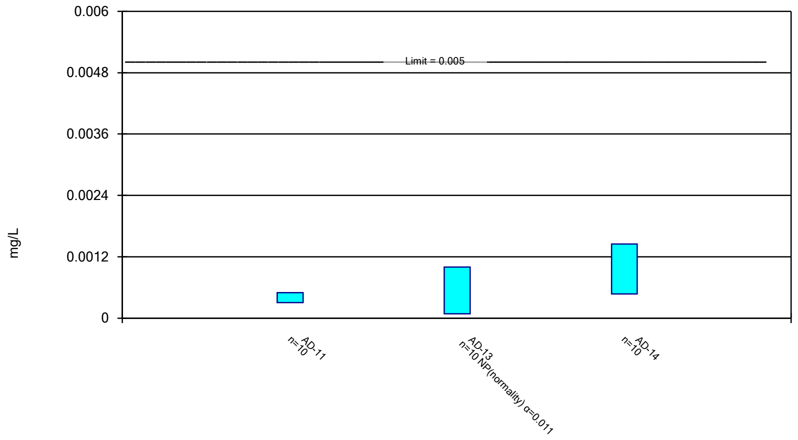


Constituent: Beryllium, total   Analysis Run 1/5/2019 11:15 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

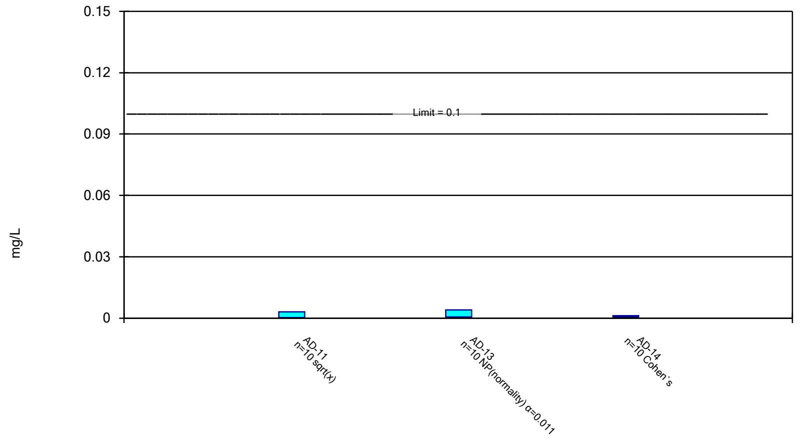


Constituent: Cadmium, total   Analysis Run 1/5/2019 11:16 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

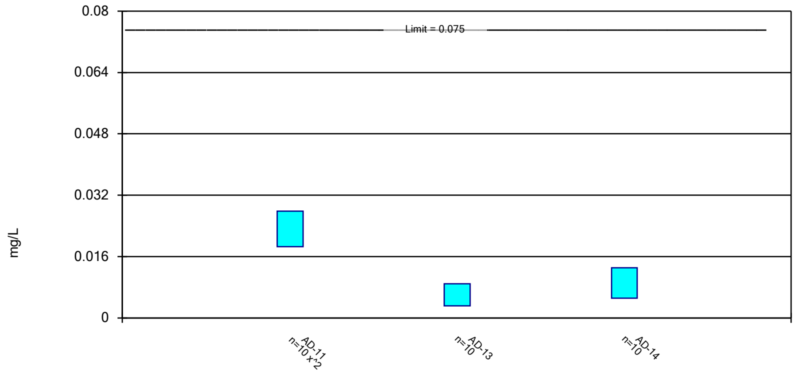


Constituent: Chromium, total   Analysis Run 1/5/2019 11:16 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

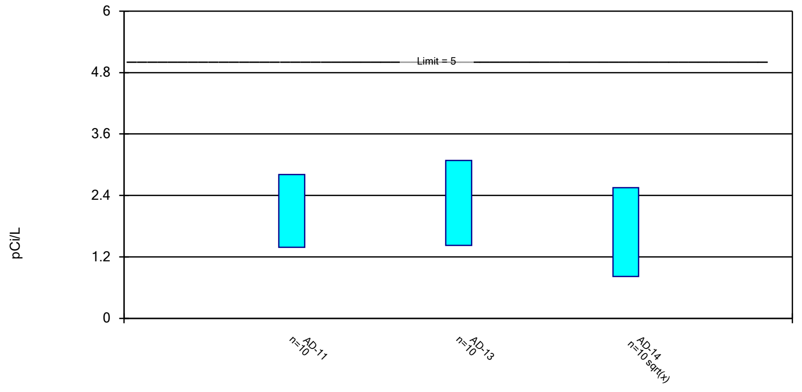


Constituent: Cobalt, total   Analysis Run 1/5/2019 11:16 AM   View: Confidence Interval - App IV
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

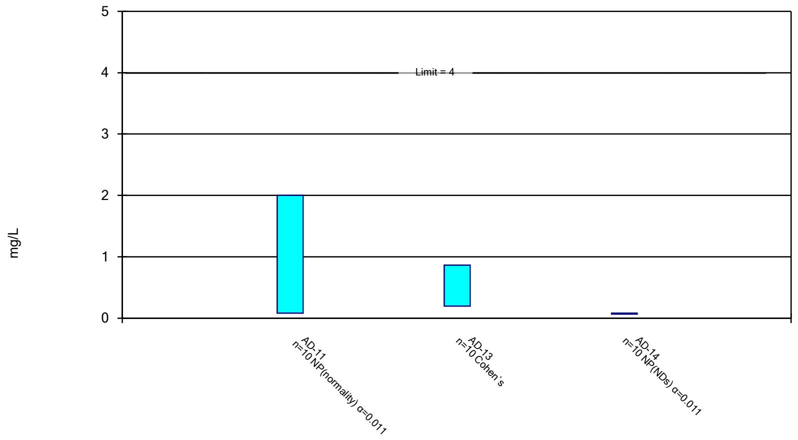


Constituent: Combined Radium 226 + 228   Analysis Run 1/5/2019 11:16 AM   View: Confidence Interval - A
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.11 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.

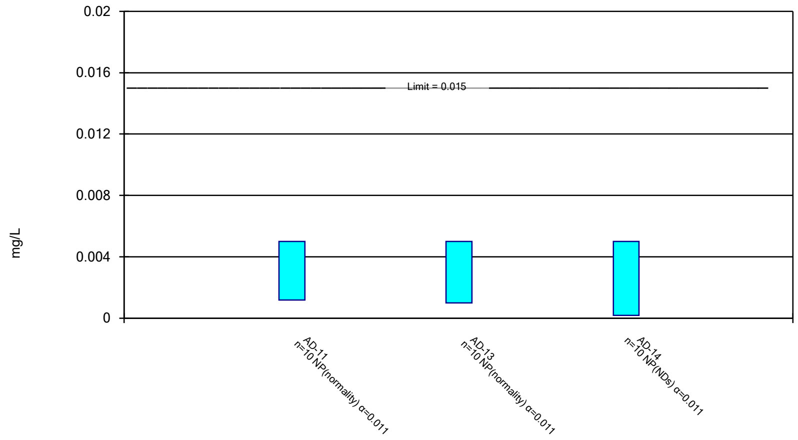


Constituent: Fluoride, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

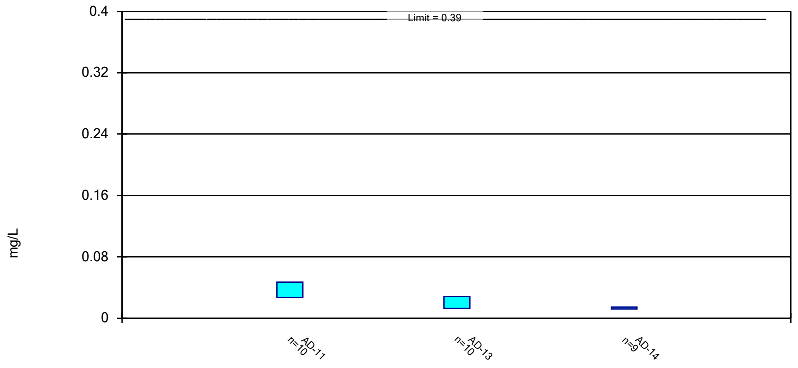


Constituent: Lead, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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.

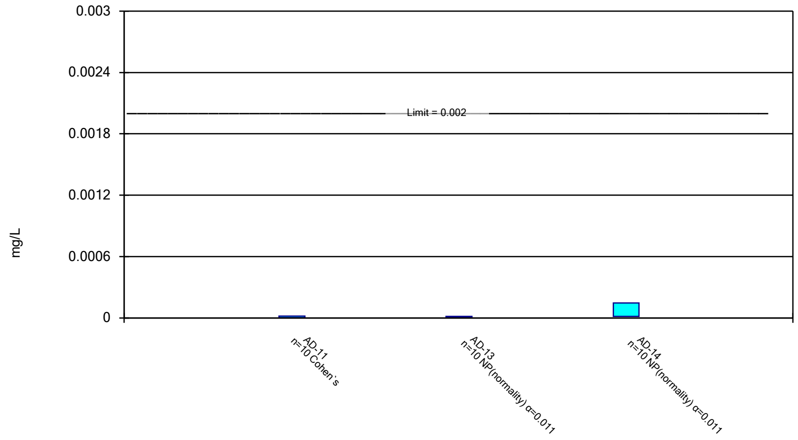


Constituent: Lithium, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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.

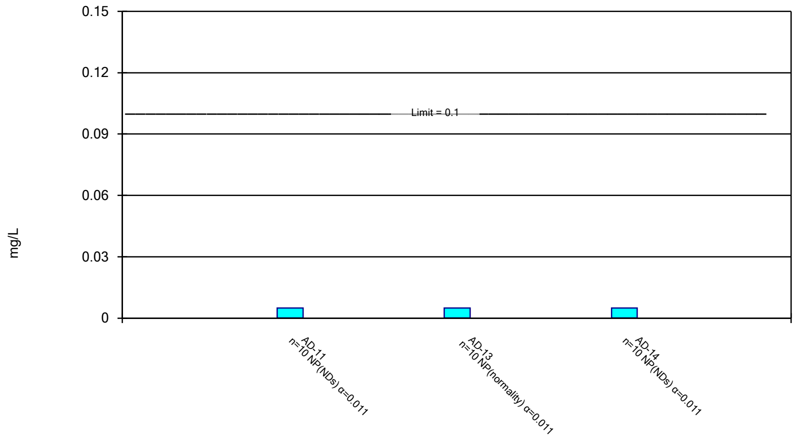


Constituent: Mercury, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

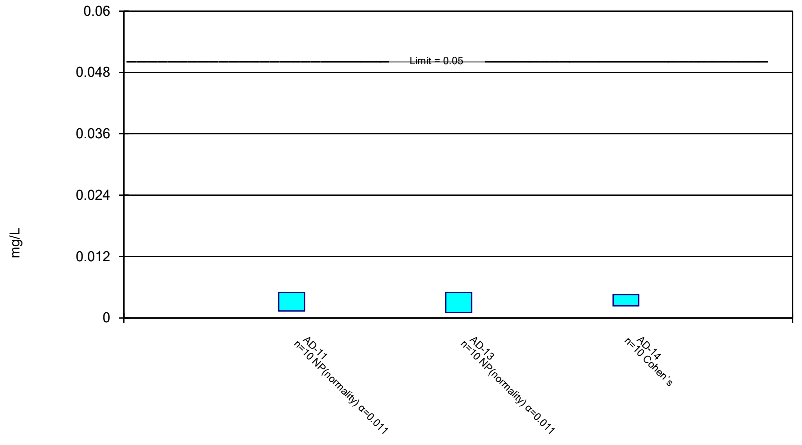


Constituent: Molybdenum, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 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.

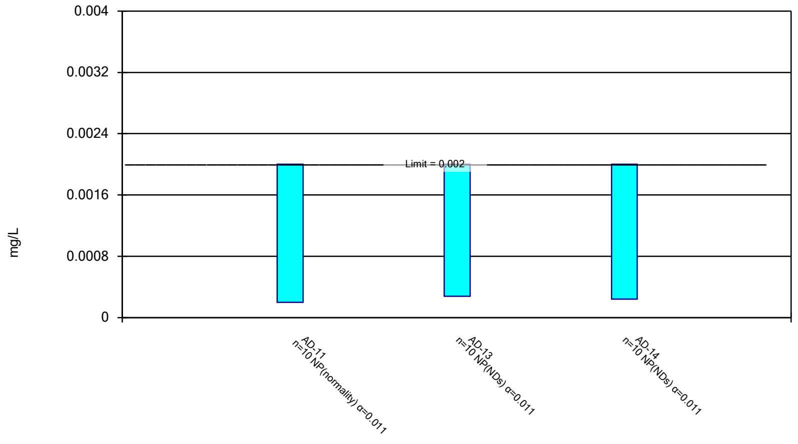


Constituent: Selenium, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.11 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total Analysis Run 1/5/2019 11:16 AM View: Confidence Interval - App IV
Welsh LF Client: Geosyntec Data: Welsh LF

STATISTICAL ANALYSIS SUMMARY
LANDFILL
J. Robert Welsh Plant
Pittsburg, 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 9, 2019

CHA8473

TABLE OF CONTENTS

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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 Welsh Power Plant located in Pittsburg, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, total dissolved solids (TDS), and sulfate 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. No SSLs were identified during these events and 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 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. No SSLs were identified, but Appendix III concentrations for boron and calcium remained above background. Thus, either the unit will remain in assessment monitoring or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can return to detection 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). Samples from the February 2019 semi-annual sampling event were analyzed for the 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 antimony, arsenic, cobalt, fluoride, lithium, mercury, molybdenum, and selenium due to apparent non-normal distributions, for lead and thallium due to a high non-detect frequency, and for cadmium and chromium due to both apparent non-normal distributions and high non-detect frequencies. 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.

No SSLs were identified at the Welsh LF.

2.2.3 Evaluation of Potential Appendix III SSIs

The CCR rule allows CCR units to move from assessment monitoring to detection monitoring if all Appendix III and Appendix IV parameters were at or below background levels for two consecutive sampling events [40 CFR 257.95(e)]. Since no Appendix IV SSLs were identified, Appendix III results were analyzed 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, chloride, TDS, and sulfate, whereas interwell tests were used to evaluate potential SSIs for boron, fluoride, and pH.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event and another monitoring event also conducted in February 2019. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. An additional three data points (i.e., one sample from three background wells) were added for boron, fluoride, and pH. 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, fluoride, and pH.

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, chloride, sulfate, and TDS.

Data collected during the February 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. Verification sampling was completed in April 2019. 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 0.775 mg/L at AD-11 (1.63 mg/L and 1.34 mg/L) and AD-14 (1.20 mg/L and 1.04 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Welsh LF during assessment monitoring. As a result, the Welsh LF CCR unit will remain in 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. No SSLs were identified.

The Appendix III results were evaluated to assess whether concentrations of Appendix III parameters exceeded background levels. Interwell tests were used to evaluate potential SSIs for boron, fluoride, and pH, and intrawell tests were used to evaluate potential SSIs for calcium, chloride, sulfate, and TDS. The prediction limits for the interwell tests were updated with additional data collected from the background wells. Prediction limits were recalculated using a one-of-two retesting procedure. The prediction limits calculated during detection monitoring were used for the intrawell tests. SSIs were identified for boron.

Based on this evaluation, either the Welsh LF CCR unit will remain in assessment monitoring or an ASD will be conducted to evaluate if the unit can return to detection monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Welsh Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Landfill, J. Robert Welsh Plant, Pittsburg, Texas. January 15, 2018.

TABLES

Table 1 - Groundwater Data Summary
Welsh - Landfill

Parameter	Unit	AD-1	AD-5	AD-11	AD-13	AD-14	AD-17
		2/20/2019	2/21/2019	2/21/2019	2/20/2019	2/20/2019	2/21/2019
Antimony	µg/L	0.160	0.0200 J	0.0300 J	0.0200 J	0.0300 J	0.0800 J
Arsenic	µg/L	0.460	1.59	0.510	0.380	0.340	2.51
Barium	µg/L	457	69.4	40.3	55.2	41.2	120
Beryllium	µg/L	0.0900 J	0.0800 J	0.824	0.302	0.387	0.240
Boron	mg/L	0.504	0.0330	1.63	0.484	1.20	0.151
Cadmium	µg/L	0.0100 J	0.0500 U	0.190	0.0500	0.350	0.270
Calcium	mg/L	142	33.9	19.1	17.7	10.3	207
Chloride	mg/L	2.82	24.7	9.23	3.95	2.20	43.2
Chromium	µg/L	0.306	0.432	0.259	0.200 J	0.247	3.34
Cobalt	µg/L	0.399	8.58	8.58	2.35	4.37	64.5
Combined Radium	pCi/L	3.16	1.27	1.51	2.53	1.17	2.66
Fluoride	mg/L	0.240	0.210	0.410	0.280	0.140	0.180
Lead	µg/L	0.124	0.147	0.523	0.0500 J	0.0900 J	2.49
Lithium	mg/L	0.00155	0.0807	0.0157	0.00940	0.0114	0.268
Mercury	mg/L	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.00000700 J
Molybdenum	µg/L	1.00 J	2.00 U	2.00 U	2.00 U	2.00 U	0.700 J
Selenium	µg/L	0.700	0.100 J	1.50	0.400	0.800	0.800
Total Dissolved Solids	mg/L	522	220	542	234	236	1720
Sulfate	mg/L	49.2	46.5	306	96.3	90.4	1060
Thallium	µg/L	0.500 U	0.500 U	0.100 J	0.500 U	0.500 U	0.500 U
pH	SU	7.31	5.38	4.85	4.86	4.28	6.93

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.
Wells AD-1, AD-5, and AD-17 are background wells

Table 2: Groundwater Protection Standards
Welsh Plant - Landfill

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.58
Beryllium, Total (mg/L)	0.004		0.00070
Cadmium, Total (mg/L)	0.005		0.0065
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.075
Combined Radium, Total (pCi/L)	5		4.18
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.39
Mercury, Total (mg/L)	0.002		0.000033
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.001

Notes:

Grey cell indicates calculated UTL (Upper Tolerance Limit) is higher than MCL.

MCL = Maximum Contaminant Level

Calculated UTL represents site-specific background values.

The higher of the calculated UTL or MCL/RSL is used as the GWPS.

Table 3: Detection Monitoring Data Evaluation
Welsh Plant - Landfill

Parameter	Units	Description	AD-11		AD-13		AD-14	
			2/21/2019	4/30/2019	2/20/2019	4/30/2019	2/20/2019	4/30/2019
Boron	mg/L	Interwell Background Value (UPL)	0.775					
		Detection Monitoring Result	**1.63**	**1.34**	0.484	0.483	**1.20**	**1.04**
Calcium	mg/L	Intrawell Background Value (UPL)	11.4		38.5		13.9	
		Detection Monitoring Result	**19.1**	7.53	17.7	--	10.3	--
Chloride	mg/L	Intrawell Background Value (UPL)	12.6		24.0		6.45	
		Detection Monitoring Result	9.23	--	3.95	--	2.2	--
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	0.41	--	0.28	--	0.14	--
pH	SU	Interwell Background Value (UPL)	7.2					
		Interwell Background Value (LPL)	4.3					
		Detection Monitoring Result	4.9	--	4.9	--	4.3	--
Sulfate	mg/L	Intrawell Background Value (UPL)	833		342		131	
		Detection Monitoring Result	306	--	96.3	--	90.4	--
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	1224		974		325	
		Detection Monitoring Result	542	--	234	--	236	--

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

*: Designates results for a duplicate sample

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

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 calculated background value.

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 Welsh 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

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

07.09.19
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: Welsh 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 February 2019 data for American Electric Power Inc.'s Welsh 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, consists of the following:

- **Upgradient wells:** AD-1, AD-5, and AD-17; and
- **Downgradient wells:** AD-11, AD-13 and AD-14

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, based on a 1-of-2 resample plan, were constructed to evaluate the following Appendix III Detection Monitoring parameters: boron, fluoride and TDS (Figure C). 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.

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 prediction limits exceedances were noted except for boron in wells AD-11 and AD-14; and pH in well AD-14 which exceeded its lower limit.

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 trends were noted (Figure D).

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 E). 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 F).

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, or ACL as discussed above (Figure G). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence intervals exceedances were found for any of the downgradient wells. 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 Welsh Landfill. If you have any questions or comments, please feel free to contact me.

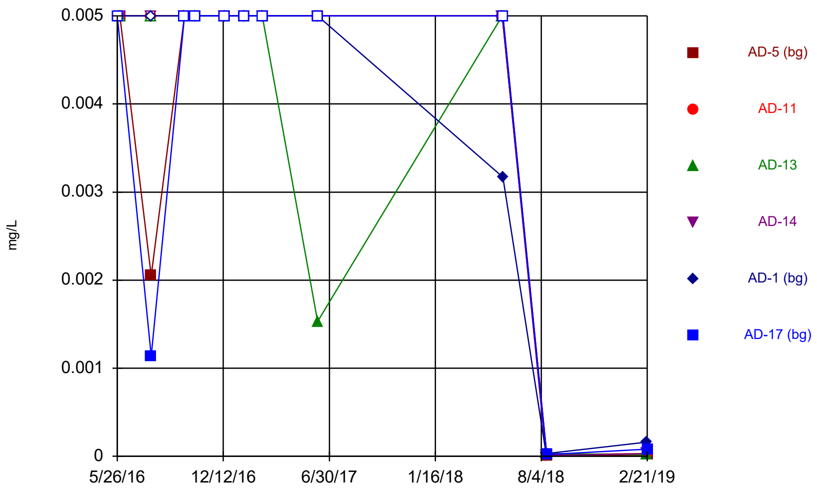
For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

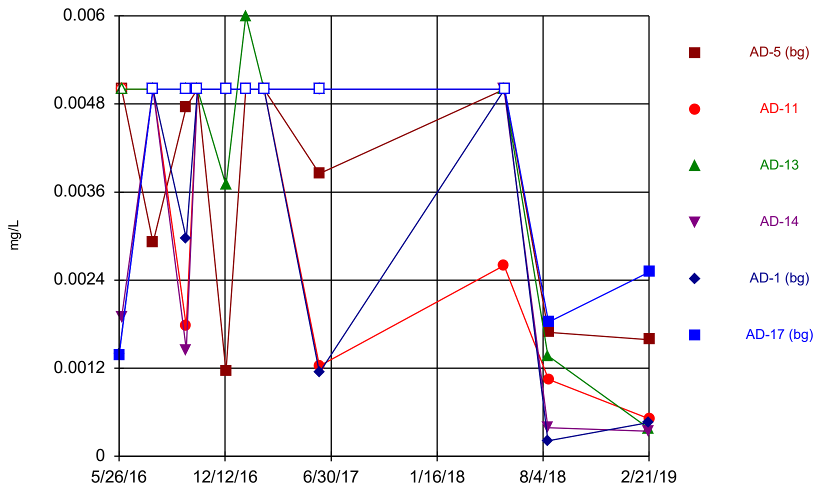
Time Series



Constituent: Antimony, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

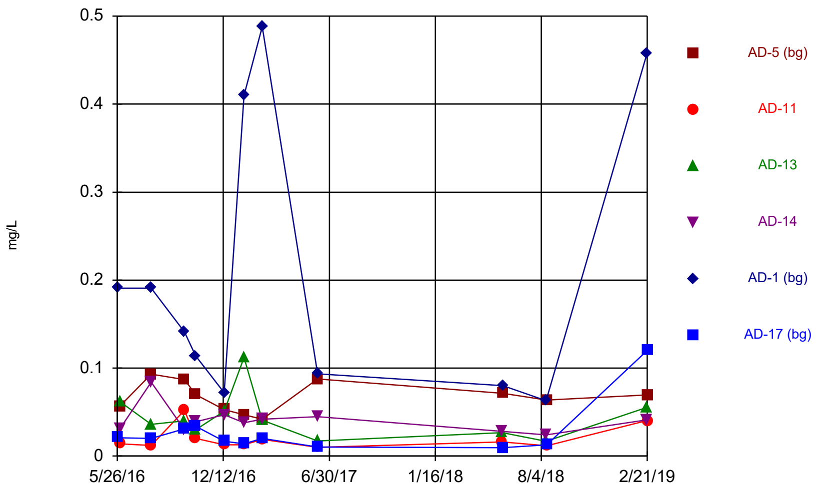
Time Series



Constituent: Arsenic, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

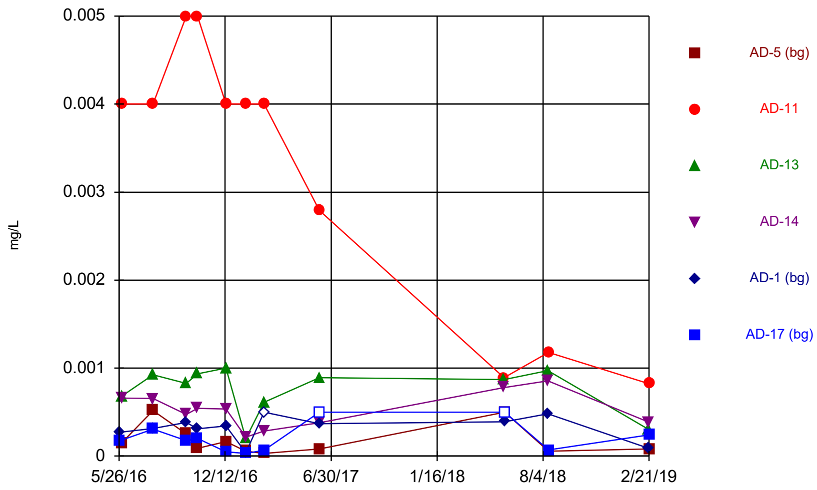
Time Series



Constituent: Barium, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

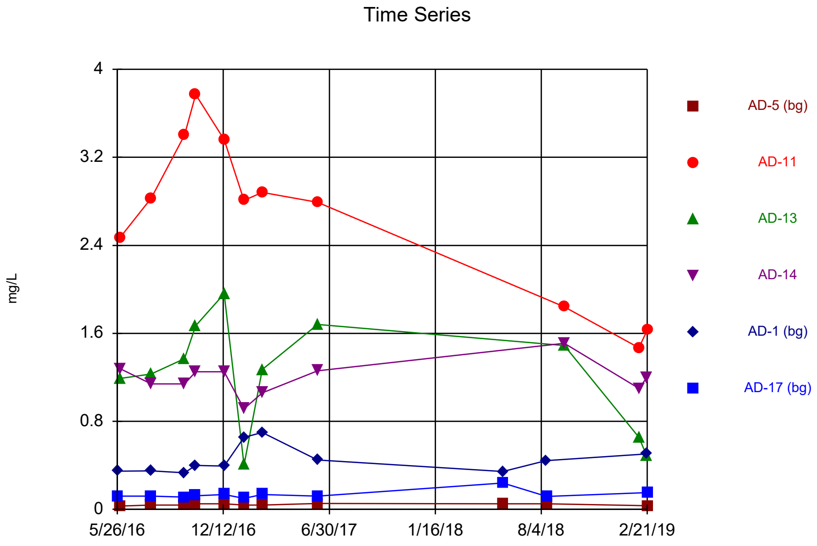
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



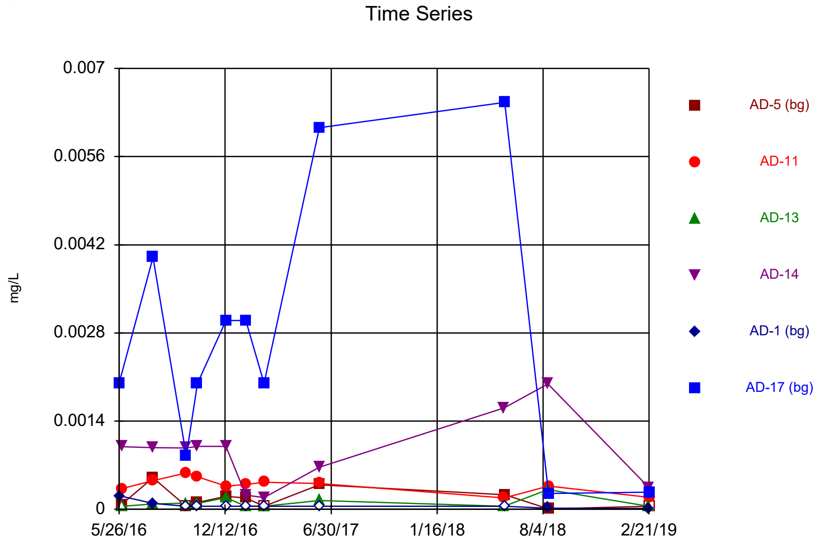
Constituent: Beryllium, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



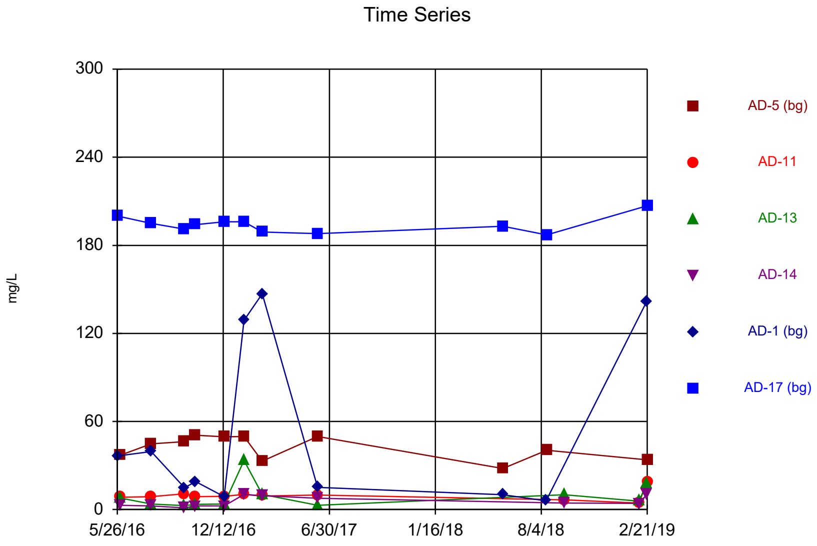
Constituent: Boron, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



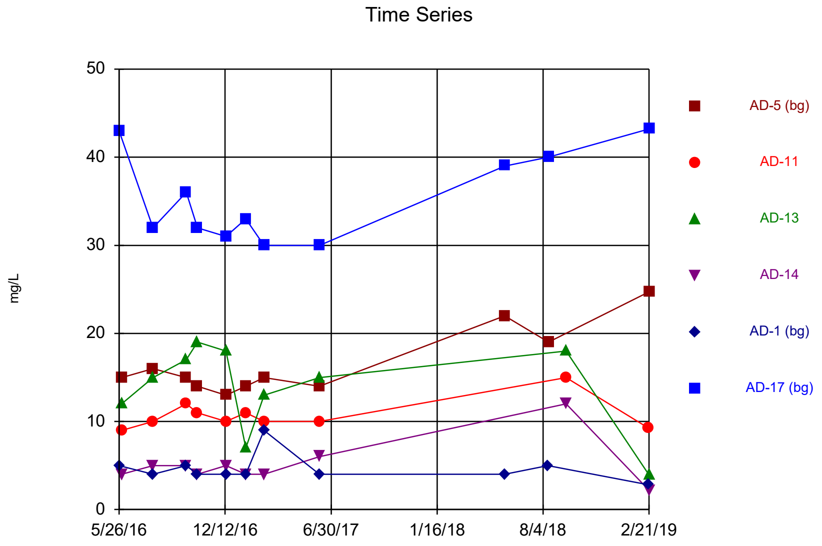
Constituent: Cadmium, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



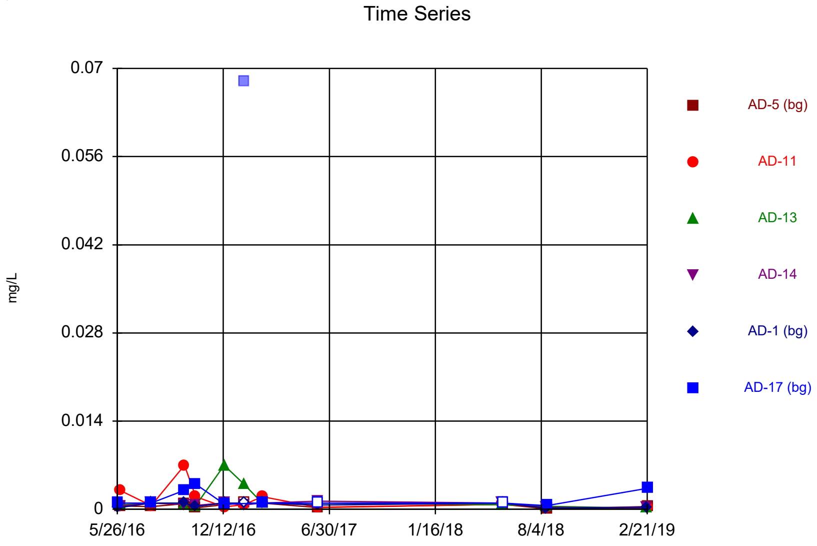
Constituent: Calcium, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



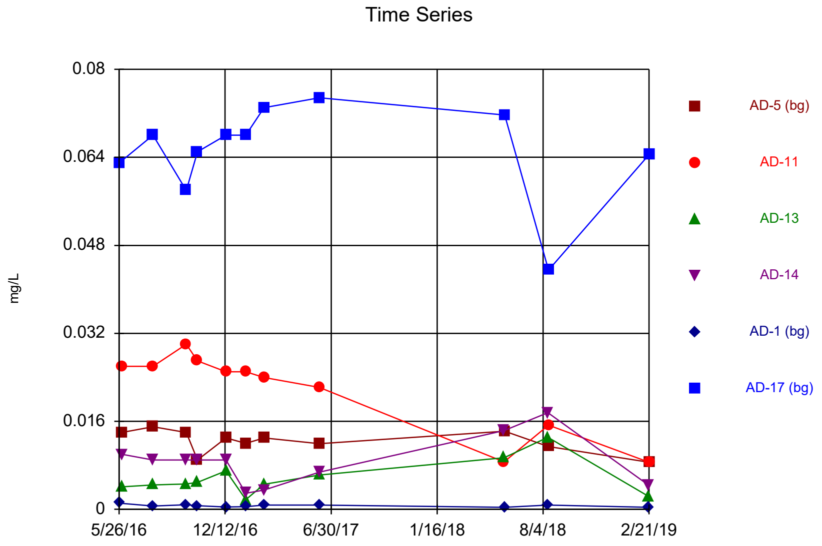
Constituent: Chloride, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



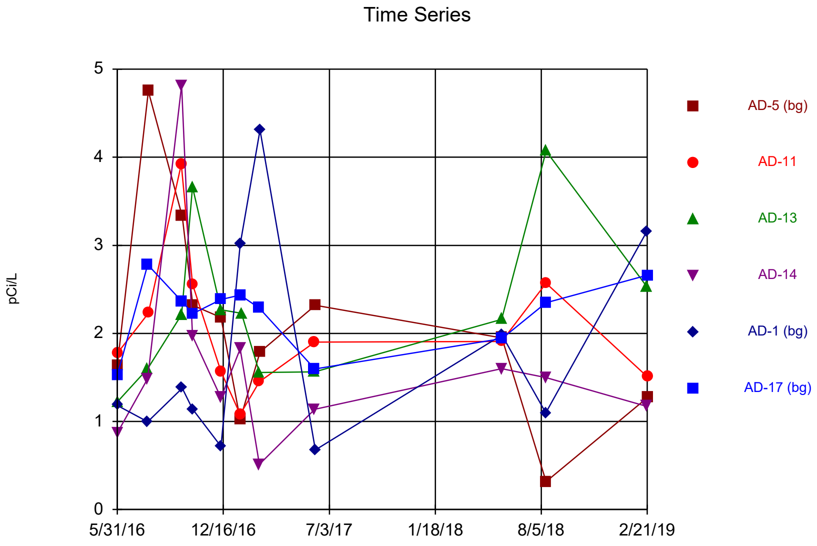
Constituent: Chromium, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



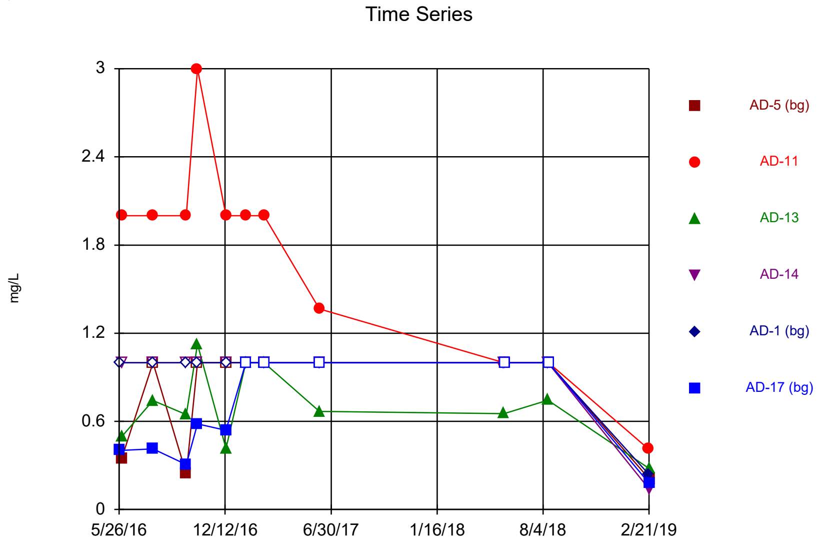
Constituent: Cobalt, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

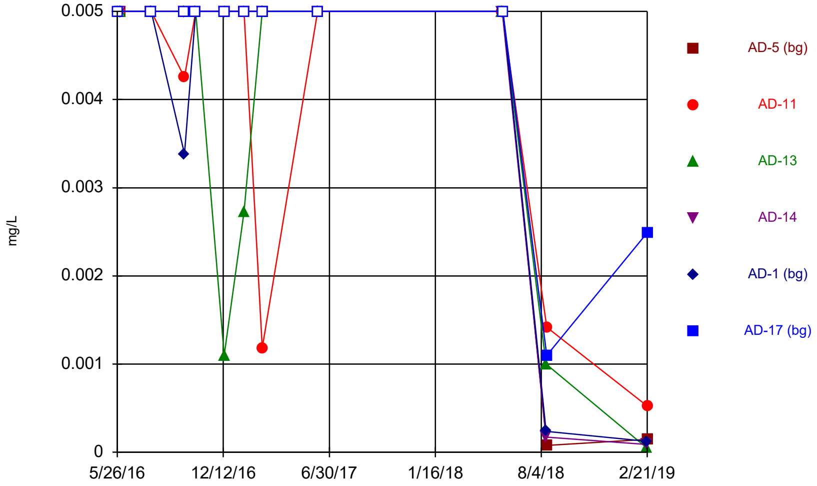
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Fluoride, total Analysis Run 6/24/2019 12:01 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

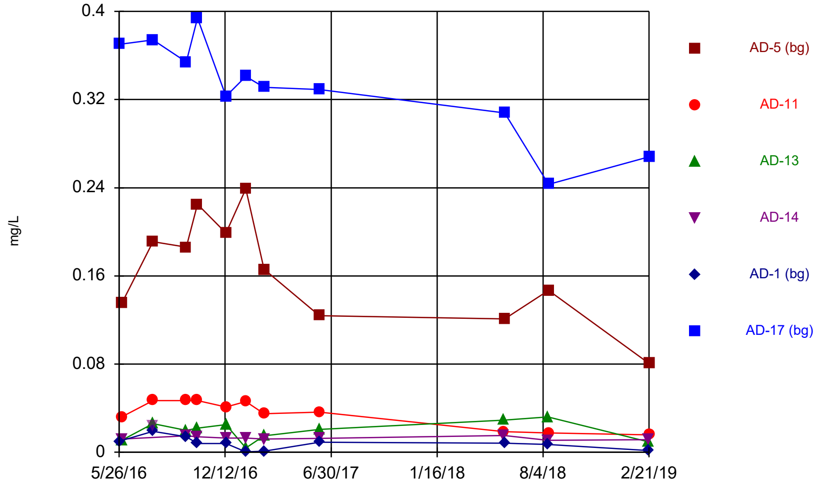
Time Series



Constituent: Lead, total   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

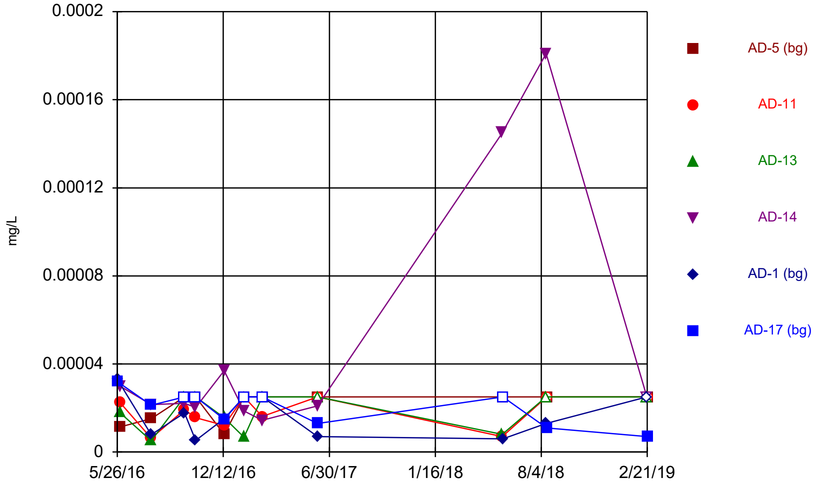
Time Series



Constituent: Lithium, total   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

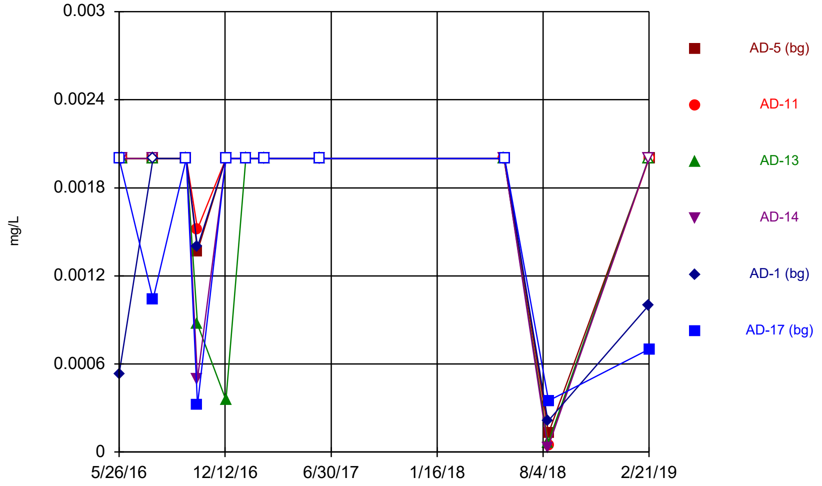
Time Series



Constituent: Mercury, total   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

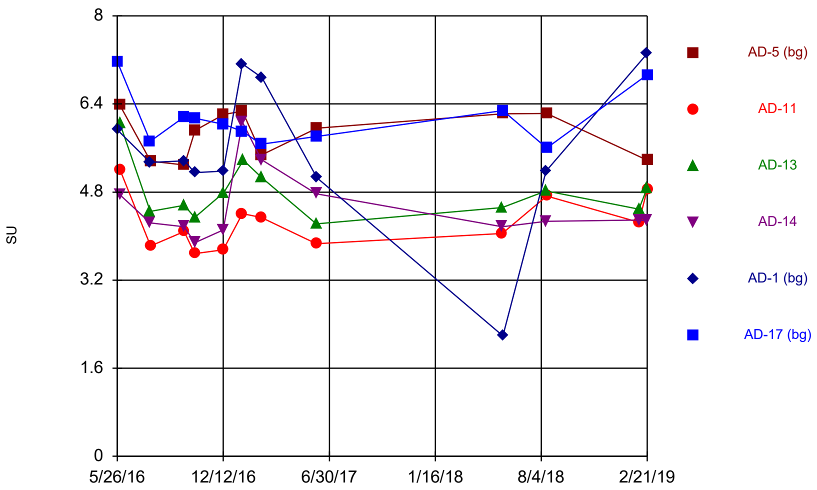
Time Series



Constituent: Molybdenum, total   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

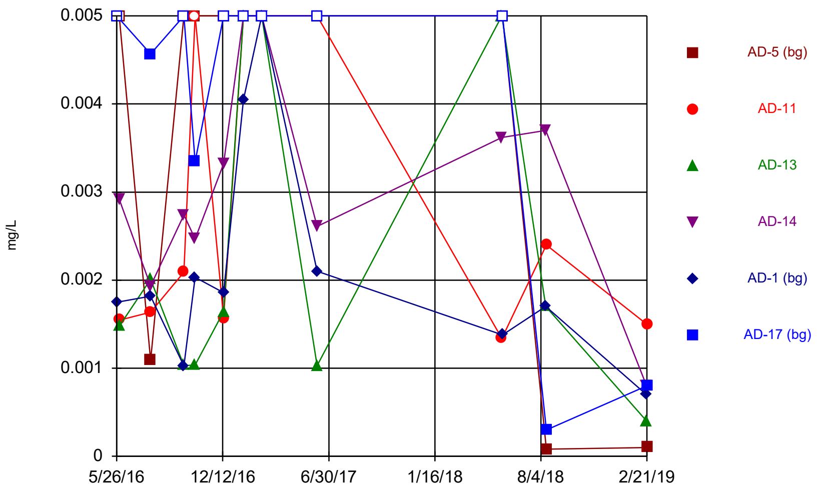
Time Series



Constituent: pH, field   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

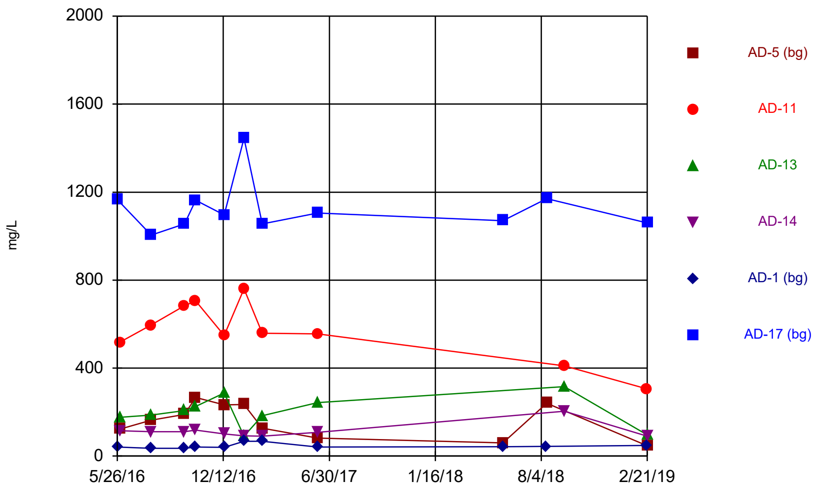
Time Series



Constituent: Selenium, total   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

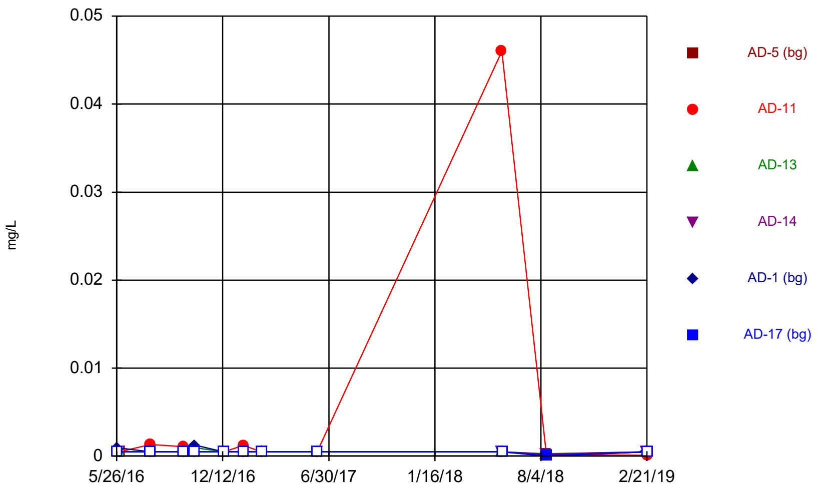
Time Series



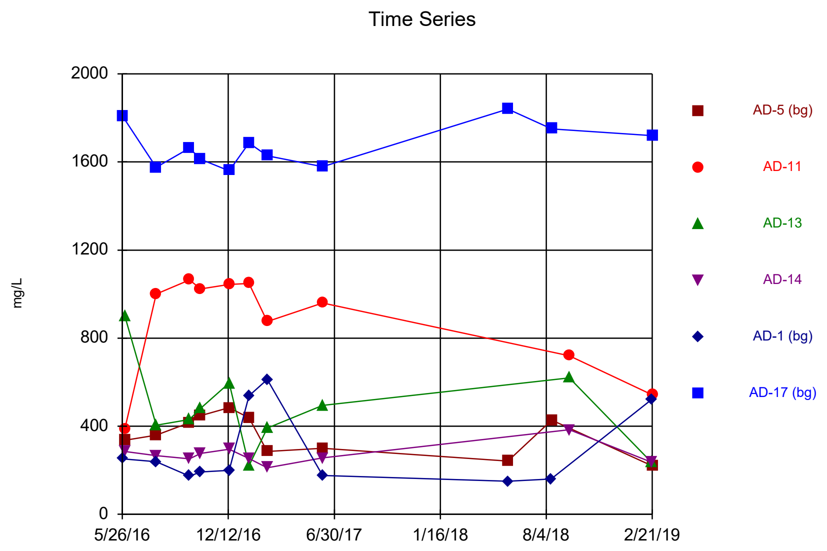
Constituent: Sulfate, total   Analysis Run 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF

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 6/24/2019 12:01 PM   View: Descriptive
Welsh LF   Client: Geosyntec   Data: Welsh LF



Constituent: Total Dissolved Solids Analysis Run 6/24/2019 12:01 PM View: Descriptive

Welsh LF Client: Geosyntec Data: Welsh LF

Outlier Summary

Welsh LF Client: Geosyntec Data: Welsh LF Printed 7/11/2019, 2:01 PM

	AD-17 Chromium, total (mg/L)	AD-14 Lithium, total (mg/L)
7/29/2016		0.024 (o)
1/20/2017	0.068 (O)	

Interwell Prediction Limit Summary - Significant Results

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 6/24/2019, 12:10 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-11**	**0.775**	**n/a**	**2/21/2019**	**1.63**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-14**	**0.775**	**n/a**	**2/20/2019**	**1.2**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
pH, field (SU)	**AD-14**	**7.177**	**4.285**	**2/20/2019**	**4.28**	**Yes**	**33**	**34.93**	**9.314**	**0**	**None**	**x^2**	**0.001253**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary - All Results

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 6/24/2019, 12:10 PM

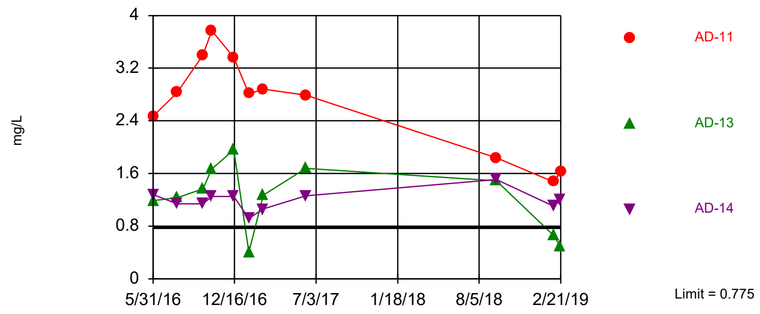
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-11**	**0.775**	**n/a**	**2/21/2019**	**1.63**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	AD-13	0.775	n/a	2/20/2019	0.484	No	33	-2.01	0.986	0	None	ln(x)	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-14**	**0.775**	**n/a**	**2/20/2019**	**1.2**	**Yes**	**33**	**-2.01**	**0.986**	**0**	**None**	**ln(x)**	**0.002505**	**Param Inter 1 of 2**
Fluoride, total (mg/L)	AD-11	1	n/a	2/20/2019	0.41	No	33	n/a	n/a	69.7	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-13	1	n/a	2/21/2019	0.28	No	33	n/a	n/a	69.7	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-14	1	n/a	2/21/2019	0.14	No	33	n/a	n/a	69.7	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
pH, field (SU)	AD-11	7.177	4.285	2/21/2019	4.85	No	33	34.93	9.314	0	None	x^2	0.001253	Param Inter 1 of 2
pH, field (SU)	AD-13	7.177	4.285	2/20/2019	4.86	No	33	34.93	9.314	0	None	x^2	0.001253	Param Inter 1 of 2
pH, field (SU)	**AD-14**	**7.177**	**4.285**	**2/20/2019**	**4.28**	**Yes**	**33**	**34.93**	**9.314**	**0**	**None**	**x^2**	**0.001253**	**Param Inter 1 of 2**

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-11, AD-14

Prediction Limit

Interwell Parametric



Background Data Summary (based on natural log transformation): Mean=-2.01, Std. Dev.=0.986, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9116, 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.

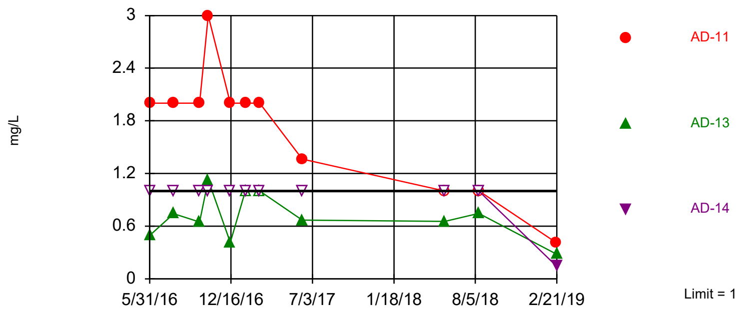
Constituent: Boron, total Analysis Run 6/24/2019 12:08 PM View: PL's - Interwell
Welsh LF Client: Geosyntec Data: Welsh LF

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. 69.7% NDs. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

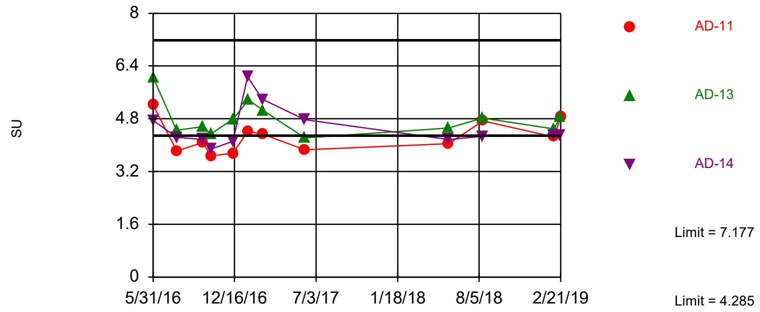
Constituent: Fluoride, total Analysis Run 6/24/2019 12:08 PM View: PL's - Interwell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits: AD-14

Prediction Limit

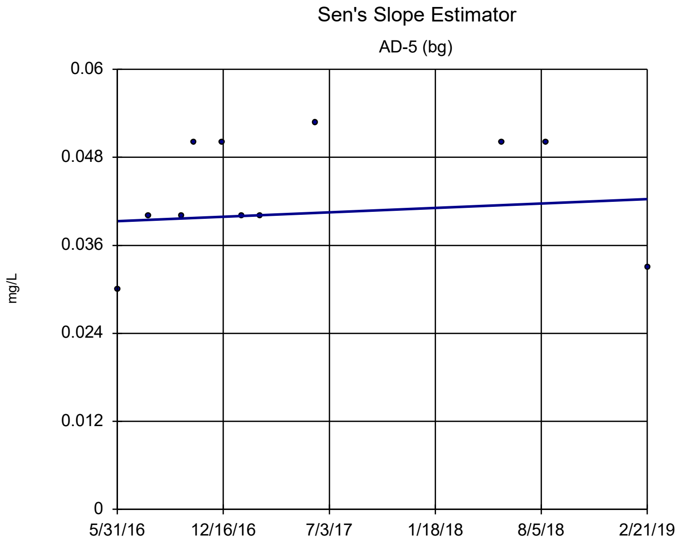
Interwell Parametric



Background Data Summary (based on square transformation): Mean=34.93, Std. Dev.=9.314, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.927, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 3 points to limit.

Constituent: pH, field Analysis Run 6/24/2019 12:08 PM View: PL's - Interwell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

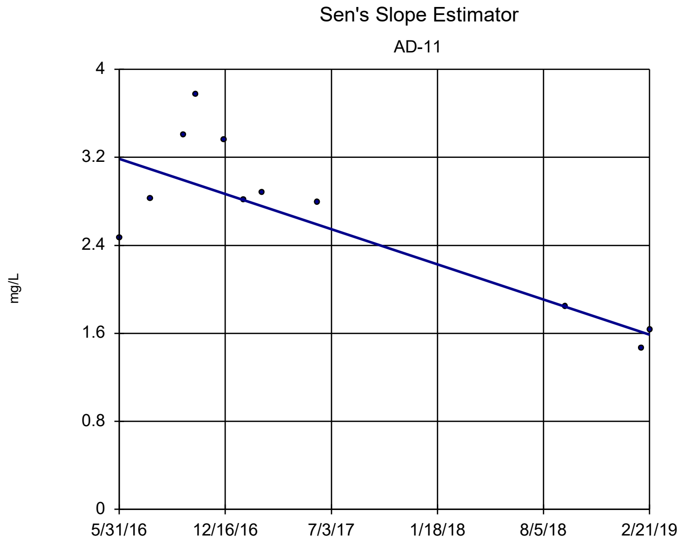
Slope = 0.001099
units per year.

Mann-Kendall
statistic = 14
critical = 34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

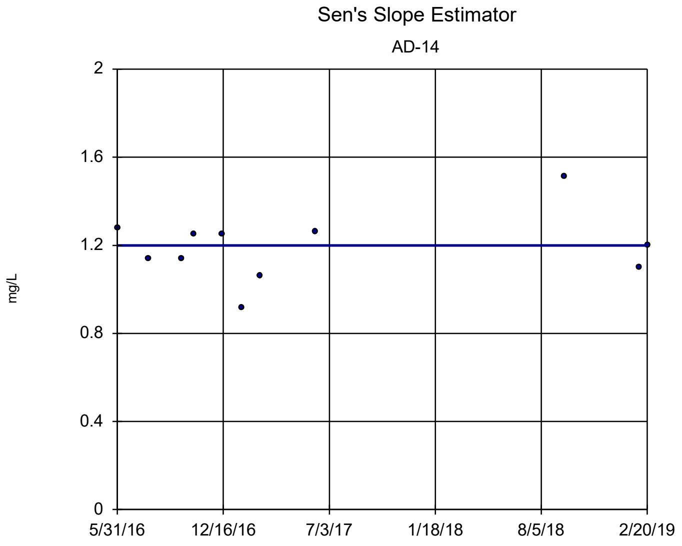
Slope = -0.5852
units per year.

Mann-Kendall
statistic = -27
critical = -34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

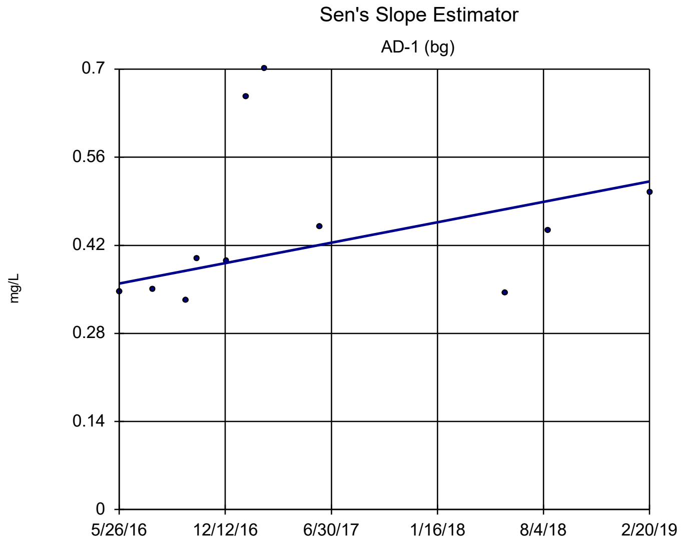
Slope = 0
units per year.

Mann-Kendall
statistic = -1
critical = -34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

Slope = 0.05932
units per year.

Mann-Kendall
statistic = 21
critical = 34

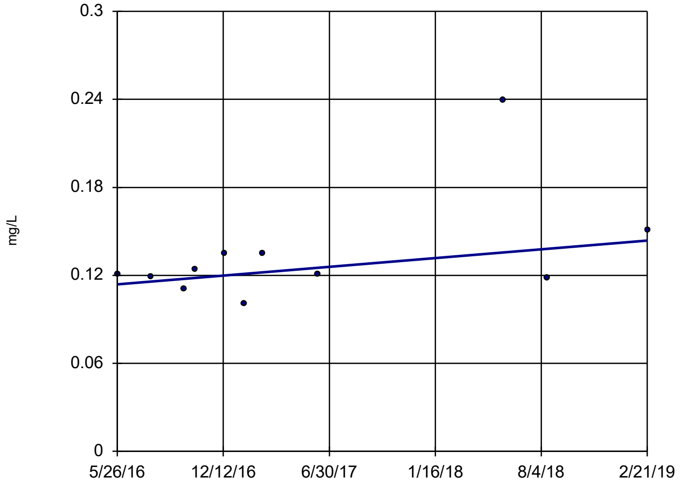
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-17 (bg)



n = 11

Slope = 0.01094
units per year.

Mann-Kendall
statistic = 15
critical = 34

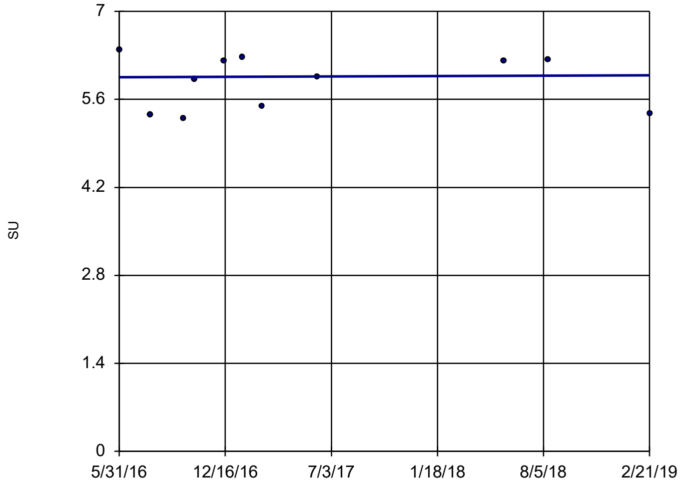
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-5 (bg)



n = 11

Slope = 0.01197
units per year.

Mann-Kendall
statistic = 5
critical = 34

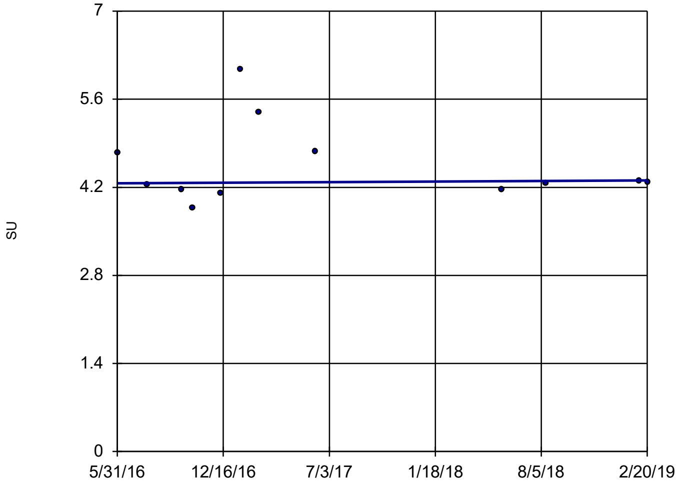
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-14



n = 12

Slope = 0.01739
units per year.

Mann-Kendall
statistic = 5
critical = 38

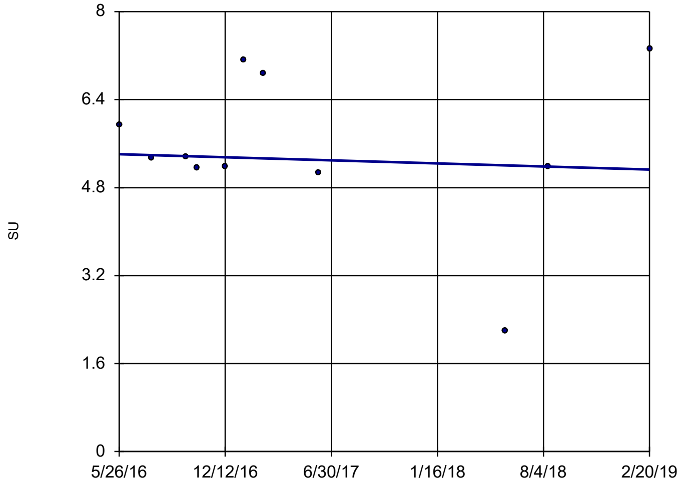
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-1 (bg)



n = 11

Slope = -0.1015
units per year.

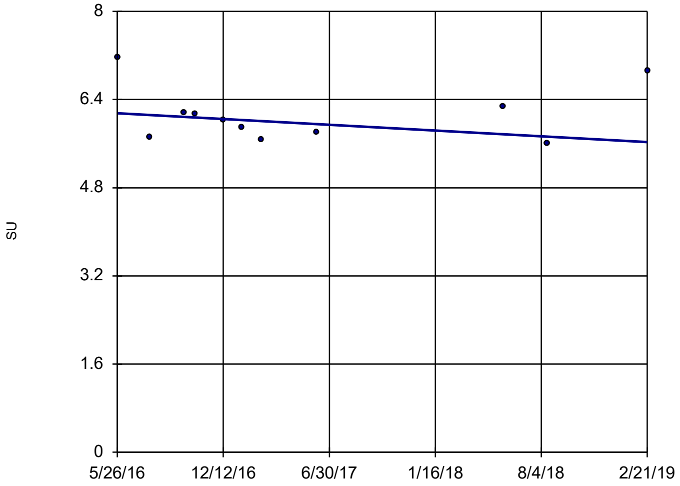
Mann-Kendall
statistic = -4
critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing
Welsh LF   Client: Geosyntec   Data: Welsh LF

Sen's Slope Estimator

AD-17 (bg)



n = 11

Slope = -0.1904 units per year.

Mann-Kendall statistic = -11 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 6/24/2019 12:12 PM   View: Trend Testing

Welsh LF   Client: Geosyntec   Data: Welsh LF

Upper Tolerance Limits - Appendix IV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 6/18/2019, 9:26 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	33	n/a	n/a	72.73	n/a	n/a	0.184	NP Inter(normality)
Arsenic, total (mg/L)	0.005	33	n/a	n/a	57.58	n/a	n/a	0.184	NP Inter(normality)
Barium, total (mg/L)	0.5818	33	-2.809	1.037	0	None	ln(x)	0.05	Inter
Beryllium, total (mg/L)	0.0007276	33	0.01425	0.005818	12.12	None	sqrt(x)	0.05	Inter
Cadmium, total (mg/L)	0.00646	33	n/a	n/a	30.3	n/a	n/a	0.184	NP Inter(Cohens/x...
Chromium, total (mg/L)	0.004	32	n/a	n/a	28.13	n/a	n/a	0.1937	NP Inter(Cohens/x...
Cobalt, total (mg/L)	0.0748	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	4.182	33	2.033	0.9825	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	33	n/a	n/a	69.7	n/a	n/a	0.184	NP Inter(normality)
Lead, total (mg/L)	0.005	33	n/a	n/a	78.79	n/a	n/a	0.184	NP Inter(NDs)
Lithium, total (mg/L)	0.394	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Mercury, total (mg/L)	0.000033	33	n/a	n/a	48.48	n/a	n/a	0.184	NP Inter(normality)
Molybdenum, total (mg/L)	0.002	33	n/a	n/a	69.7	n/a	n/a	0.184	NP Inter(normality)
Selenium, total (mg/L)	0.005	33	n/a	n/a	48.48	n/a	n/a	0.184	NP Inter(normality)
Thallium, total (mg/L)	0.001251	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)

Confidence Intervals - All Appendix IV (No Significant Results)

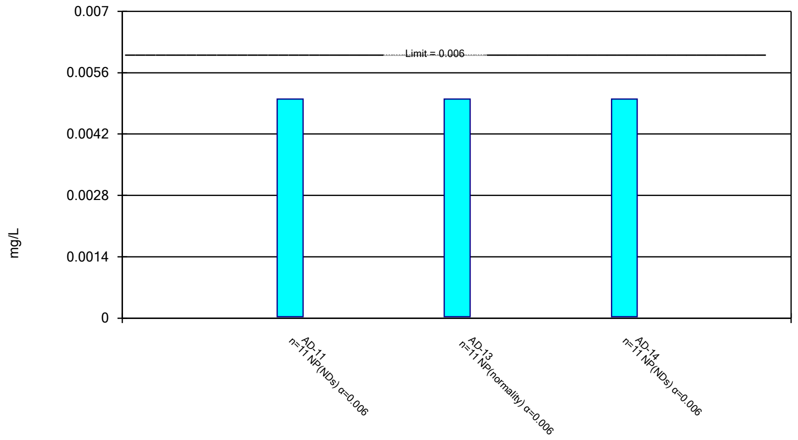
Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 6/18/2019, 9:34 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-11	0.005	0.00003	0.006	No	11	81.82	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-13	0.005	0.00003	0.006	No	11	72.73	No	0.006	NP (normality)
Antimony, total (mg/L)	AD-14	0.005	0.00003	0.006	No	11	81.82	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-11	0.005	0.00105	0.01	No	11	54.55	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-13	0.005	0.00137	0.01	No	11	63.64	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-14	0.005	0.00039	0.01	No	11	63.64	No	0.006	NP (normality)
Barium, total (mg/L)	AD-11	0.0403	0.0119	2	No	11	0	No	0.006	NP (normality)
Barium, total (mg/L)	AD-13	0.0634	0.02381	2	No	11	0	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-14	0.05248	0.02864	2	No	11	0	sqrt(x)	0.01	Param.
Beryllium, total (mg/L)	AD-11	0.004496	0.002314	0.004	No	11	0	x^2	0.01	Param.
Beryllium, total (mg/L)	AD-13	0.0009506	0.0005881	0.004	No	11	0	x^2	0.01	Param.
Beryllium, total (mg/L)	AD-14	0.0006918	0.000357	0.004	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-11	0.0004842	0.0002825	0.0065	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-13	0.0005	0.000085	0.0065	No	11	36.36	No	0.006	NP (Cohens/xfrm)
Cadmium, total (mg/L)	AD-14	0.001367	0.0004472	0.0065	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-11	0.002504	0.0003169	0.1	No	11	0	x^(1/3)	0.01	Param.
Chromium, total (mg/L)	AD-13	0.004	0.000503	0.1	No	11	27.27	No	0.006	NP (Cohens/xfrm)
Chromium, total (mg/L)	AD-14	0.001127	0.0004973	0.1	No	11	18.18	No	0.01	Param.
Cobalt, total (mg/L)	AD-11	0.02727	0.01701	0.075	No	11	0	x^2	0.01	Param.
Cobalt, total (mg/L)	AD-13	0.008368	0.002991	0.075	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-14	0.01236	0.004993	0.075	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-11	2.689	1.398	5	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-13	3.016	1.543	5	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-14	2.333	0.8758	5	No	11	0	x^(1/3)	0.01	Param.
Fluoride, total (mg/L)	AD-11	2	0.083	4	No	11	18.18	No	0.006	NP (normality)
Fluoride, total (mg/L)	AD-13	0.8099	0.2031	4	No	11	18.18	No	0.01	Param.
Fluoride, total (mg/L)	AD-14	0.083	0.083	4	No	11	90.91	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-11	0.005	0.001183	0.015	No	11	63.64	No	0.006	NP (normality)
Lead, total (mg/L)	AD-13	0.005	0.001	0.015	No	11	63.64	No	0.006	NP (normality)
Lead, total (mg/L)	AD-14	0.005	0.000174	0.015	No	11	81.82	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-11	0.04493	0.02632	0.39	No	11	0	x^2	0.01	Param.
Lithium, total (mg/L)	AD-13	0.02679	0.0122	0.39	No	11	0	No	0.01	Param.
Lithium, total (mg/L)	AD-14	0.01421	0.01165	0.39	No	10	0	No	0.01	Param.
Mercury, total (mg/L)	AD-11	0.00002919	0.00001196	0.002	No	11	36.36	No	0.01	Param.
Mercury, total (mg/L)	AD-13	0.000025	0.00000673	0.002	No	11	54.55	No	0.006	NP (normality)
Mercury, total (mg/L)	AD-14	0.000145	0.00001863	0.002	No	11	9.091	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-11	0.002	0.001519	0.1	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-13	0.002	0.0003533	0.1	No	11	72.73	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-14	0.002	0.000497	0.1	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-11	0.005	0.0015	0.05	No	11	36.36	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-13	0.005	0.00103	0.05	No	11	27.27	No	0.006	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-14	0.004435	0.002023	0.05	No	11	18.18	No	0.01	Param.
Thallium, total (mg/L)	AD-11	0.001317	0.0002	0.002	No	11	45.45	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-13	0.0005	0.0005	0.002	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-14	0.0005	0.0005	0.002	No	11	90.91	No	0.006	NP (NDs)

Sanitas™ v.9.6.16 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

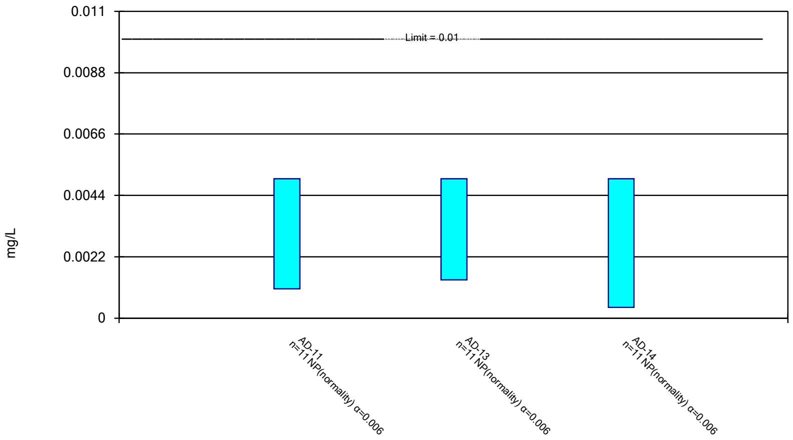


Constituent: Antimony, total   Analysis Run 6/18/2019 9:32 AM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

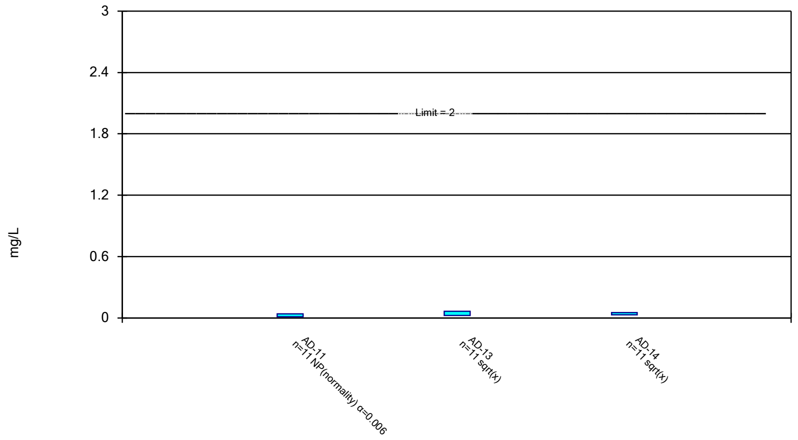


Constituent: Arsenic, total   Analysis Run 6/18/2019 9:32 AM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.

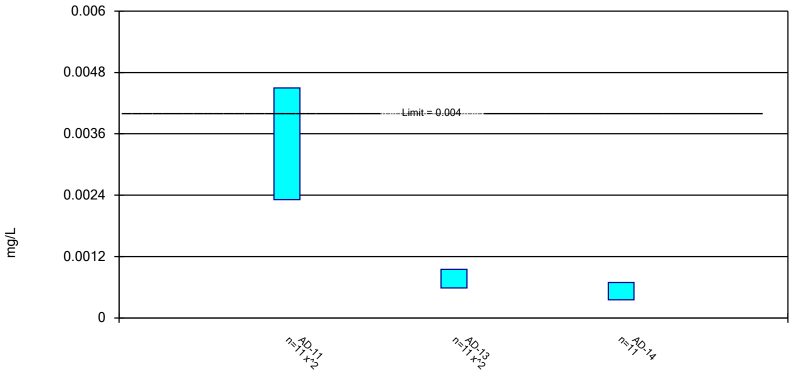


Constituent: Barium, total   Analysis Run 6/18/2019 9:32 AM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.

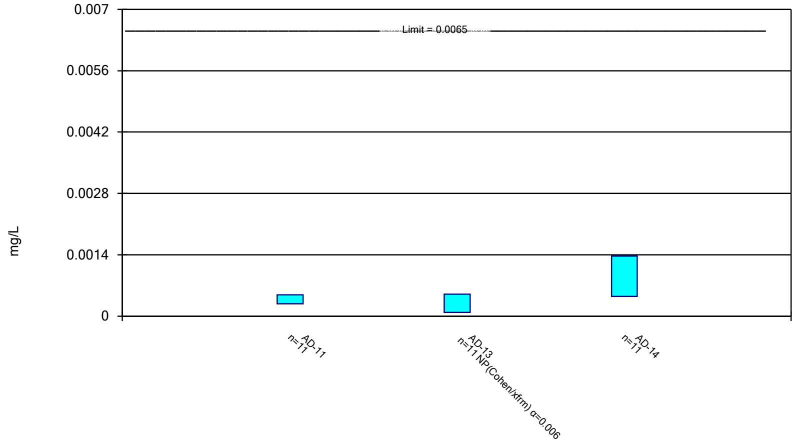


Constituent: Beryllium, total   Analysis Run 6/18/2019 9:32 AM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



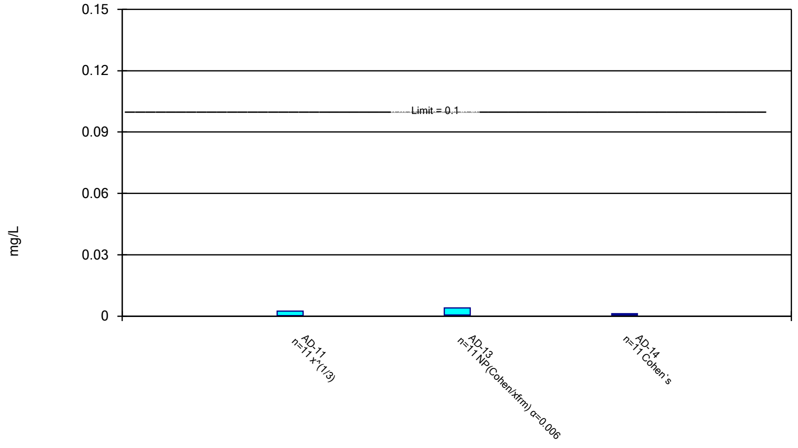
Constituent: Cadmium, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



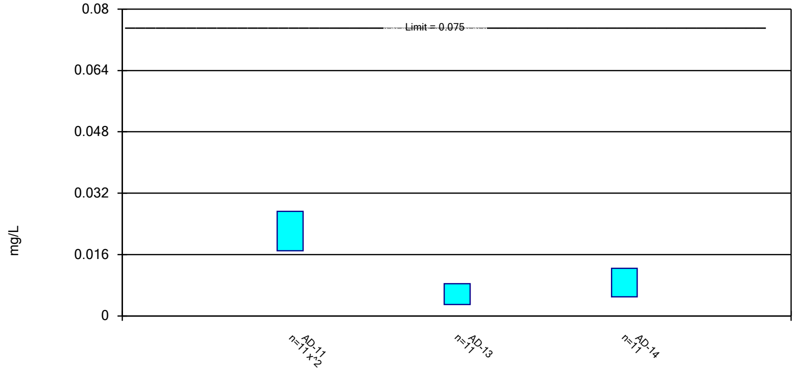
Constituent: Chromium, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



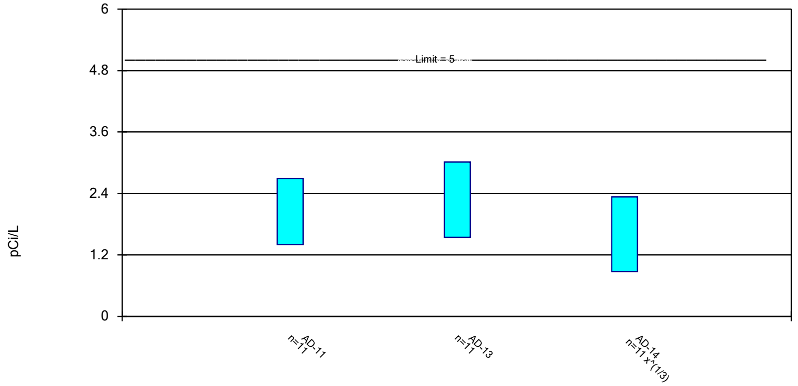
Constituent: Cobalt, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



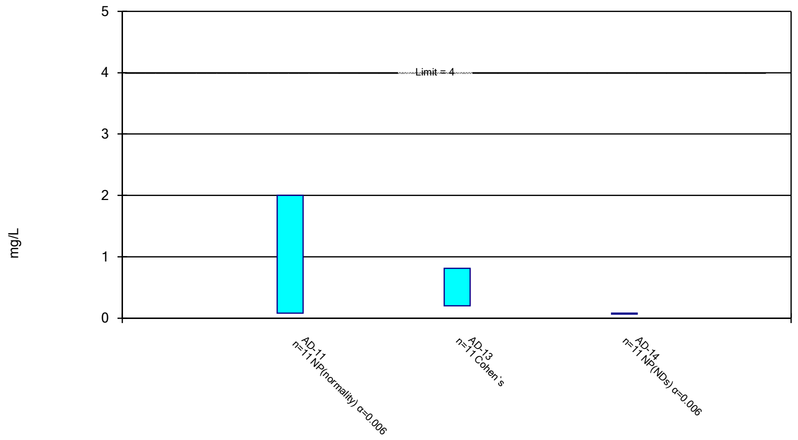
Constituent: Combined Radium 226 + 228   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



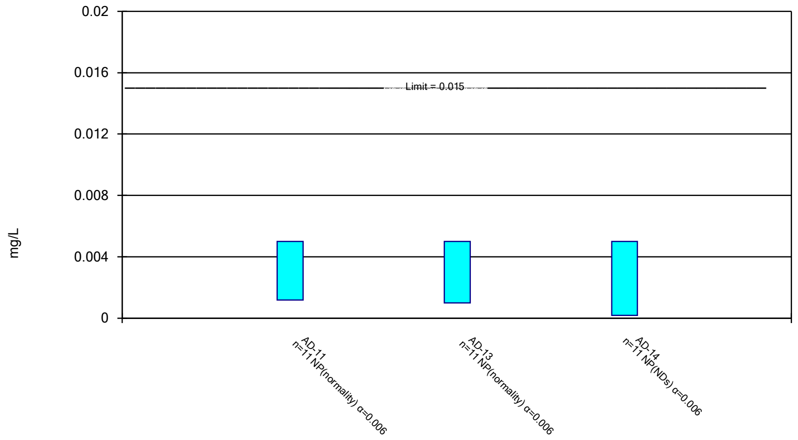
Constituent: Fluoride, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



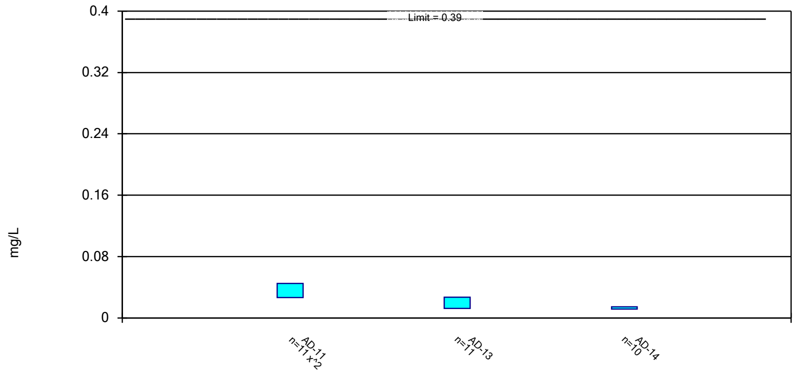
Constituent: Lead, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



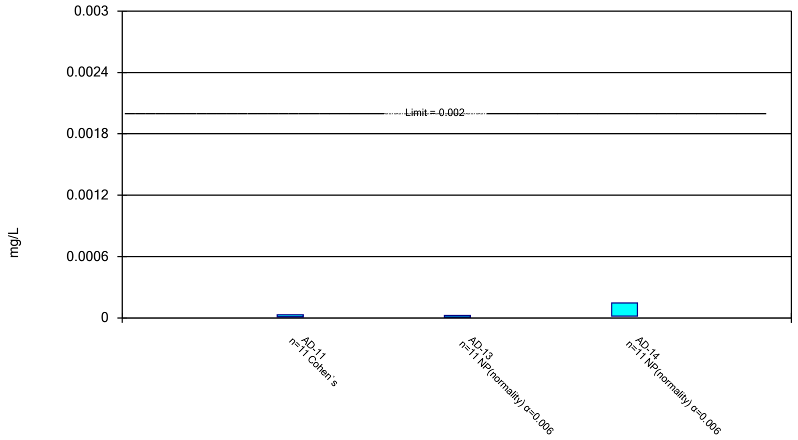
Constituent: Lithium, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



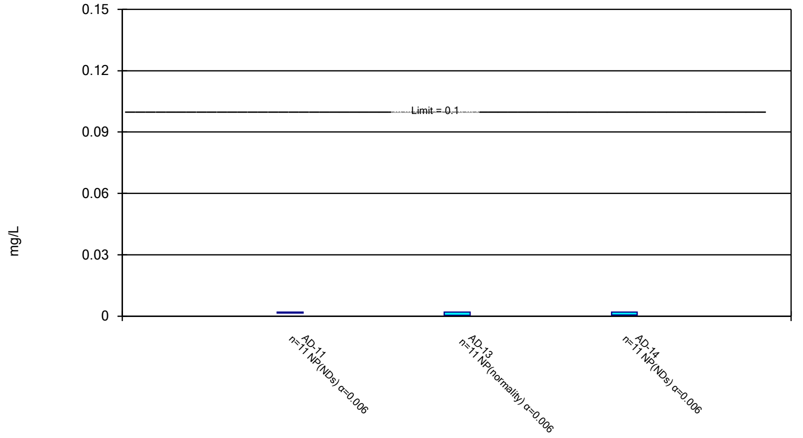
Constituent: Mercury, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



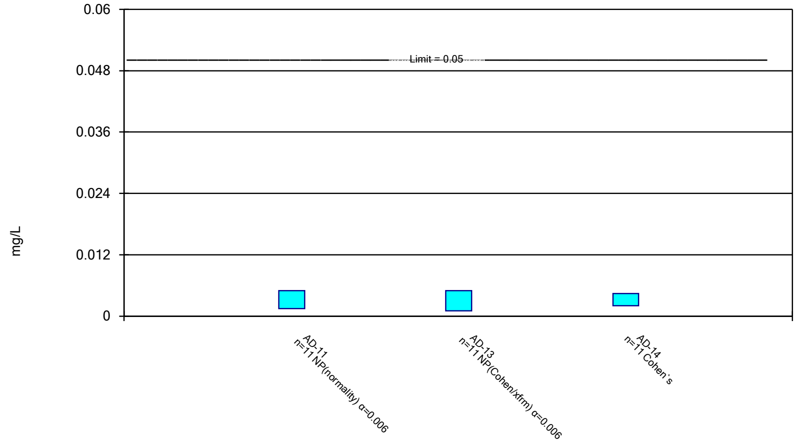
Constituent: Molybdenum, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 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.



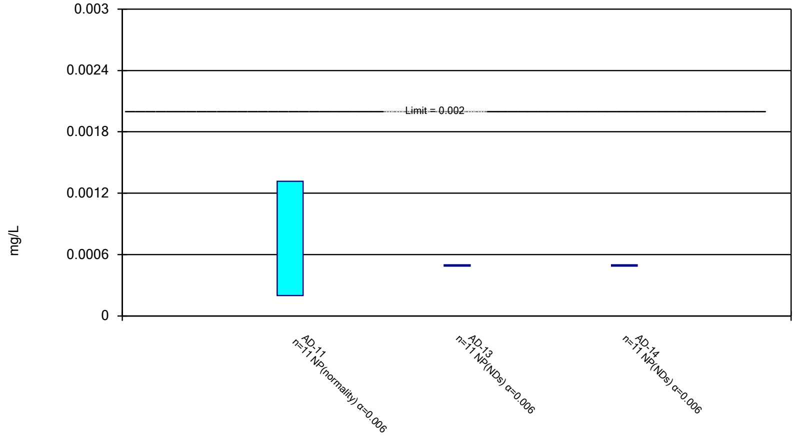
Constituent: Selenium, total   Analysis Run 6/18/2019 9:32 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.16 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total   Analysis Run 6/18/2019 9:33 AM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

STATISTICAL ANALYSIS SUMMARY
LANDFILL
J. Robert Welsh Plant
Pittsburg, 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

December 16, 2019

CHA8473

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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
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 Welsh Power Plant located in Pittsburg, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, total dissolved solids (TDS), and sulfate at the LF. An alternative source was not identified at the time, so the LF has been in assessment monitoring since. Groundwater protection standards (GWPS) were set in accordance with 40 CFR 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. During the most recent assessment monitoring event, completed in February 2019, no SSLs were identified during these events, and the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the LF in May 2019 and July 2019, in accordance with 40 CFR 257.95(b) and (d), respectively. The results of these assessment 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. No SSLs were identified.

Prediction limits were calculated for Appendix III parameters. When compared to the revised prediction limits, concentrations for boron and TDS remained above background. Thus, either the unit will remain in assessment monitoring or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can return to detection 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, 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) (July 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 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 in May and July 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. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for barium, beryllium, and combined radium. Non-parametric tolerance limits were calculated for antimony, arsenic, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, and selenium due to apparent non-normal distributions and for 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.

No SSLs were identified at the Welsh LF.

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, chloride, and pH, whereas interwell tests were used to evaluate potential SSIs for boron, 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 LF. 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 - June 2017) to the new compliance samples (October 2017 – February 2019) for calcium, chloride, and 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 would have continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Appendix B. Significant differences were found between the two groups for chloride in upgradient well AD-5 at sulfate at downgradient well AD-11. However, because AD-5 is an upgradient monitoring well and more recent data are similar to background and better represent the groundwater quality upgradient of the facility, the background dataset was updated to include the compliance data for chloride at AD-5. Because concentrations for sulfate at downgradient well AD-11 are lower in the more recent sampling events, the background dataset was updated to include all available information, which will result in a more conservative prediction limit.

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, chloride, TDS, and sulfate, whereas interwell tests continued to be used to evaluate potential SSIs for boron, fluoride, and pH. The 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

The CCR rule allows CCR units to move from assessment monitoring to detection monitoring if all Appendix III and Appendix IV parameters were at or below background levels for two consecutive sampling events [40 CFR 257.95(e)]. Since no Appendix IV SSLs were identified, Appendix III results were analyzed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May 2019 and July 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from these events 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 0.700 mg/L at AD-11 (1.56 mg/L), AD-13 (0.780 mg/L), and AD-14 (1.25 mg/L)

- The TDS concentration at AD-14 exceeded the intrawell UPL of 369 mg/L at AD-14 (440 mg/L).

The results from June 2019 each represent the initial sampling for a detection monitoring event. While the prediction limits were calculated assuming one-of-two testing procedures, it was conservatively assumed that an SSI was identified if the initial sample exceeded the UPL or was below the pH LPL during each event. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Welsh 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 May and July 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. No SSLs were identified.

Revised prediction limits were calculated for Appendix III parameters. Intrawell tests were used to evaluate potential SSIs for calcium, chloride, TDS, and sulfate, whereas interwell tests were used to evaluate potential SSIs for boron, fluoride, and pH. Prediction limits were recalculated using a one-of-two retesting procedure. The Appendix III results were evaluated to assess whether concentrations of Appendix III parameters exceeded background levels. Boron and TDS results exceeded background levels.

Based on this evaluation, either the Welsh LF CCR unit will remain in assessment monitoring or an ASD will be conducted to evaluate if the unit can return to detection monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Welsh Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Landfill, J. Robert Welsh Plant, Pittsburg, Texas. January 15, 2018.

TABLES

Table 1 - Groundwater Data Summary
Welsh - Landfill

Component	Unit	AD-1		AD-5		AD-11		AD-13		AD-14		AD-17	
		5/30/2019	**7/24/2019**	**5/30/2019**	**7/24/2019**	**5/29/2019**	**7/23/2019**	**5/30/2019**	**7/23/2019**	**5/29/2019**	**7/23/2019**	**5/30/2019**	**7/24/2019**
Antimony	µg/L	0.160	0.080 J	0.100 U	0.100 U	0.100 U	0.100 U	0.030 J	0.020 J	0.030 J	0.100 U	0.100 U	0.100 U
Arsenic	µg/L	0.600	0.390	3.05	2.48	0.780	0.590	0.320	0.370	0.400	0.430	0.410	1.07
Barium	µg/L	512	245	60.5	77.4	19.1	16.4	60.9	23.6	44.8	36.2	19.6	14.3
Beryllium	µg/L	0.244	0.540	0.080 J	0.050 J	1.05	0.987	0.385	0.443	0.556	0.934	0.020 J	0.130
Boron	mg/L	0.689	0.644	0.030 J	0.040 J	1.40	1.56	0.477	0.780	1.21	1.25	0.158	0.113
Cadmium	µg/L	0.010 J	0.020 J	0.050 U	0.050 U	0.200	0.240	0.07	0.09	0.810	2.49	0.030 J	0.030 J
Calcium	mg/L	138	62.7	30.0	41.1	5.78	7.19	9.88	6.16	9.80	9.93	202	216
Chloride	mg/L	1.59	2.00	22.3	18.0	6.96	6.00	3.60	5.00	3.65	8.00	41.7	37.0
Chromium	µg/L	0.100 J	0.100 J	0.060 J	0.050 J	0.369	0.413	0.310	0.283	0.200 J	0.286	0.246	0.228
Cobalt	µg/L	0.756	0.789	11.8	8.38	9.82	10.5	3.15	3.82	7.82	18.5	51.1	57.7
Combined Radium	pCi/L	2.72	1.82	1.43	2.53	1.47	2.25	3.15	1.75	1.95	2.73	2.51	3.45
Fluoride	mg/L	0.290	0.106 J	0.290	0.112 J	0.470	0.338 J	0.530	0.169 J	0.190	0.162 J	0.200 U	0.085 J
Lead	µg/L	0.197	0.100 J	0.0500 J	0.200 U	0.847	0.976	0.050 J	0.204	0.137	0.200	0.030 J	0.263
Lithium	mg/L	0.030 U	0.006	0.104	0.108	0.020 J	0.015	0.009 J	0.018	0.020 J	0.016	0.341	0.283
Mercury	mg/L	0.0000250 U	0.0000250 U	0.00000600 J	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.000181	0.000123	0.0000250 U	0.0000250 U
Molybdenum	µg/L	2.43	2.00 J	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Selenium	µg/L	1.40	3.40	0.050 J	0.060 J	2.20	1.00	0.400	0.300	2.00	2.70	0.060 J	0.100 J
Total Dissolved Solids	mg/L	588	180	238	354	680	700	196	334	274	440	1550	1860
Sulfate	mg/L	43.3	58.0	51.3	90.0	367	342	94.0	146	122	171	1120	1130
Thallium	µg/L	0.500 U	0.500 U	0.500 U	0.500 U	0.100 J	0.200 J	0.500 U	0.100 J	0.500 U	0.200 J	0.500 U	0.500 U
pH	SU	6.7	6.0	6.3	6.3	4.2	4.5	5.2	4.8	4.5	5.5	6.1	6.0

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
Welsh Plant - Landfill

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.003
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.62
Beryllium, Total (mg/L)	0.004		0.00079
Cadmium, Total (mg/L)	0.005		0.0065
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.075
Combined Radium, Total (pCi/L)	5		4.11
Fluoride, Total (mg/L)	4		0.583
Lead, Total (mg/L)	n/a	0.015	0.003
Lithium, Total (mg/L)	n/a	0.04	0.39
Mercury, Total (mg/L)	0.002		0.000033
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.001

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
Welsh Plant - Landfill

Parameter	Unit	Description	AD-11	AD-13	AD-14
Boron	mg/L	Interwell Background Value (UPL)	0.700		
Calcium	mg/L	Intrawell Background Value (UPL)	17.1	28.4	12.2
Chloride	mg/L	Intrawell Background Value (UPL)	14.3	24.0	11.5
Fluoride	mg/L	Interwell Background Value (UPL)	0.583		
pH	SU	Interwell Background Value (UPL)	7.1		
		Interwell Background Value (LPL)	4.3		
Sulfate	mg/L	Intrawell Background Value (UPL)	829	422	189
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	1330	881	369

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Welsh - Landfill

Parameter	Unit	Description	AD-11		AD-13		AD-14	
			5/29/2019*	7/23/2019	5/30/2019*	7/23/2019	5/29/2019*	7/23/2019
Boron	mg/L	Interwell Background Value (UPL)	0.700					
		Detection Monitoring Result	1.40	**1.56**	0.477	**0.780**	1.21	**1.25**
Calcium	mg/L	Intrawell Background Value (UPL)	17.1		28.4		12.2	
		Detection Monitoring Result	5.78	7.19	9.88	6.16	9.80	9.93
Chloride	mg/L	Intrawell Background Value (UPL)	14.3		24.0		11.5	
		Detection Monitoring Result	6.96	6.00	3.60	5.00	3.65	8.00
Fluoride	mg/L	Interwell Background Value (UPL)	0.583					
		Detection Monitoring Result	0.470	0.338	0.530	0.169	0.190	0.162
pH	SU	Interwell Background Value (UPL)	7.1					
		Interwell Background Value (LPL)	4.3					
		Detection Monitoring Result	4.2	4.5	5.2	4.8	4.5	5.5
Sulfate	mg/L	Intrawell Background Value (UPL)	829		422		189	
		Detection Monitoring Result	367	342	94.0	146	122	171
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	1330		881		369	
		Detection Monitoring Result	680	700	196	334	274	**440**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.
*257.95(b) results not used to determine SSI

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 Welsh Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

12.17.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 8, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Welsh Landfill - 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 statistical analysis and background update of groundwater data for American Electric Power Inc.'s Welsh 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. Below is a list of the monitoring well network, as provided by Geosyntec Consultants. Note that originally the network included upgradient well AD-18; however, further research, reportedly, identified that this well was not providing adequate representation of the groundwater quality upgradient of this site and exhibited different chemical properties from the neighboring upgradient wells. Therefore, data from this well is no longer included in the statistical analysis.

- **Upgradient wells:** AD-1, AD-5, and AD-17
- **Downgradient wells:** AD-11, AD-13 and AD-14

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 prepared by GSC and 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 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). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells. Values flagged as outliers may be seen in the Outlier Summary following this letter (Figure C). These values are plotted in a lighter font and disconnected symbol on the time series graphs.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium, chloride, sulfate and TDS; and
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, fluoride and pH.

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 is 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 December 2017

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 variation for the following Appendix III parameters: boron, calcium, chloride, sulfate and TDS suggesting intrawell methods should be considered. No differences were noted for fluoride and pH; therefore, these parameters are eligible for interwell prediction limits. Boron, calcium, chloride, sulfate and TDS data were further evaluated as described below for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results was 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 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 the upgradient well. 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 the upgradient well, 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 upgradient well data for each of the Appendix III parameters. 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. 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 all parameters except boron. Therefore, intrawell methods are recommended for calcium, chloride, sulfate and TDS; and interwell methods are initially recommended for boron, fluoride and pH. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through June 2017 at each well were used to establish intrawell background limits for the parameters identified above 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 AD-1, AD-5 and AD-17.

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 included in background during each subsequent event after careful screening for new outliers. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points 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.

November 2019 - Background Update

Data were re-evaluated using Tukey's outlier test and visual screening with the February 2019 samples. Boron, fluoride and pH are tested using interwell prediction limits and, therefore, pooled upgradient wells were tested for outliers for these constituents (Figure C). All other Appendix III parameters, which use intrawell prediction limits, were tested for outliers at each well (Figure C). Tukey's test did not identify any outliers except for Chromium AD-13. The following values were not identified as outliers by Tukey's test; However, these values were flagged as outliers in the database because they do not appear to represent the population at these wells: chromium, fluoride, and thallium in well AD-11.

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through June 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 not be updated with more recent compliance data (Figure D). Statistically significant differences were found for chloride in upgradient well AD-5, with the median of the more recent group of data slightly higher than the background median. Additionally, a significant difference was noted for sulfate in downgradient well AD-11, with the median of the more recent group of data slightly lower than the background median.

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. Chloride, however, was updated to include more recent data in upgradient well AD-5 as those data represent groundwater quality upgradient of the facility. In the case of sulfate, while concentrations have decreased over the entire record, background was updated to include all data through February 2019. In both cases, limited data are currently available but all data will be reevaluated during the next background update, and earlier measurements will be deselected if they no longer represent present-day groundwater quality. 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 reported through February 2019, combined with a 1-of-2 resample plan, were constructed and a summary of the updated limits follows this letter (Figure E).

The Sen's Slope/Mann Kendall trend test was used to evaluate data at upgradient wells for fluoride 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 fluoride (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. 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, 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. No confidence intervals exceedances were found for any of the downgradient wells. 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 Welsh Landfill. If you have any questions or comments, please feel free to contact me.

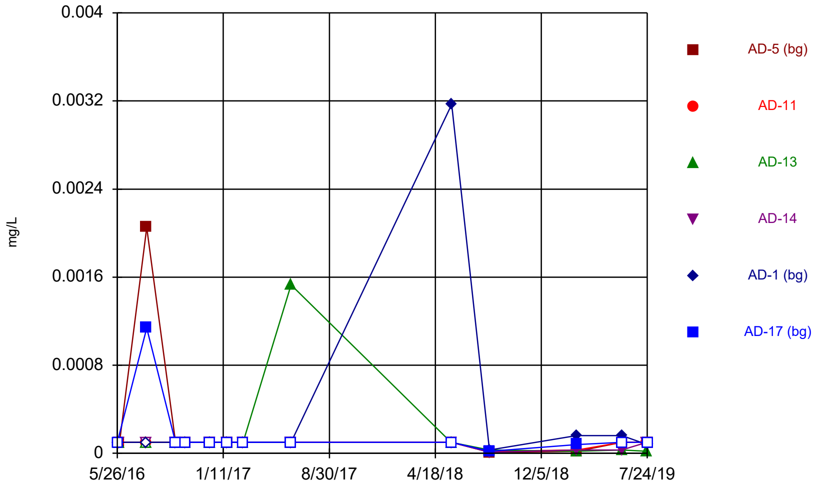
For Groundwater Stats Consulting,

Kristina Rayner

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



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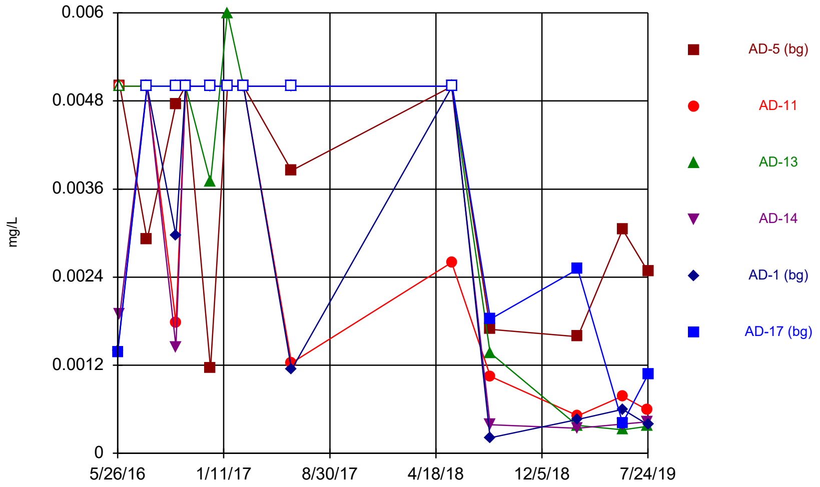
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

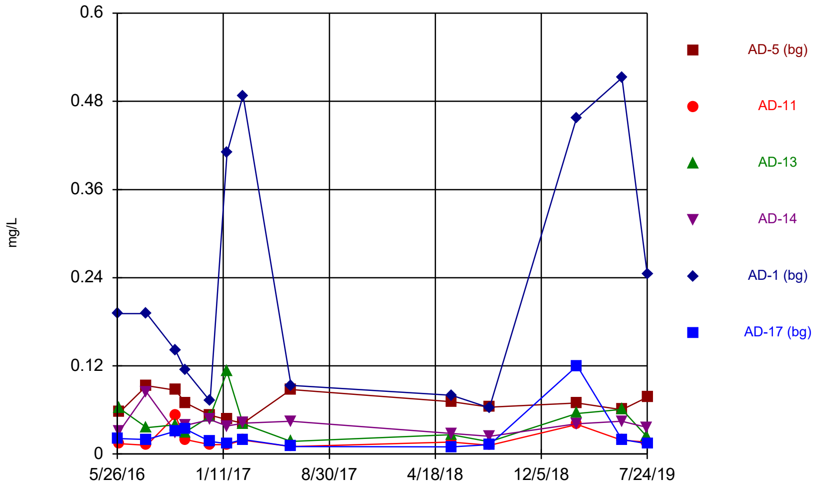
Time Series



Constituent: Arsenic, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



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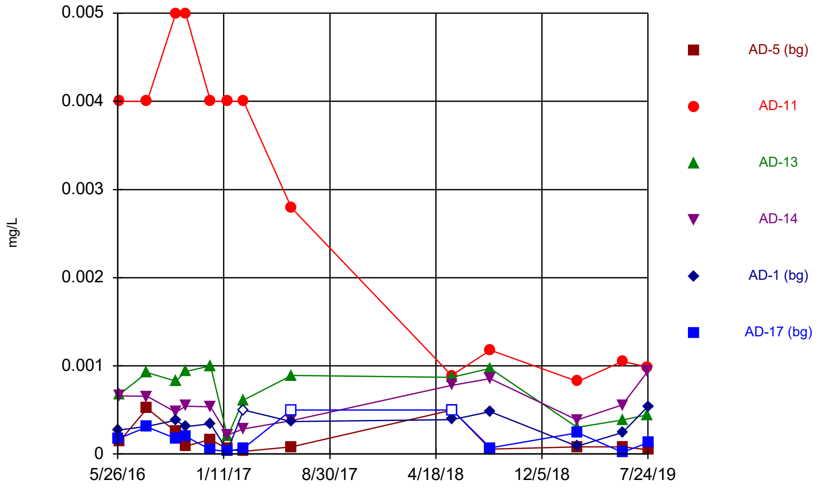
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

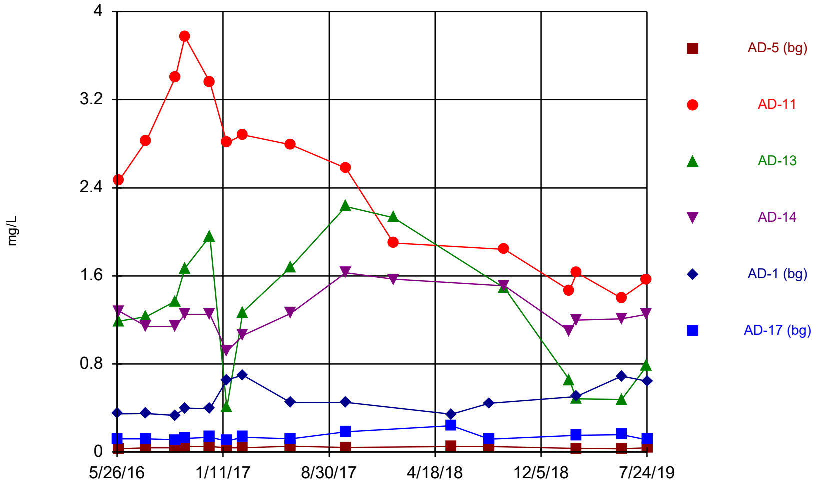
Time Series



Constituent: Beryllium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

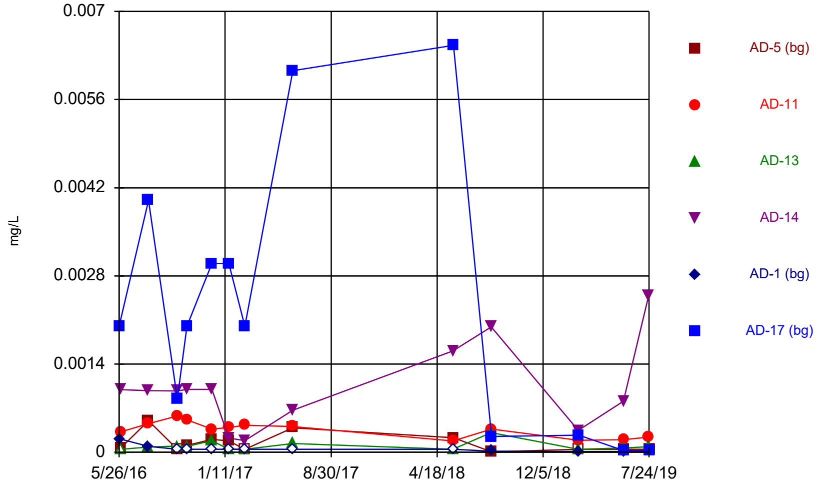
Time Series



Constituent: Boron, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

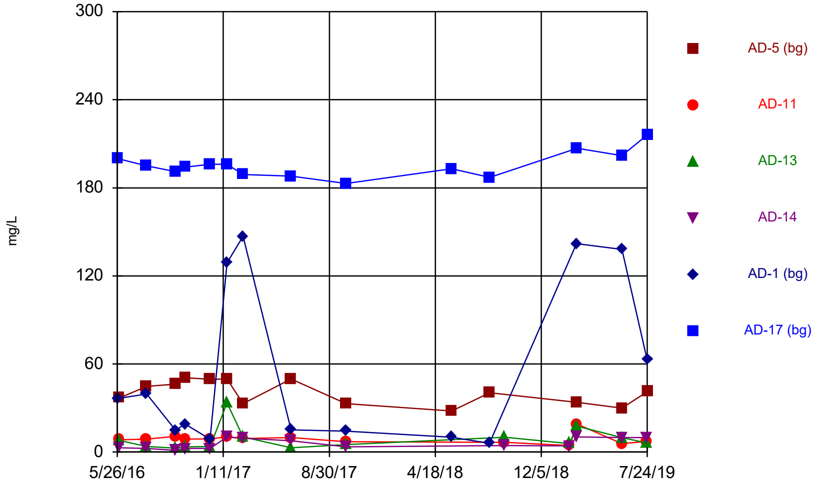
Time Series



Constituent: Cadmium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

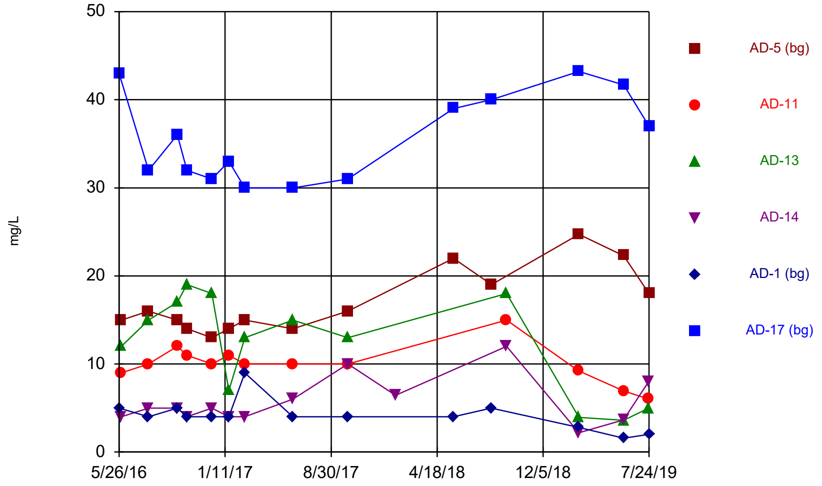
Time Series



Constituent: Calcium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

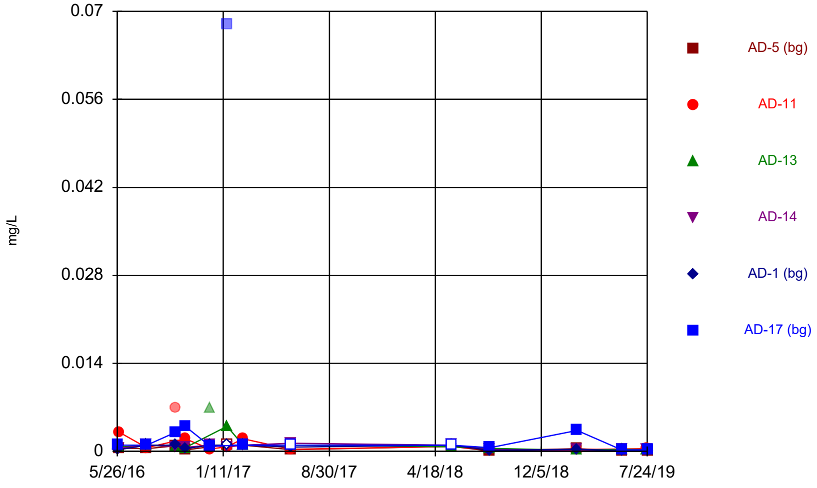
Time Series



Constituent: Chloride, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

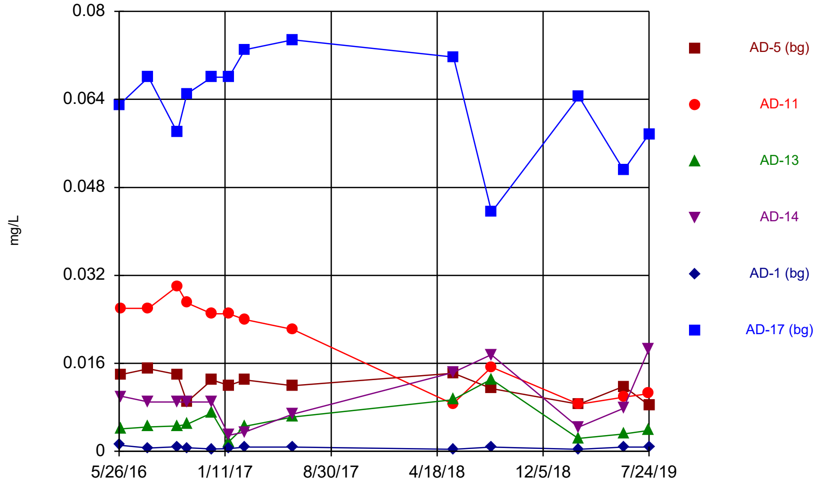
Time Series



Constituent: Chromium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

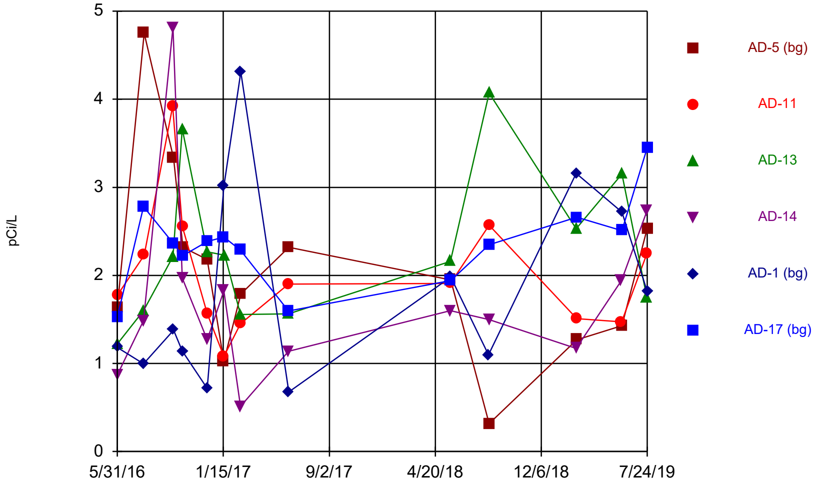
Time Series



Constituent: Cobalt, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

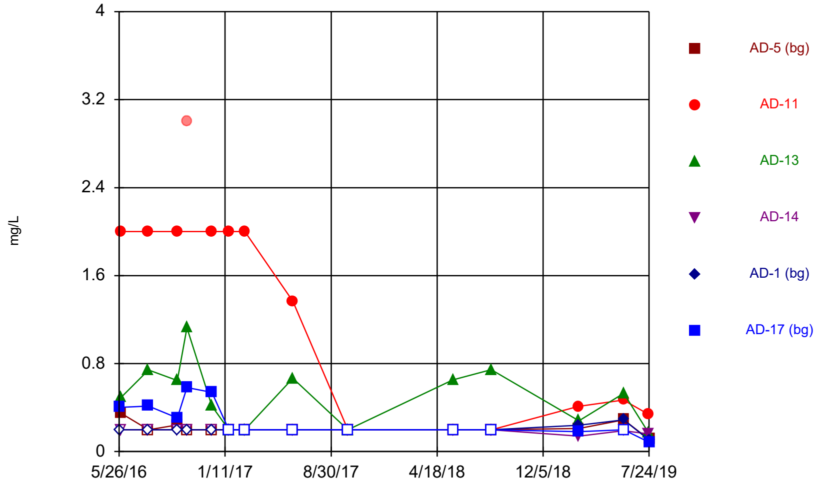
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

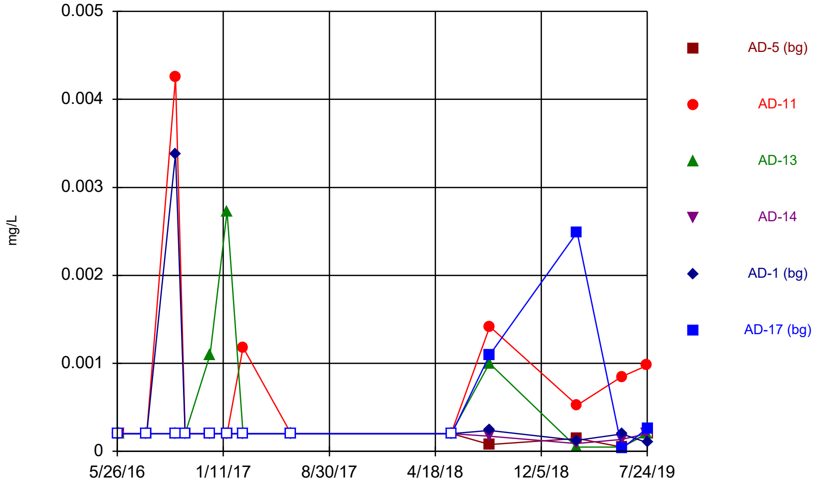
Time Series



Constituent: Fluoride, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

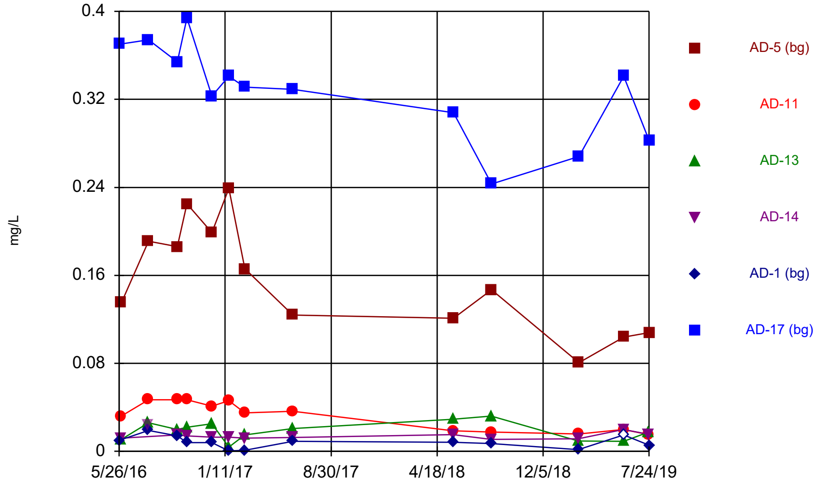
Time Series



Constituent: Lead, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

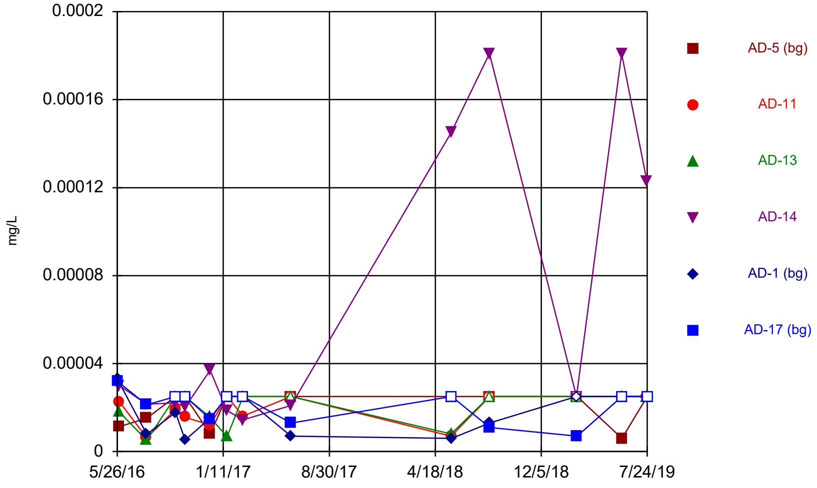
Time Series



Constituent: Lithium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

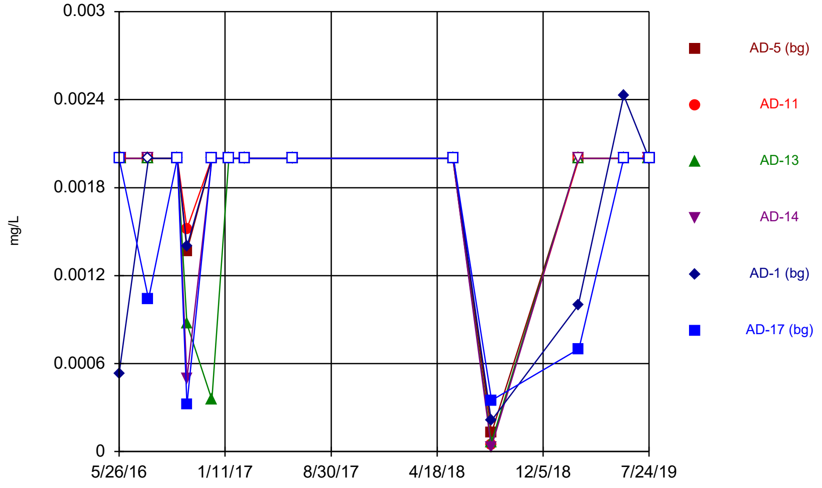
Time Series



Constituent: Mercury, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

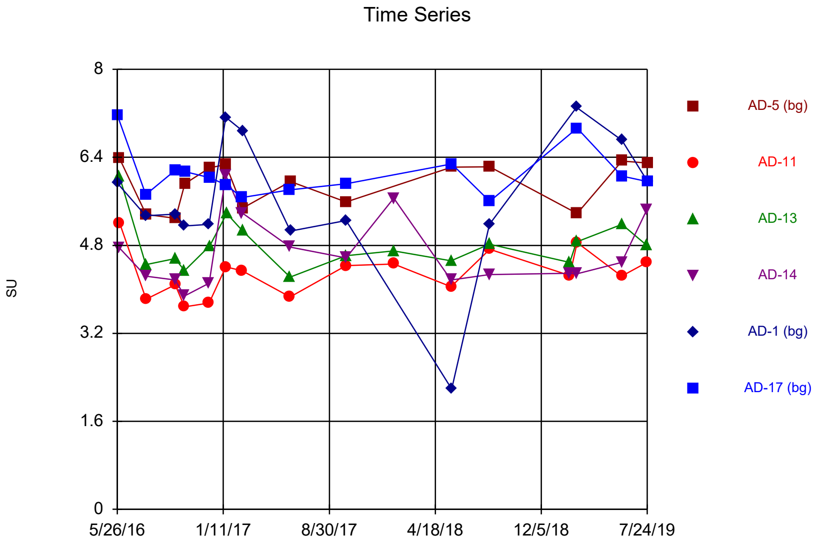
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



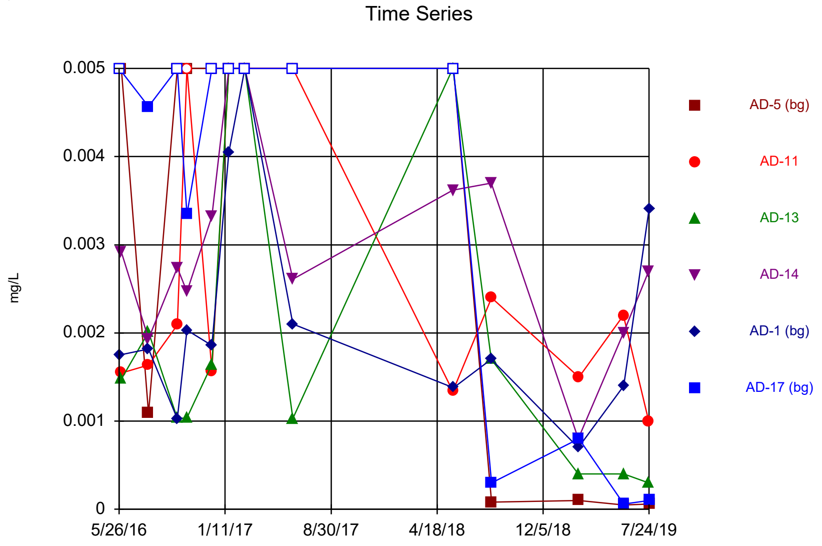
Constituent: Molybdenum, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



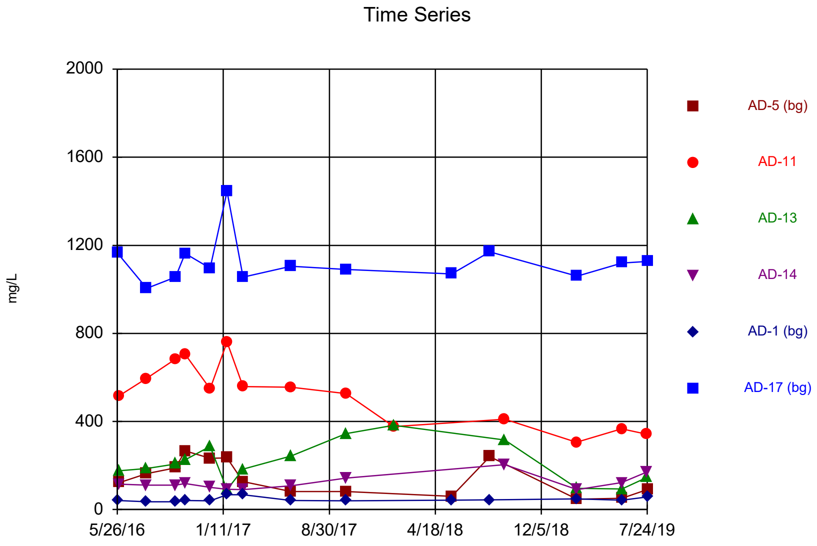
Constituent: pH, field Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



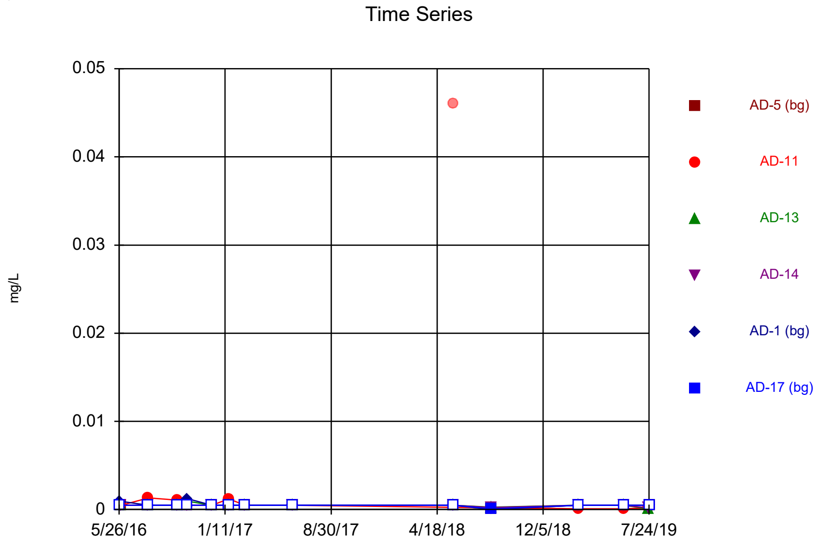
Constituent: Selenium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

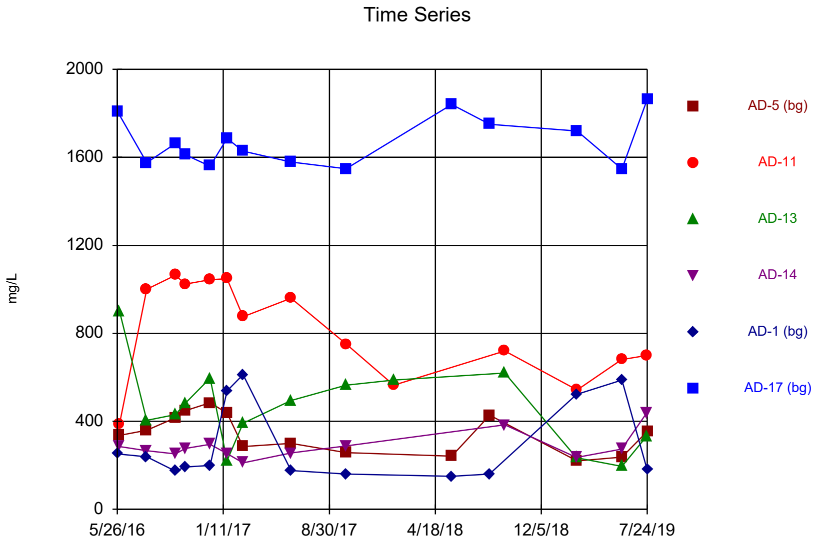


Constituent: Sulfate, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Thallium, total Analysis Run 12/5/2019 12:32 PM View: Descriptive
Welsh LF Client: Geosyntec Data: Welsh LF

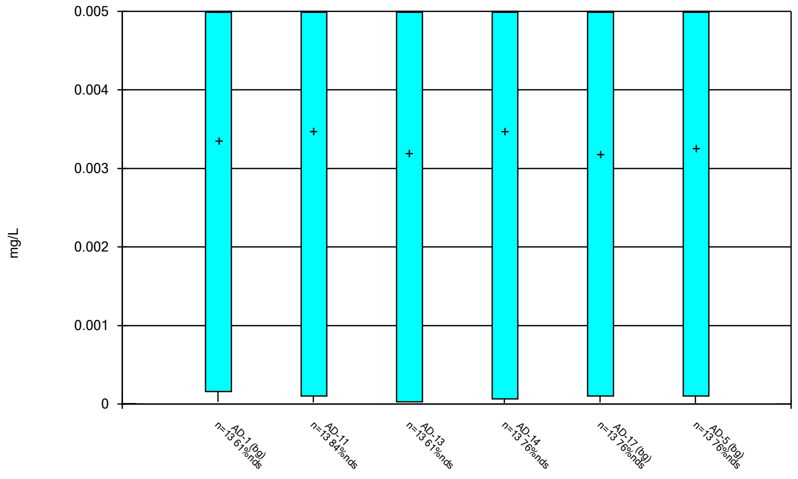


Constituent: Total Dissolved Solids Analysis Run 12/5/2019 12:32 PM View: Descriptive

Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

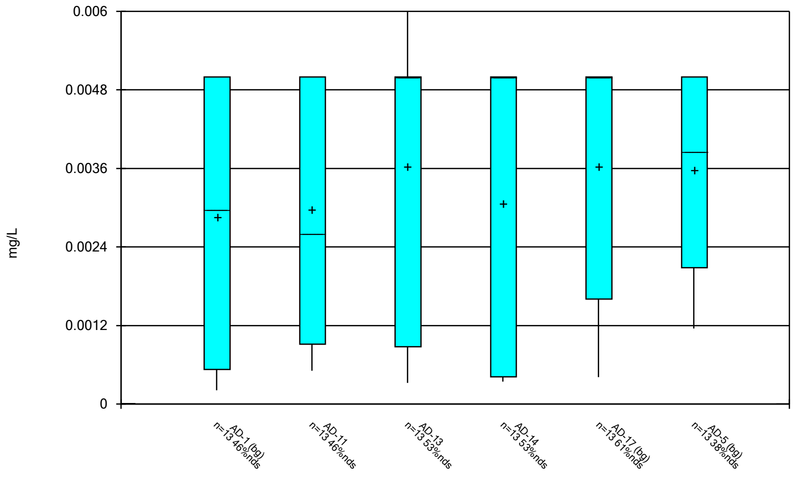
Box & Whiskers Plot



Constituent: Antimony, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

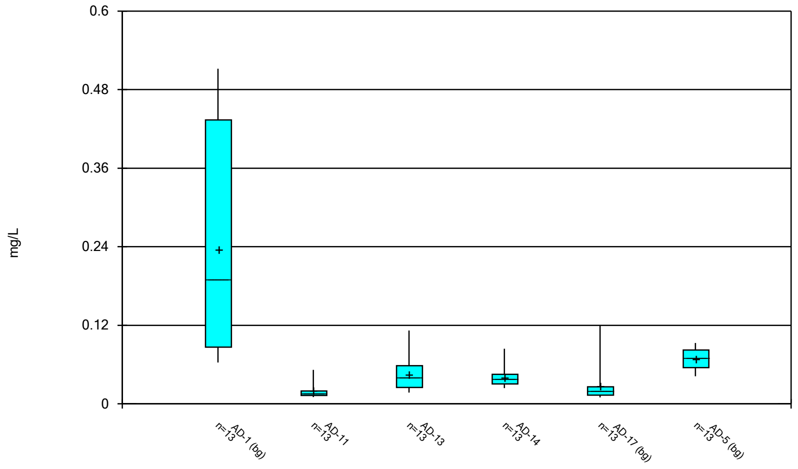
Box & Whiskers Plot



Constituent: Arsenic, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

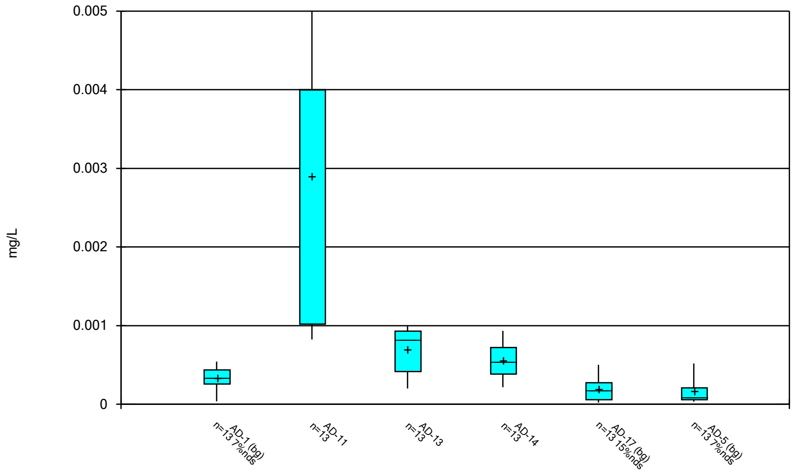
Box & Whiskers Plot



Constituent: Barium, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

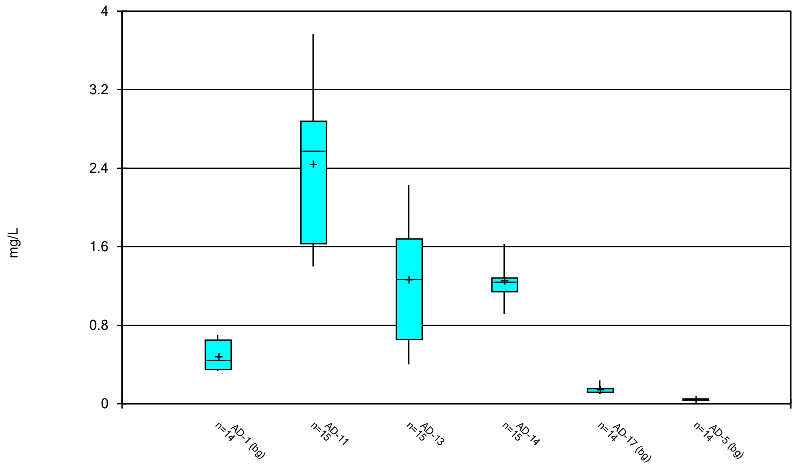
Box & Whiskers Plot



Constituent: Beryllium, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

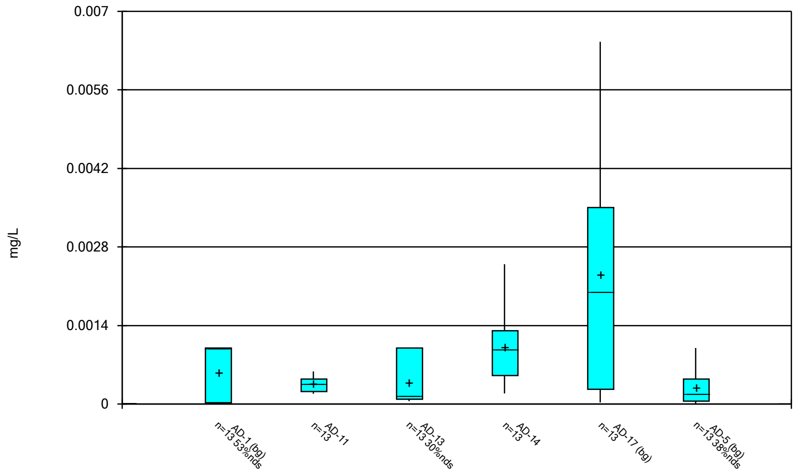


Constituent: Boron, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

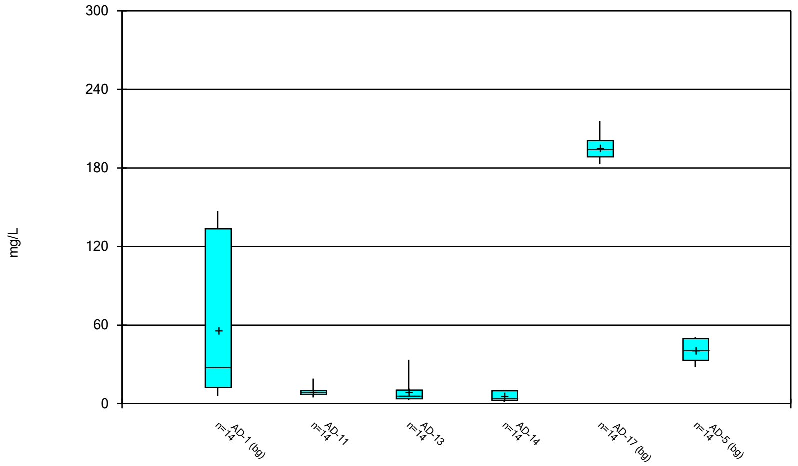


Constituent: Cadmium, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

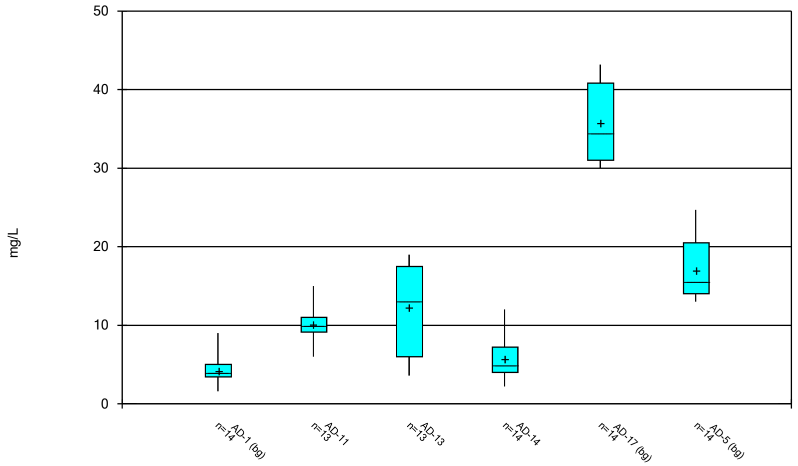


Constituent: Calcium, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

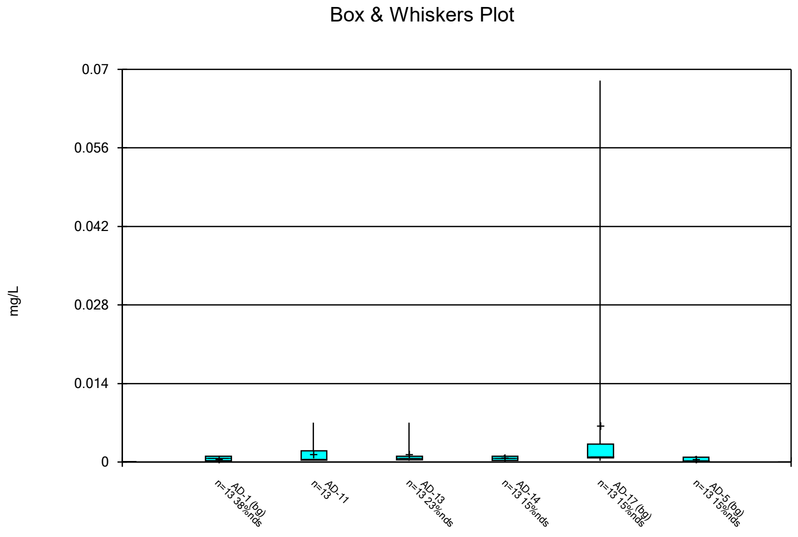
Box & Whiskers Plot



Constituent: Chloride, total   Analysis Run 11/22/2019 5:25 PM

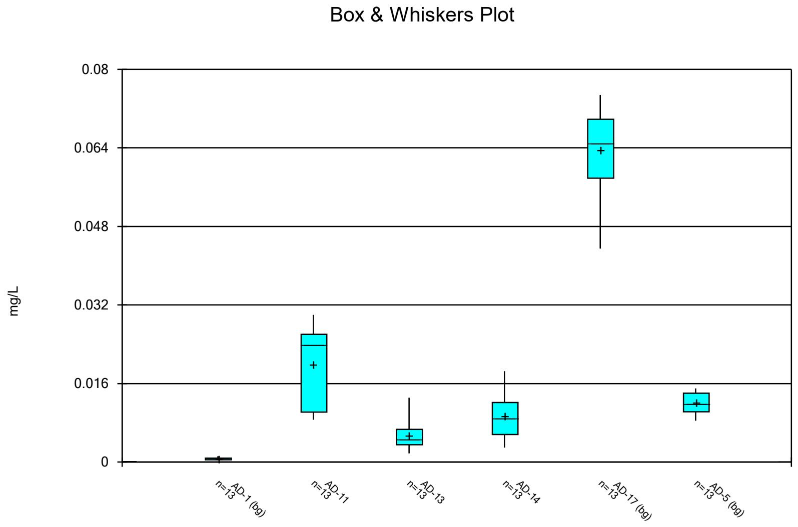
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG



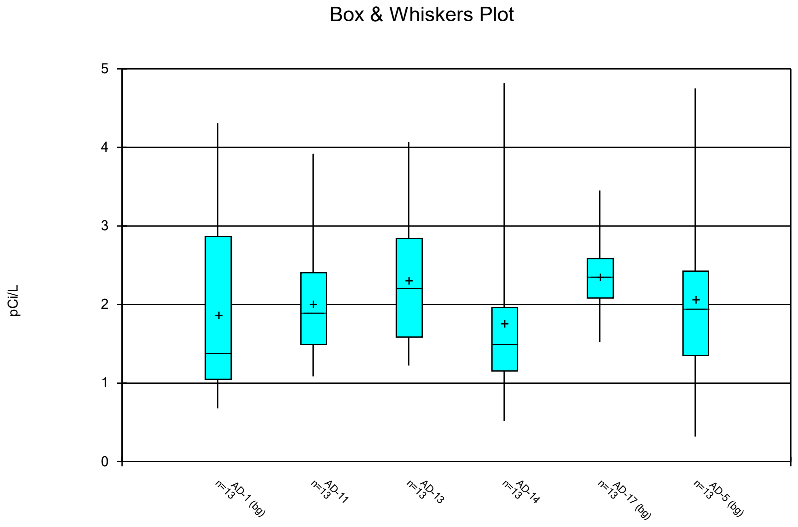
Constituent: Chromium, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG



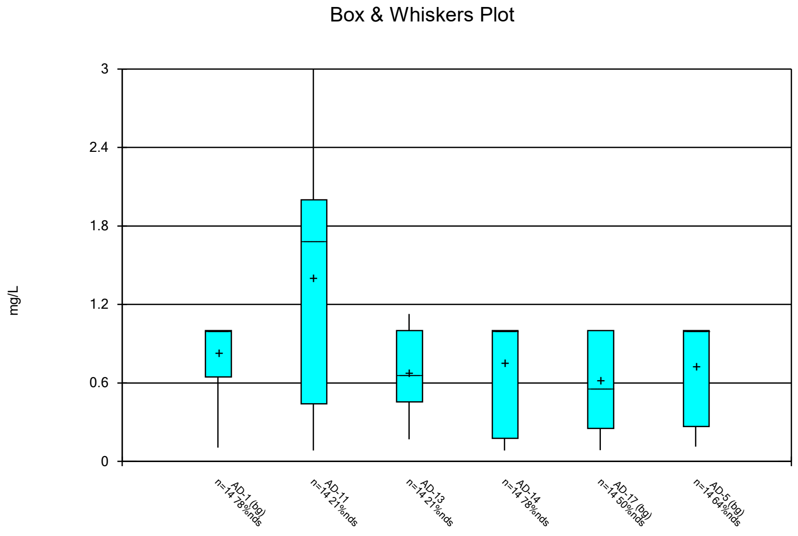
Constituent: Cobalt, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG



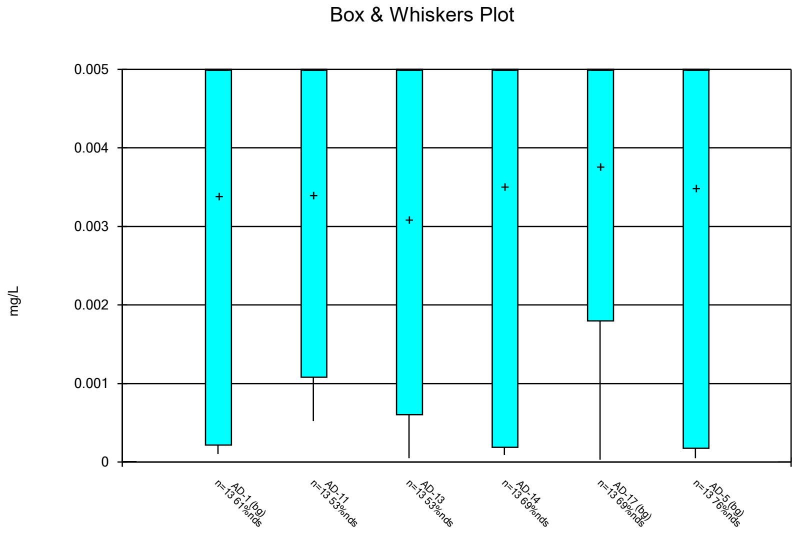
Constituent: Combined Radium 226 + 228   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Constituent: Fluoride, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

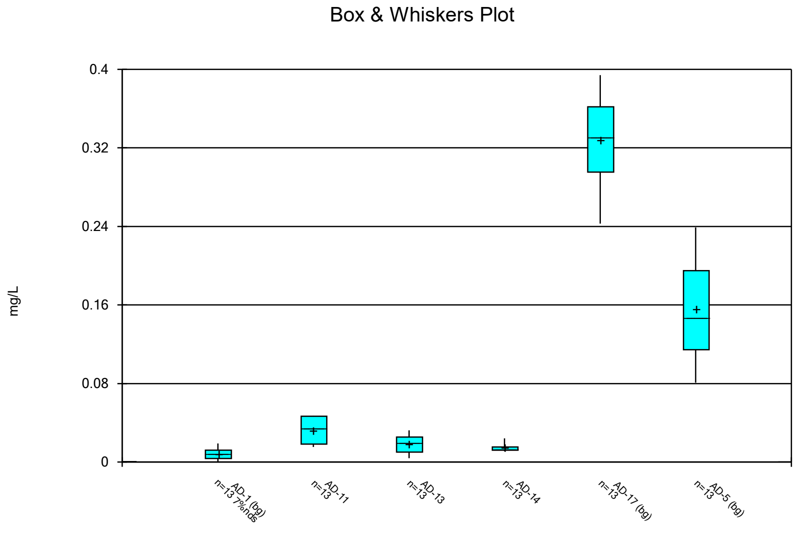
Sanitas™ v.9.6.23 . UG



Constituent: Lead, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

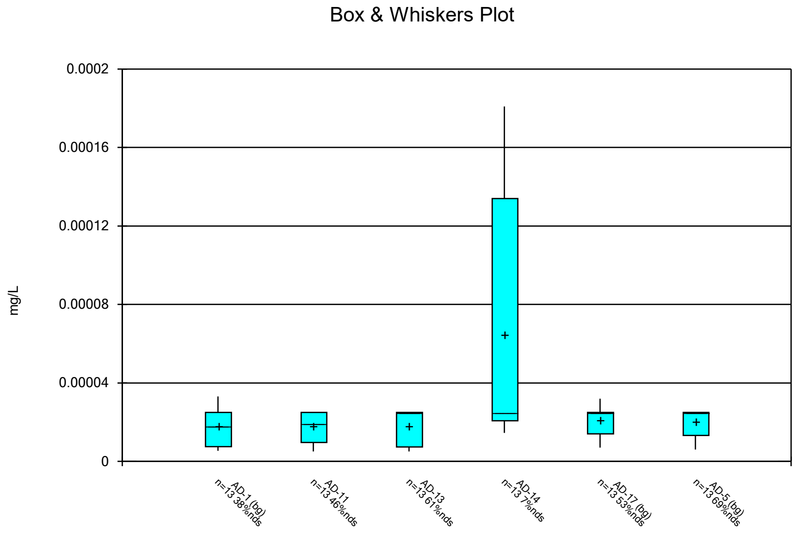
Sanitas™ v.9.6.23 . UG



Constituent: Lithium, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

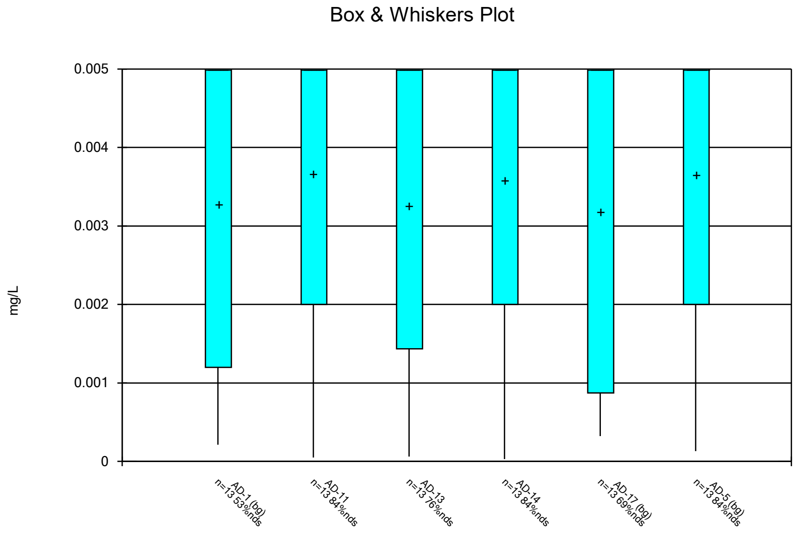
Sanitas™ v.9.6.23 . UG



Constituent: Mercury, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

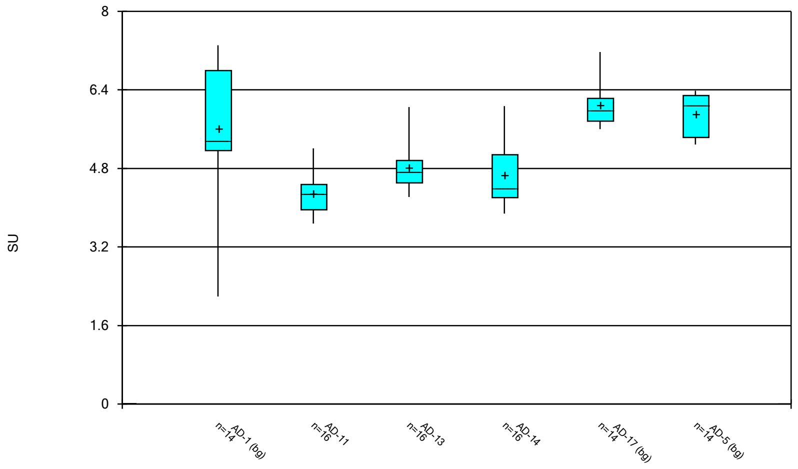


Constituent: Molybdenum, total   Analysis Run 11/22/2019 5:25 PM

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

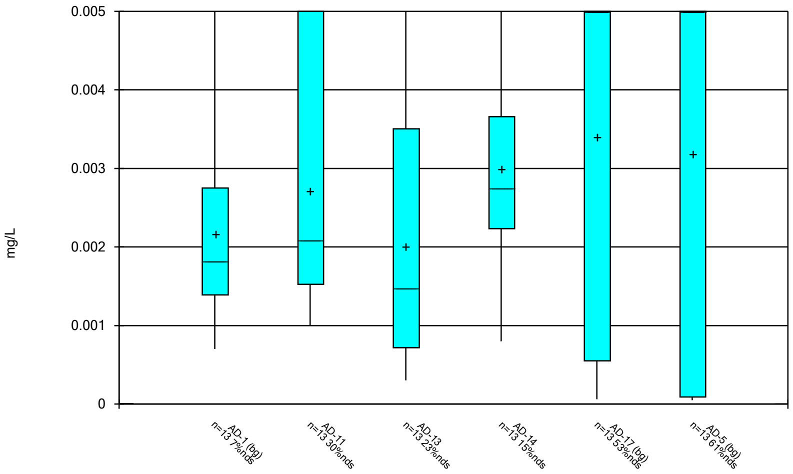
Box & Whiskers Plot



Constituent: pH, field   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

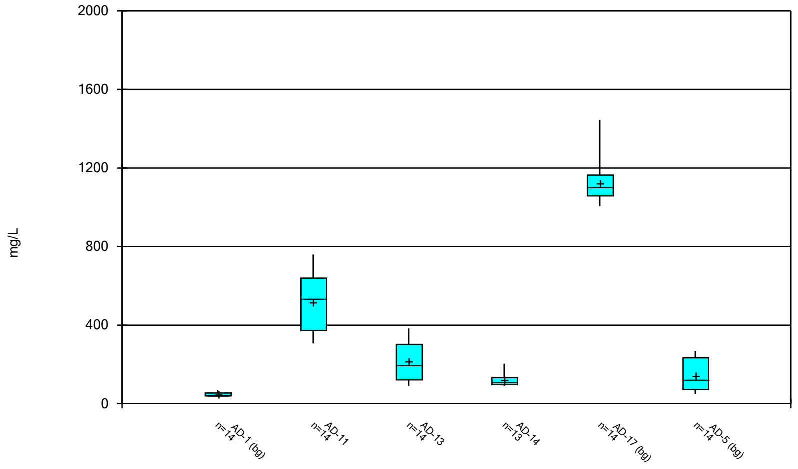
Box & Whiskers Plot



Constituent: Selenium, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

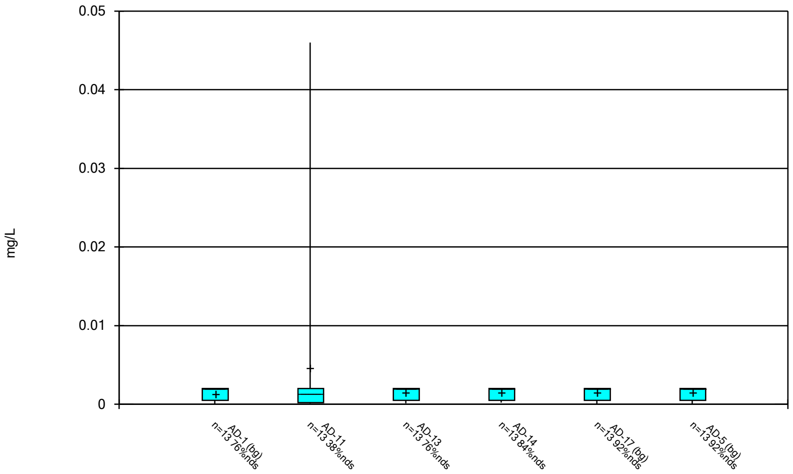
Box & Whiskers Plot



Constituent: Sulfate, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

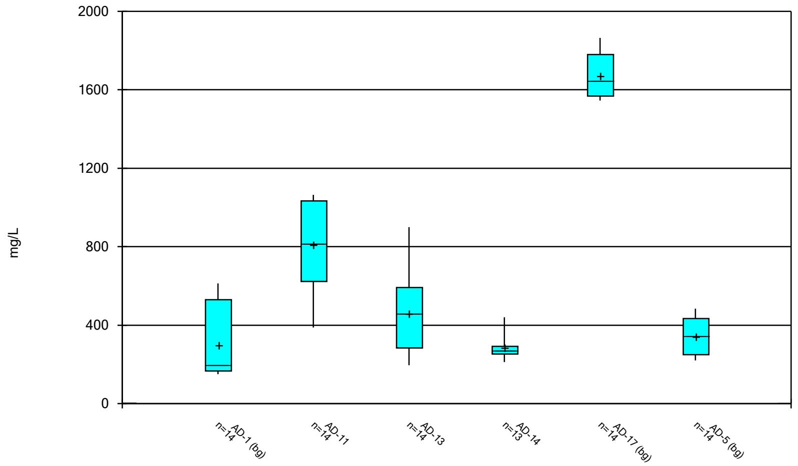
Box & Whiskers Plot



Constituent: Thallium, total   Analysis Run 11/22/2019 5:25 PM
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot



Constituent: Total Dissolved Solids Analysis Run 11/22/2019 5:25 PM

Welsh Landfill Client: Geosyntec Data: Welsh LF

Outlier Summary

Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 11/25/2019, 3:39 PM

	AD-11 Chromium, total (mg/L)	AD-13 Chromium, total (mg/L)	AD-17 Chromium, total (mg/L)	AD-11 Fluoride, total (mg/L)	AD-14 Lithium, total (mg/L)	AD-11 Thallium, total (mg/L)
7/29/2016					0.024 (o)	
9/30/2016	0.007 (o)					
10/21/2016				3 (o)		
12/14/2016		0.007 (o)				
1/20/2017			0.068 (O)			
5/23/2018						0.046 (o)

Interwell Appendix III Outlier Analysis - All Results (No Significant)

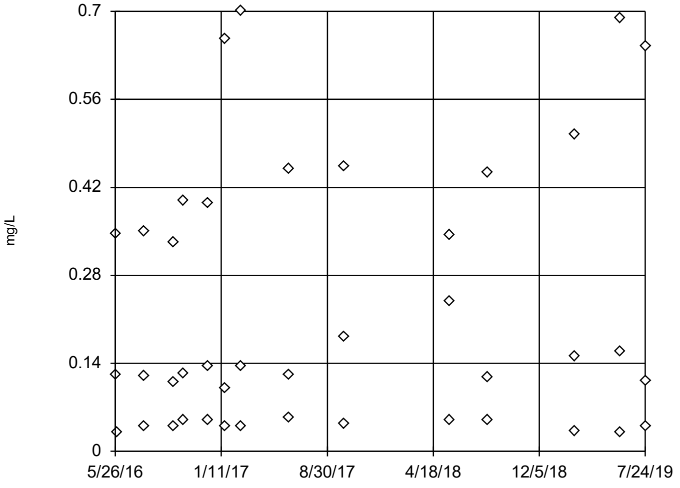
Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 11/20/2019, 1:15 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Boron, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	0.2196	0.2058	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	0.7273	0.3627	ln(x)	ShapiroWilk
pH, field (SU)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	5.879	0.8205	x^3	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



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).

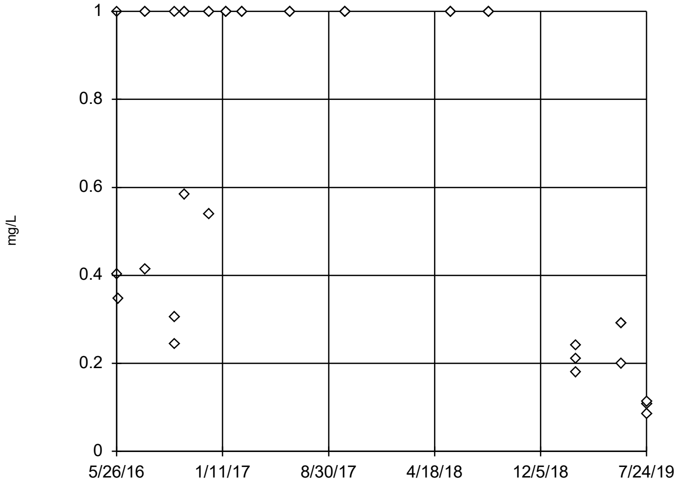
High cutoff = 152.1, low cutoff = 0.000122, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/20/2019 1:14 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



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).

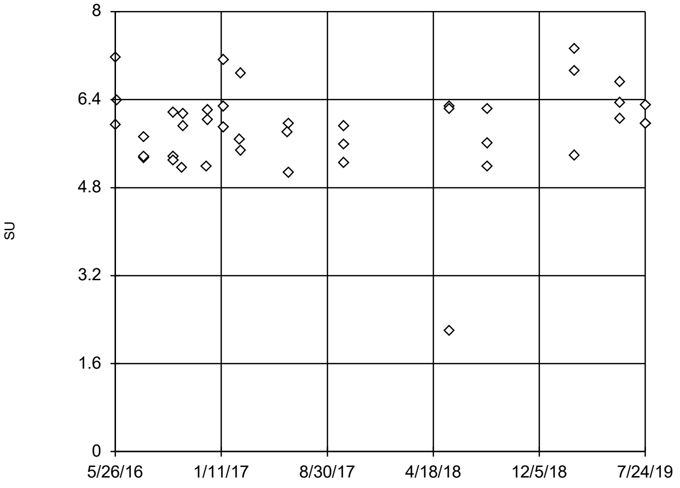
High cutoff = 37.92, low cutoff = 0.007849, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:14 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 42

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 = 8.054, low cutoff = -4.934, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/20/2019 1:14 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Upgradient Appendix IV Outlier Analysis - All Results

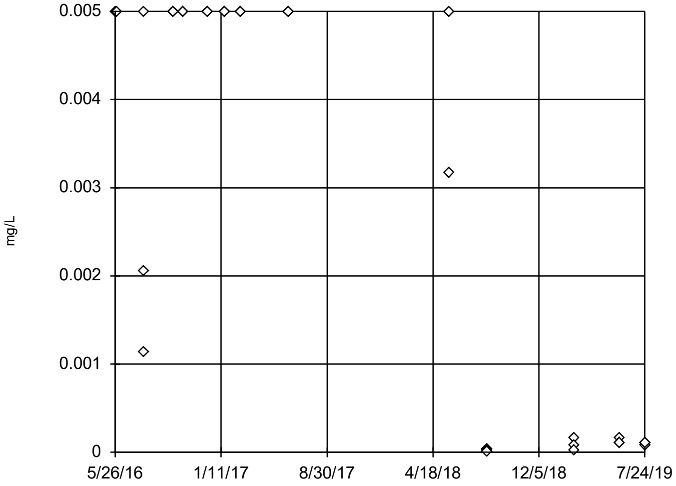
Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 11/20/2019, 1:29 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-1,AD-1...	n/a	n/a	n/a w/com...	NP	NaN	39	0.003265	0.002294	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.003355	0.001848	sqrt(x)	ShapiroWilk
Barium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.1097	0.1337	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.000...	0.000171	x^(1/3)	ShapiroWilk
Cadmium, total (mg/L)	AD-1,AD-1...	n/a	n/a	n/a w/com...	NP	NaN	39	0.001055	0.001552	unknown	ShapiroWilk
Chromium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	38	0.000...	0.00086	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.02542	0.02821	x^(1/3)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	2.091	0.9476	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	42	0.7273	0.3627	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.003549	0.002164	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.1639	0.1373	normal	ShapiroWilk
Mercury, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.000...	0.0000...	x^2	ShapiroWilk
Molybdenum, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.003371	0.001944	x^(1/3)	ShapiroWilk
Selenium, total (mg/L)	AD-1,AD-1...	No	n/a	n/a w/com...	NP	NaN	39	0.002917	0.002031	sqrt(x)	ShapiroWilk
Thallium, total (mg/L)	AD-1,AD-1...	n/a	n/a	n/a w/com...	NP	NaN	39	0.001457	0.00076	unknown	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 both the lower and upper quartiles represent reporting limits.

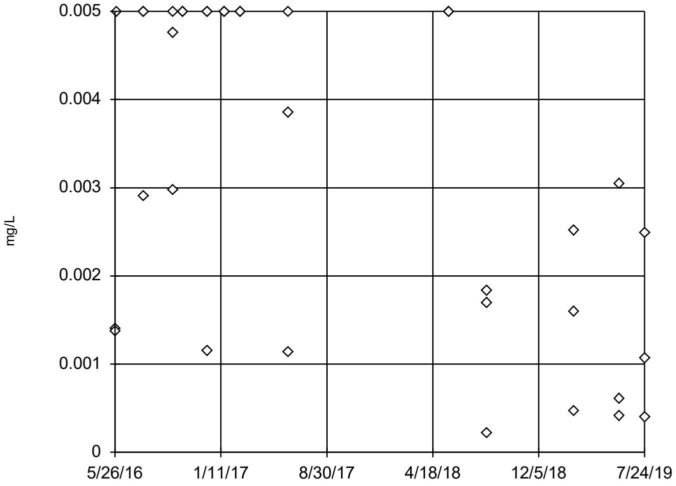
Constituent: Antimony, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 0.02919, low cutoff = -0.003945, based on IQR multiplier of 3.

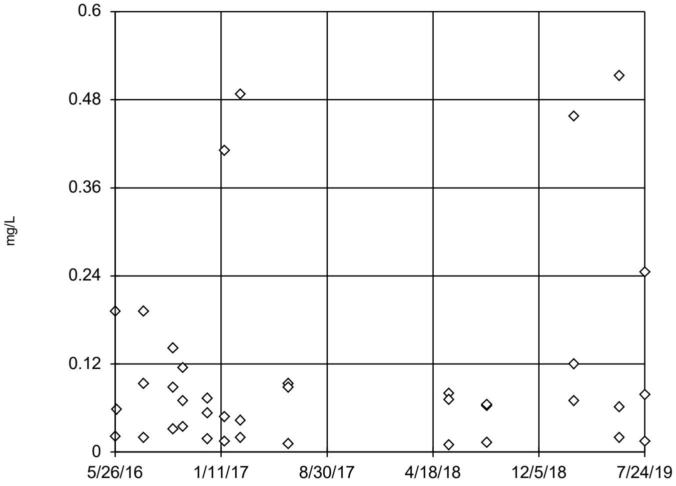
Constituent: Arsenic, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 18.24, low cutoff = 0.0001313, based on IQR multiplier of 3.

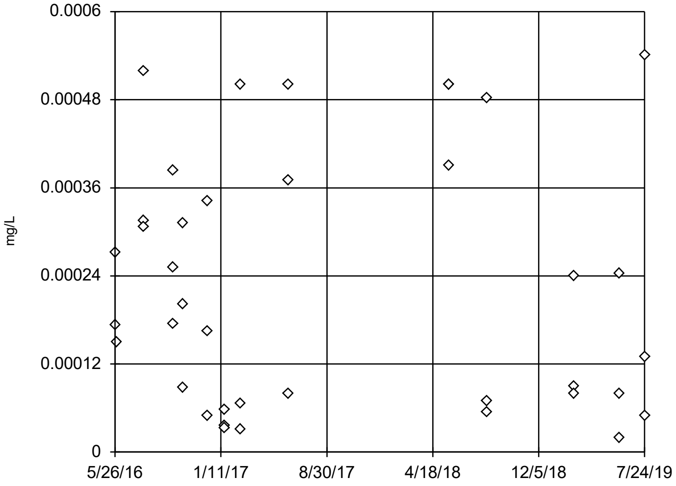
Constituent: Barium, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 0.00442, low cutoff = -0.0001351, based on IQR multiplier of 3.

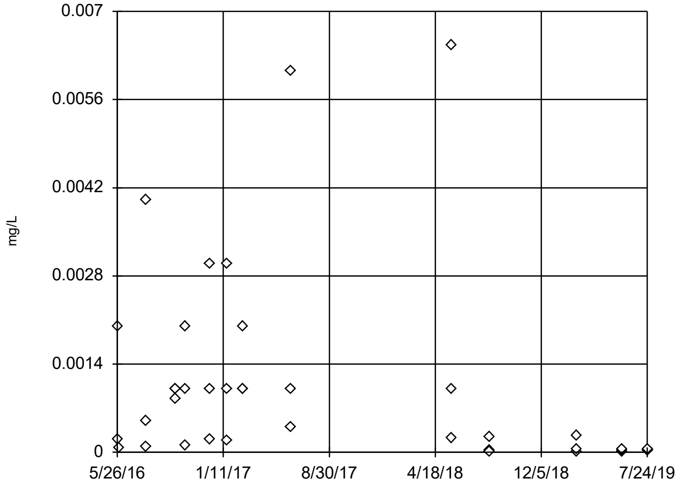
Constituent: Beryllium, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 both the lower and upper quartiles represent reporting limits.

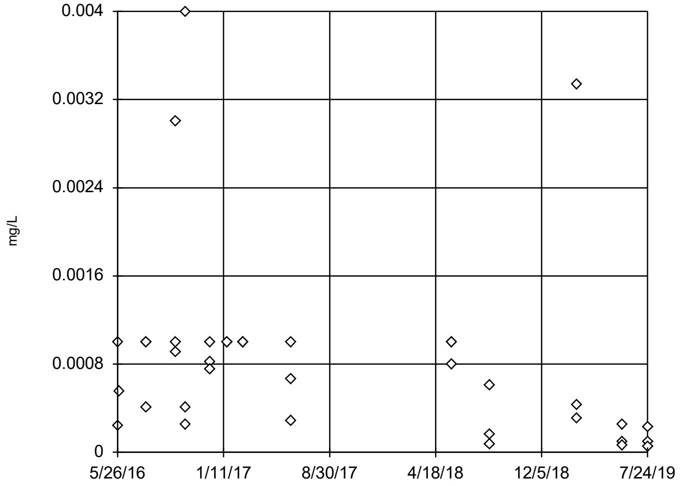
Constituent: Cadmium, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 38

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 = 0.06633, low cutoff = 0.000003725, based on IQR multiplier of 3.

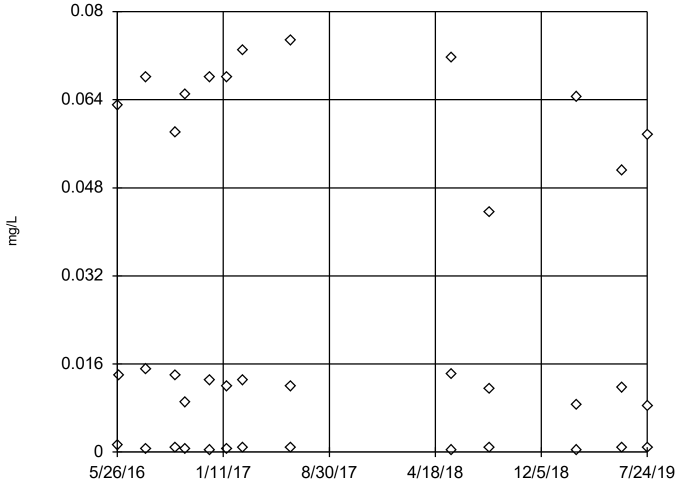
Constituent: Chromium, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 2.054, low cutoff = -0.4961, based on IQR multiplier of 3.

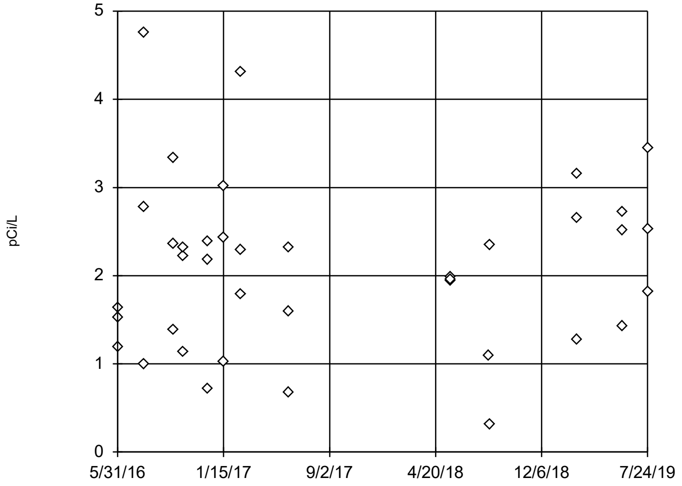
Constituent: Cobalt, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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 = 8.077, low cutoff = -0.005728, based on IQR multiplier of 3.

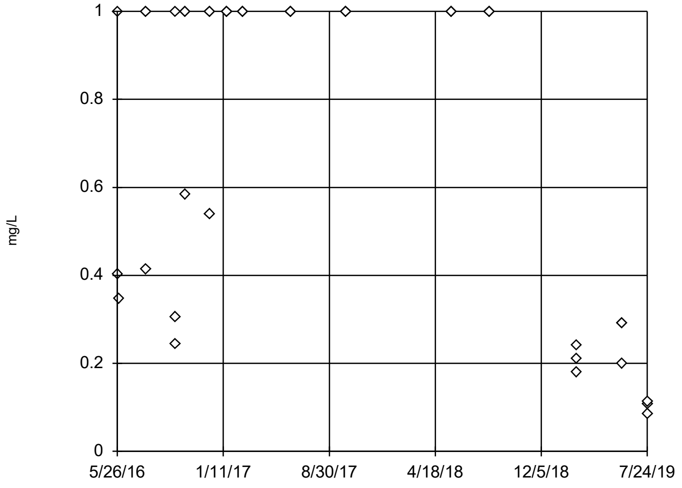
Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



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).

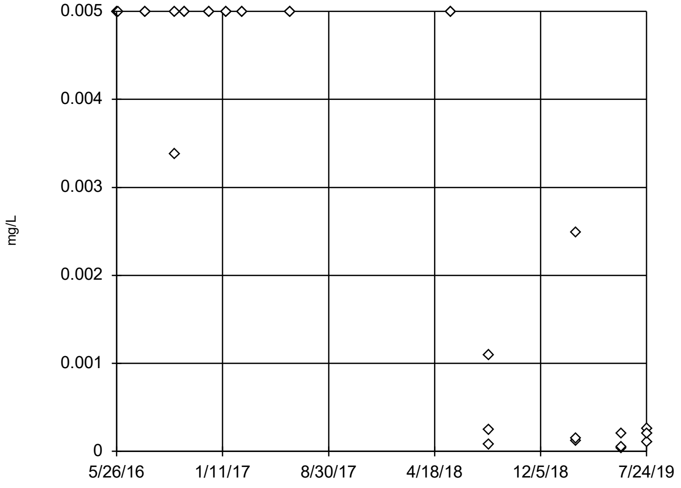
High cutoff = 37.92, low cutoff = 0.007849, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:28 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

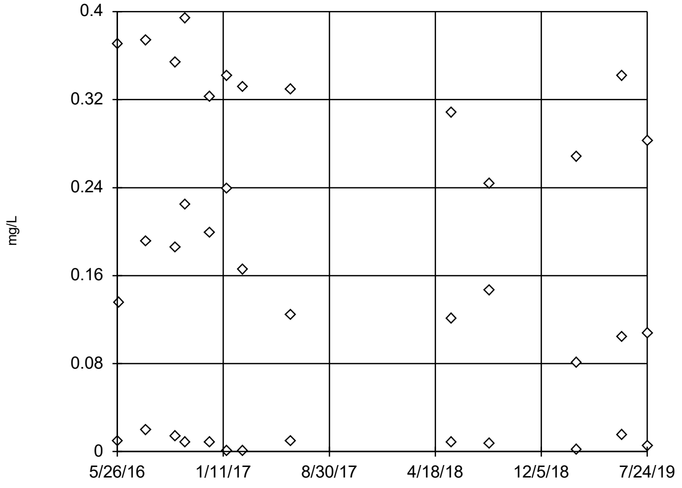
High cutoff = 34.36, low cutoff = 3.8e-8, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:28 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

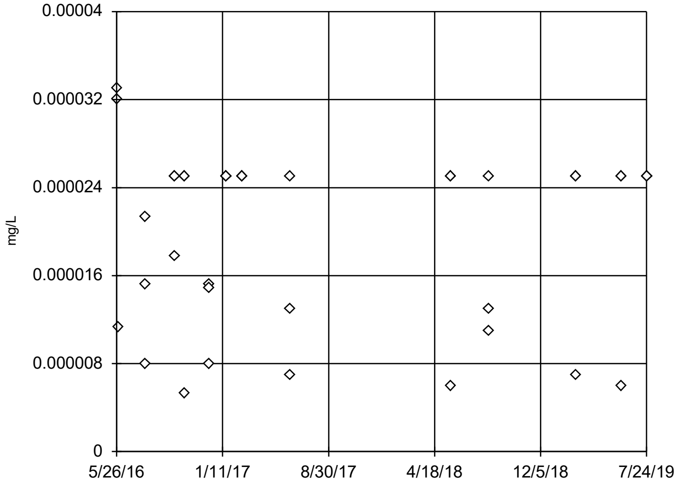
High cutoff = 1.202, low cutoff = -0.884, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/20/2019 1:28 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

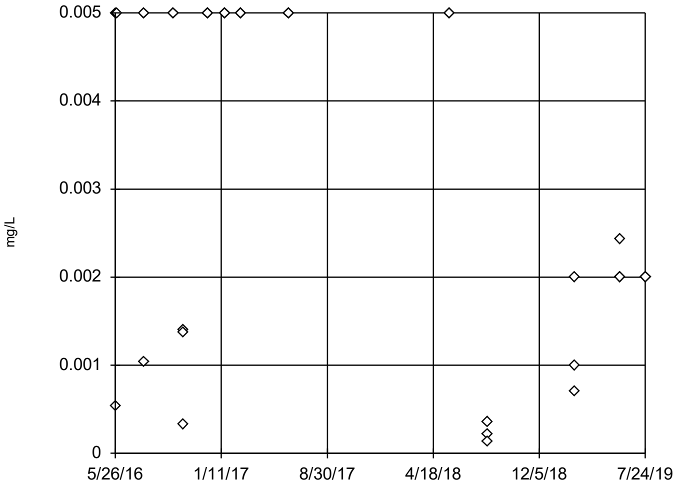
High cutoff = 0.00004464, low cutoff = -0.00003463, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/20/2019 1:28 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

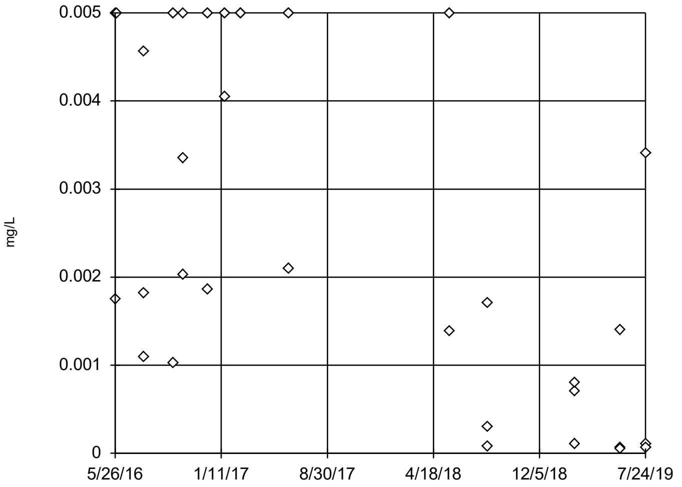
High cutoff = 0.04232, low cutoff = -0.000283, based on IQR multiplier of 3.

Constituent: Molybdenum, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

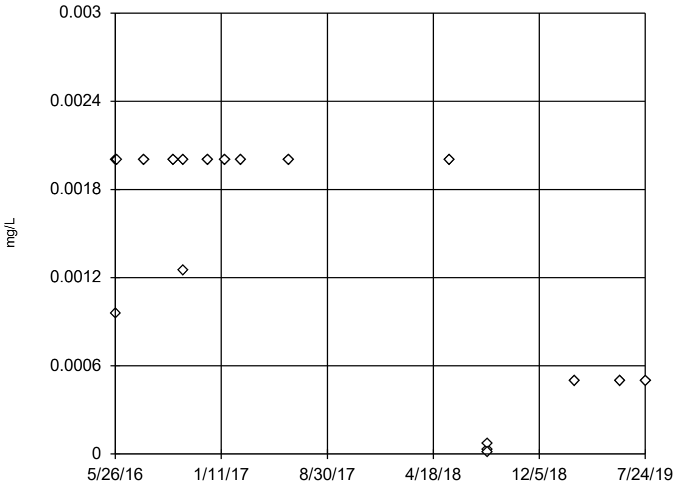
High cutoff = 0.03487, low cutoff = -0.007054, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-1,AD-17,AD-5



n = 39

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.

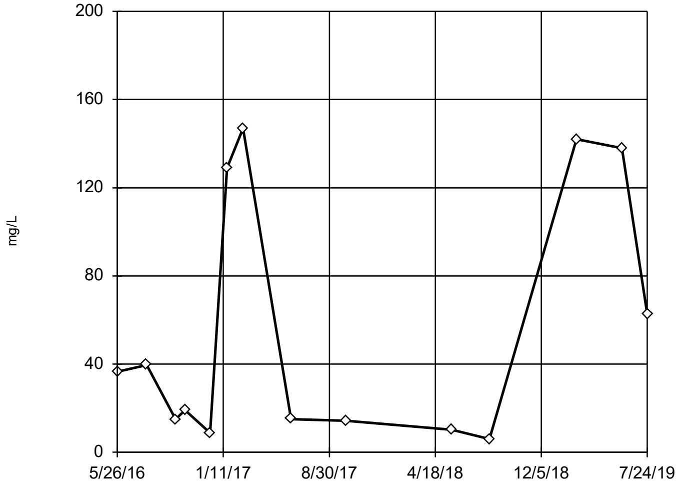
Constituent: Thallium, total   Analysis Run 11/20/2019 1:28 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Intrawell Appendix III Outlier Analysis - All Results

Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 11/20/2019, 1:27 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Calcium, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	55.94	56.65	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	14	8.97	3.408	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	14	8.82	8.193	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	14	5.797	3.544	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	195.5	8.645	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	40.53	8.044	x^(1/3)	ShapiroWilk
Chloride, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	4.172	1.727	x^(1/3)	ShapiroWilk
Chloride, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	10.01	2.195	sqrt(x)	ShapiroWilk
Chloride, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	12.27	5.586	x^2	ShapiroWilk
Chloride, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	14	5.663	2.683	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	35.64	4.965	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	17	3.662	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	46.46	10.67	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	14	518.1	141.8	normal	ShapiroWilk
Sulfate, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	14	213	93.58	sqrt(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	121.3	33.45	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	1123	104.3	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	142.1	78.09	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-1 (bg)	No	n/a	n/a	NP	NaN	14	295.9	180	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-11	No	n/a	n/a	NP	NaN	14	811.6	221.2	normal	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-13	No	n/a	n/a	NP	NaN	14	461.2	189.8	sqrt(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	286.2	61.3	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-17 (bg)	No	n/a	n/a	NP	NaN	14	1670	111	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	AD-5 (bg)	No	n/a	n/a	NP	NaN	14	343.5	88.41	sqrt(x)	ShapiroWilk

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-1 (bg)

n = 14

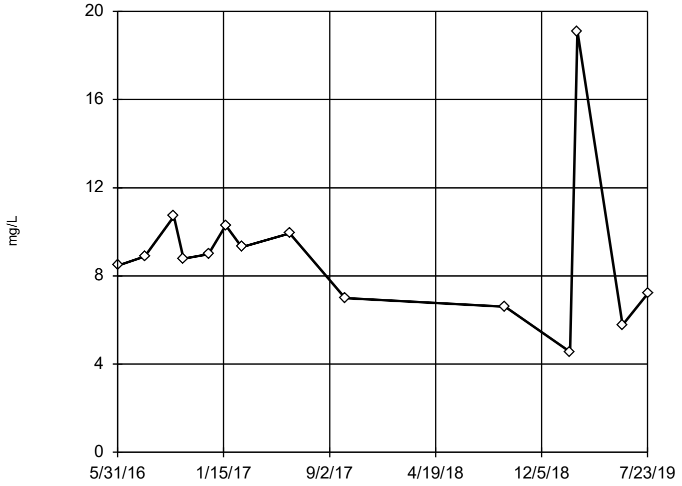
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 179901, low cutoff = 0.008957, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-11

n = 14

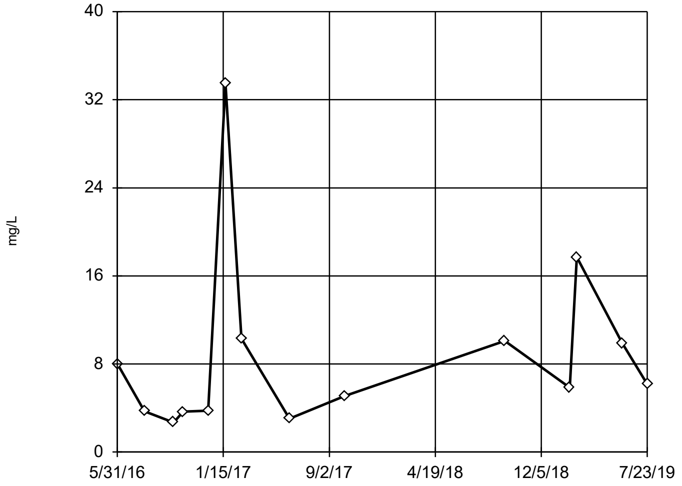
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 33.31, low cutoff = 2.064, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-13

n = 14

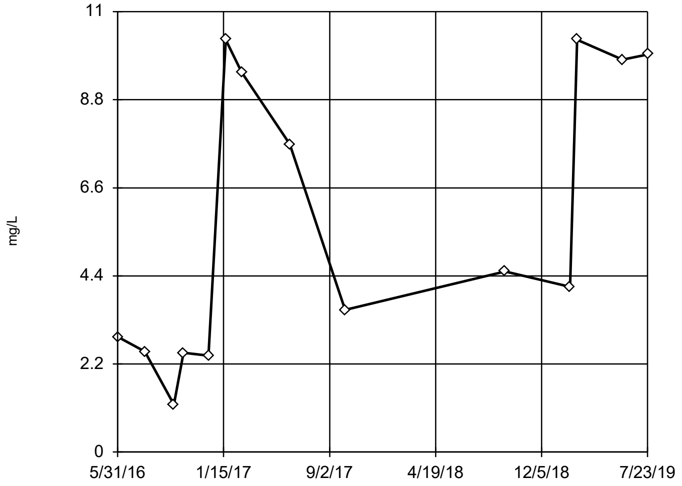
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 217.2, low cutoff = 0.1728, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-14

n = 14

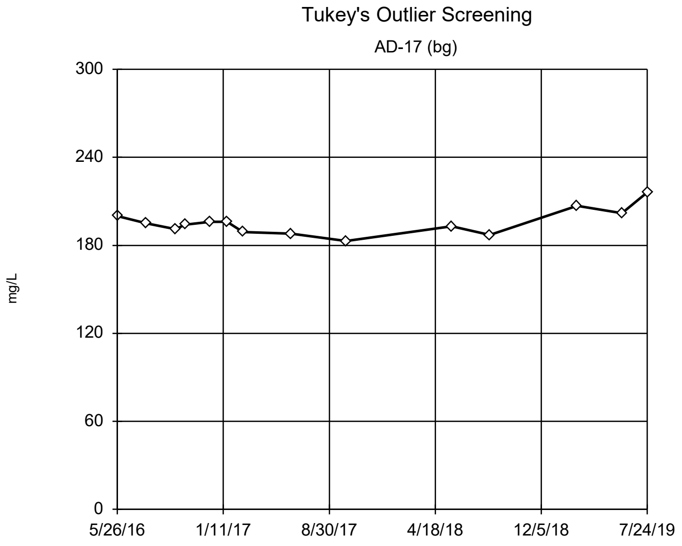
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 609.8, low cutoff = 0.04036, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 14

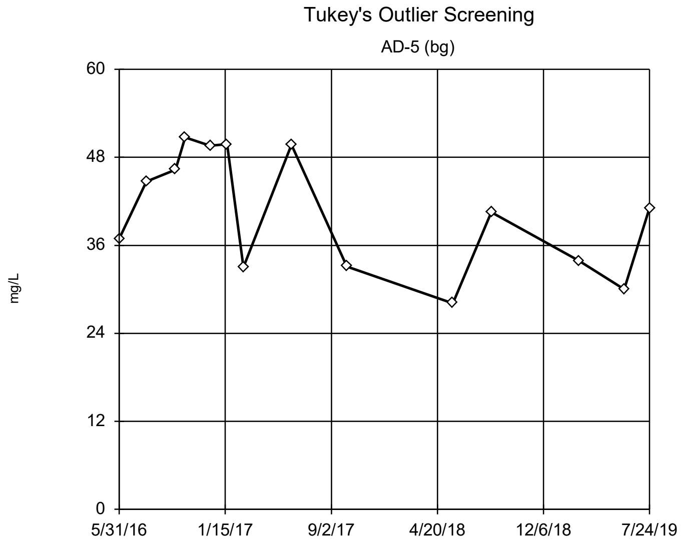
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 243.7, low cutoff = 155.5, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 14

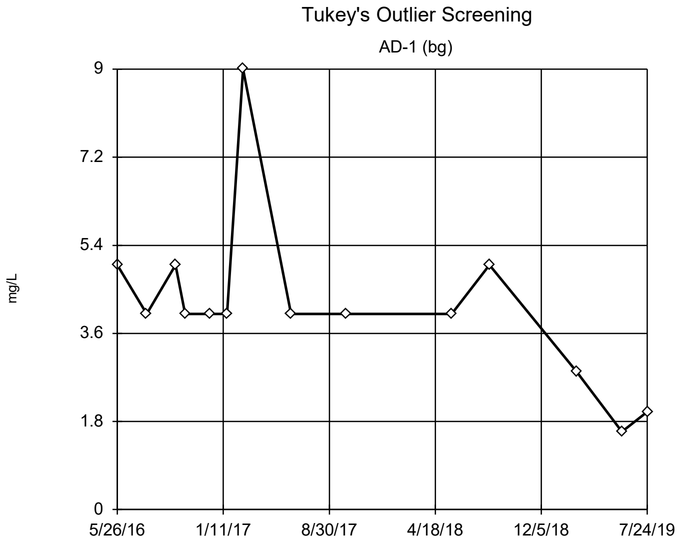
No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 130.6, low cutoff = 5.933, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 14

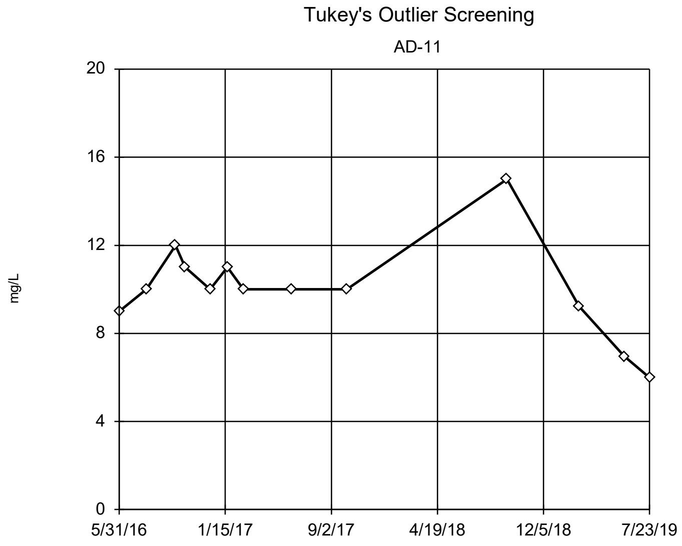
No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 12.81, low cutoff = 0.6596, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



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).

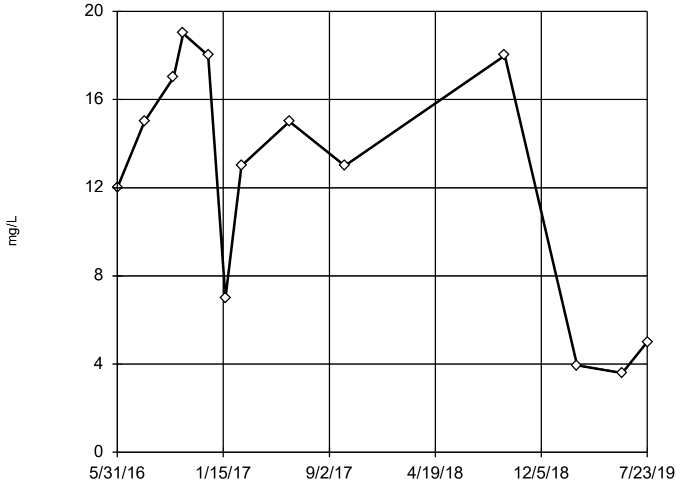
High cutoff = 17.72, low cutoff = 4.521, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

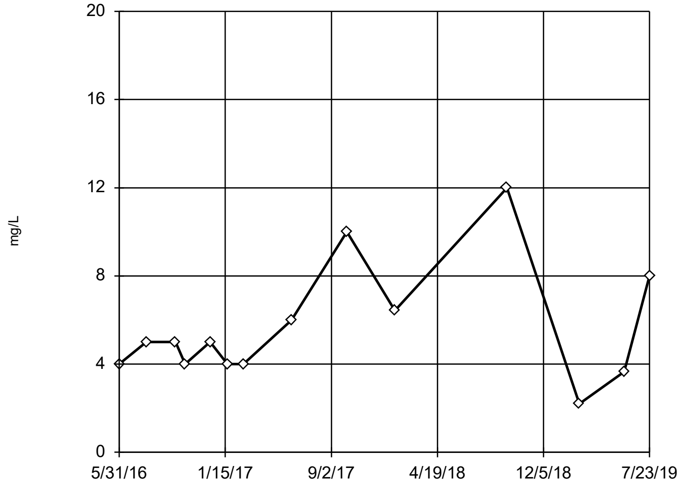
High cutoff = 33.39, low cutoff = -27.78, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/20/2019 1:26 PM   View: Intrawell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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 = 41.34, low cutoff = 0.6939, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/20/2019 1:26 PM   View: Intrawell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-17 (bg)

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).

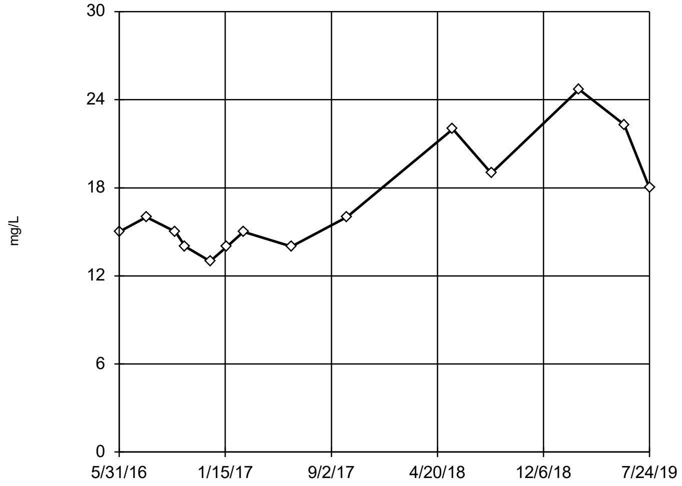
High cutoff = 93.39, low cutoff = 13.56, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/20/2019 1:26 PM   View: Intrawell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-5 (bg)



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).

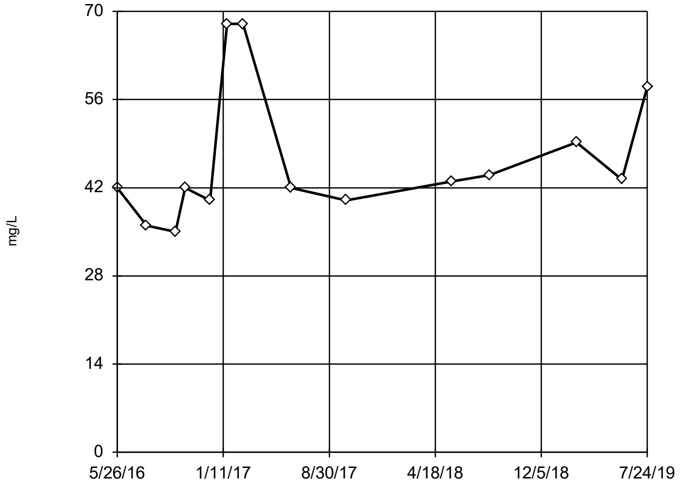
High cutoff = 63.67, low cutoff = 4.495, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/20/2019 1:26 PM   View: Intrawell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-1 (bg)



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).

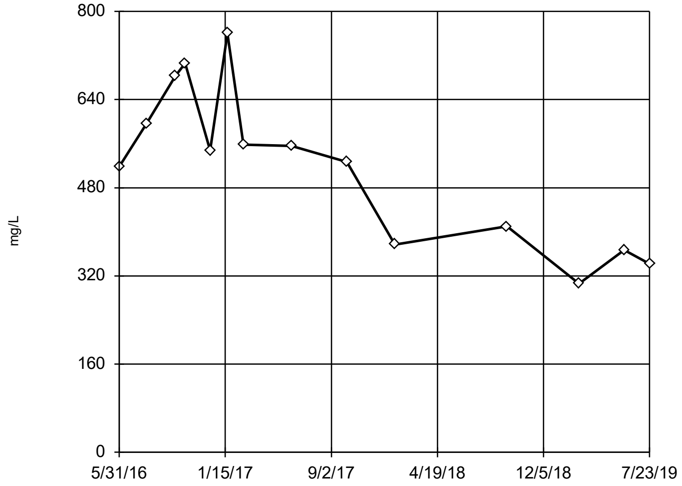
High cutoff = 127.2, low cutoff = 16.79, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-11



n = 14

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

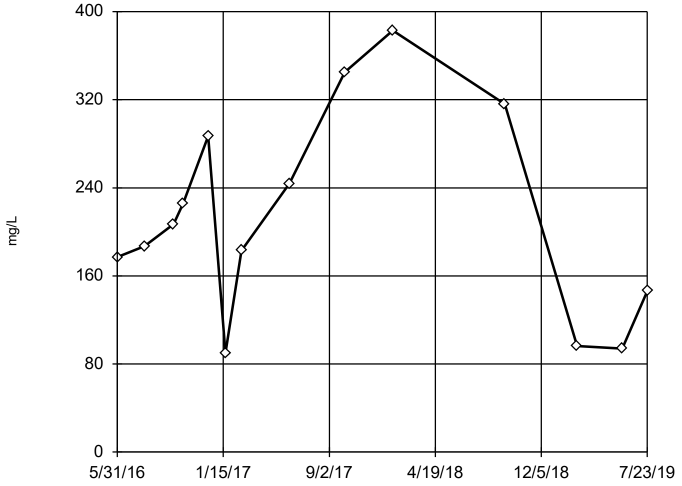
High cutoff = 1442, low cutoff = -430.5, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



n = 14

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

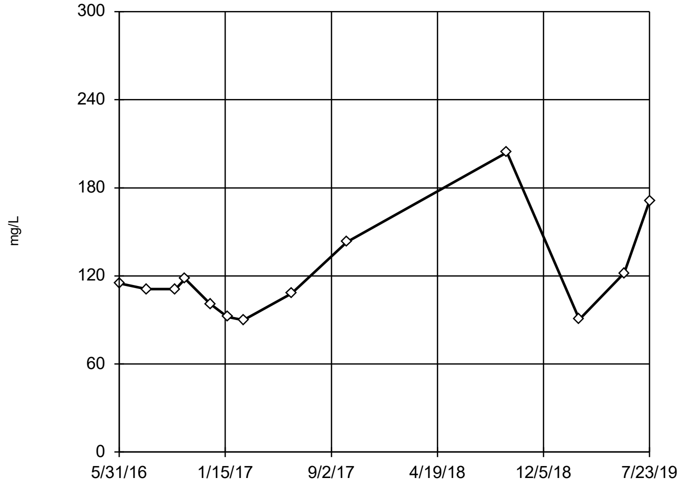
High cutoff = 1339, low cutoff = -68.62, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



n = 13

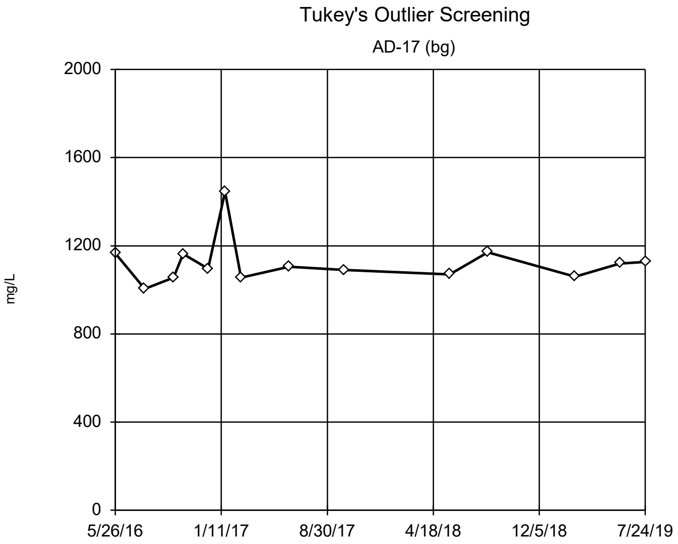
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 339.8, low cutoff = 37.47, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-17 (bg)

n = 14

No outliers found. Tukey's method selected by user.

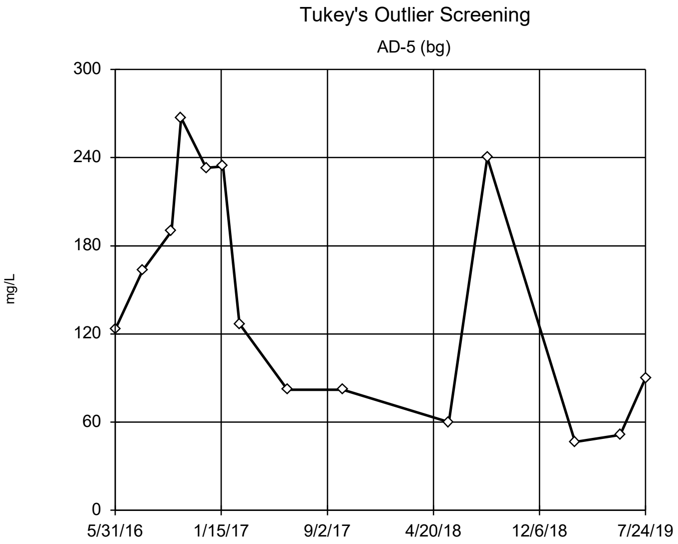
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1555, low cutoff = 792, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII

Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-5 (bg)

n = 14

No outliers found. Tukey's method selected by user.

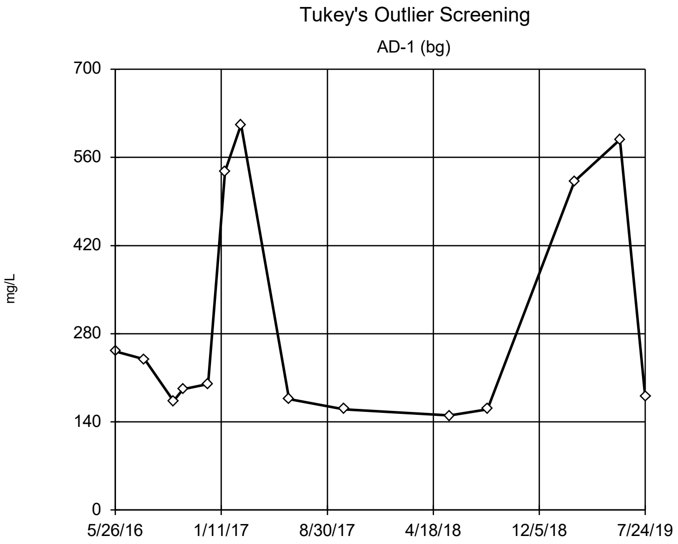
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 8614, low cutoff = 1.901, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII

Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-1 (bg)

n = 14

No outliers found. Tukey's method selected by user.

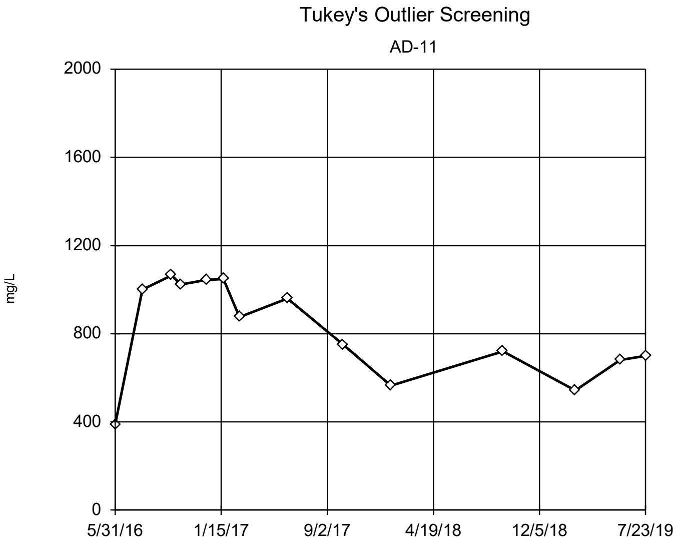
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 17126, low cutoff = 5.148, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII

Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



Tukey's Outlier Screening

AD-11

n = 14

No outliers found. Tukey's method selected by user.

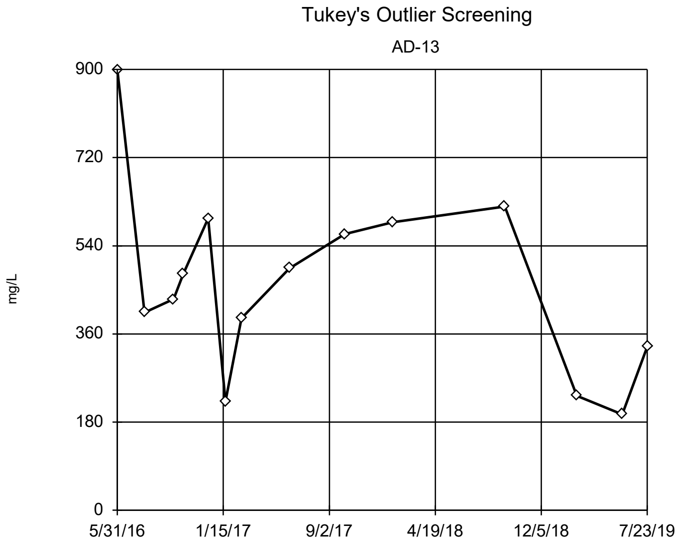
Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 2270, low cutoff = -614, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII

Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 14

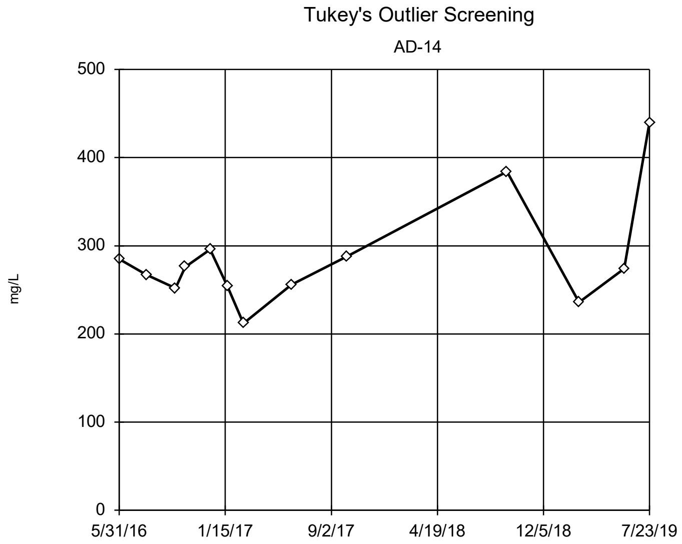
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2206, low cutoff = -34.19, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 13

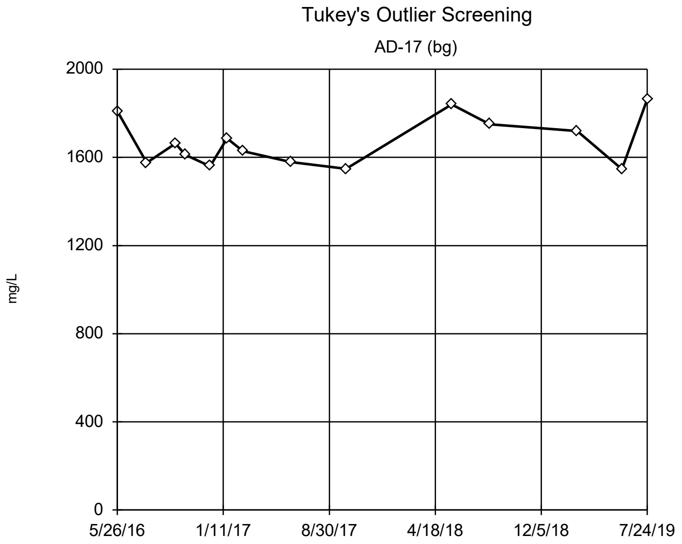
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 448.8, low cutoff = 164.6, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 14

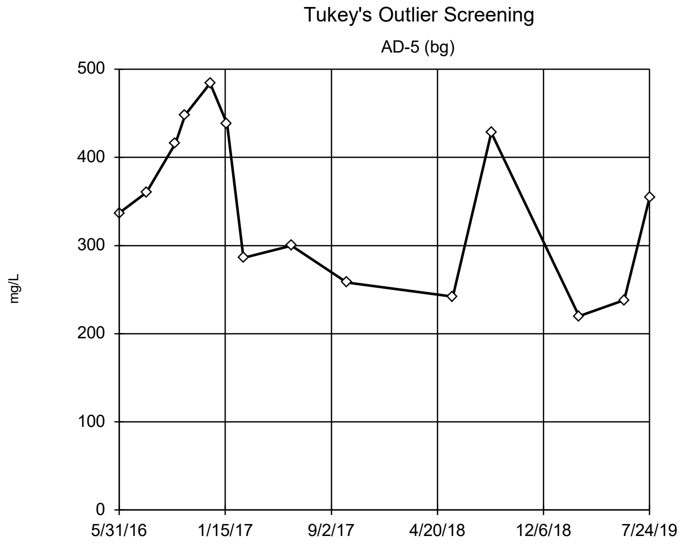
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2603, low cutoff = 1072, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 14

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 = 1282, low cutoff = 0.6602, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 11/20/2019 1:26 PM View: Intrawell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Downgradient Appendix IV Outlier Analysis - Significant Results

Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 11/20/2019, 1:21 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Chromium, total (mg/L)	**AD-13**	**Yes**	**0.007**	**12/14/2016**	**NP**	**NaN**	**13**	**0.001275**	**0.00198**	**ln(x)**	**ShapiroWilk**

Downgradient Appendix IV Outlier Analysis - All Results

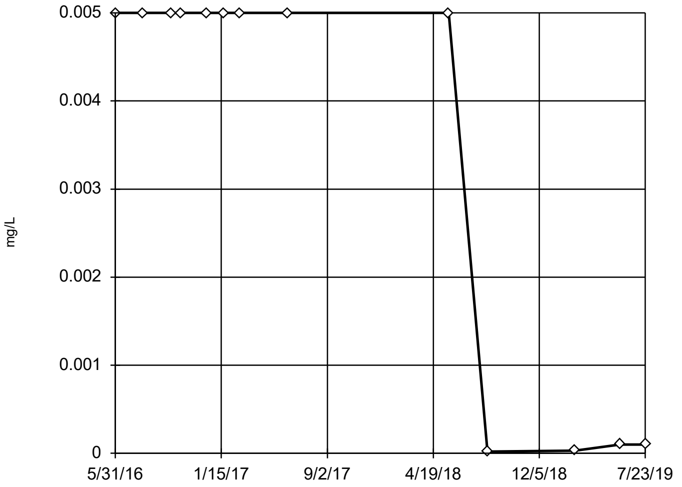
Welsh Landfill Client: Geosyntec Data: Welsh LF Printed 11/20/2019, 1:21 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-11	n/a	n/a	n/a	NP	NaN	13	0.003481	0.002372	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.003202	0.002398	sqrt(x)	ShapiroWilk
Antimony, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.003475	0.002382	ln(x)	ShapiroWilk
Arsenic, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.002964	0.002031	ln(x)	ShapiroWilk
Arsenic, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.003626	0.00216	x^3	ShapiroWilk
Arsenic, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.00307	0.002214	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.01978	0.01233	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.04402	0.02561	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.04079	0.01479	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.002902	0.001665	x^2	ShapiroWilk
Beryllium, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.000...	0.0002788	x^3	ShapiroWilk
Beryllium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.000...	0.0002155	sqrt(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.000...	0.0001266	normal	ShapiroWilk
Cadmium, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.000...	0.000192	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.001022	0.0006704	sqrt(x)	ShapiroWilk
Chromium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.001393	0.001892	ln(x)	ShapiroWilk
Chromium, total (mg/L)	**AD-13**	**Yes**	**0.007**	**12/14/2016**	**NP**	**NaN**	**13**	**0.001275**	**0.00198**	**ln(x)**	**ShapiroWilk**
Chromium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.000...	0.0003319	x^(1/3)	ShapiroWilk
Cobalt, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.01985	0.007995	x^4	ShapiroWilk
Cobalt, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.005342	0.003061	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.009368	0.004887	x^(1/3)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-11	No	n/a	n/a	NP	NaN	13	2.015	0.7276	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-13	No	n/a	n/a	NP	NaN	13	2.306	0.8584	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-14	No	n/a	n/a	NP	NaN	13	1.757	1.075	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	14	1.405	0.8659	normal	ShapiroWilk
Fluoride, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	14	0.6763	0.2861	normal	ShapiroWilk
Fluoride, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	14	0.7554	0.402	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.0034	0.002003	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.003087	0.002251	sqrt(x)	ShapiroWilk
Lead, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.003508	0.00233	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.03222	0.01308	normal	ShapiroWilk
Lithium, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.01853	0.008507	normal	ShapiroWilk
Lithium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	12	0.01373	0.002473	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	normal	ShapiroWilk
Mercury, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	normal	ShapiroWilk
Mercury, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-11	n/a	n/a	n/a	NP	NaN	13	0.003659	0.001831	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.003253	0.002048	sqrt(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-14	n/a	n/a	n/a	NP	NaN	13	0.003579	0.001952	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.002714	0.001628	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-13	No	n/a	n/a	NP	NaN	13	0.002002	0.001787	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-14	No	n/a	n/a	NP	NaN	13	0.002985	0.001174	normal	ShapiroWilk
Thallium, total (mg/L)	AD-11	No	n/a	n/a	NP	NaN	13	0.004632	0.01246	ln(x)	ShapiroWilk
Thallium, total (mg/L)	AD-13	n/a	n/a	n/a	NP	NaN	13	0.001412	0.0007975	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-14	n/a	n/a	n/a	NP	NaN	13	0.001496	0.0007917	unknown	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

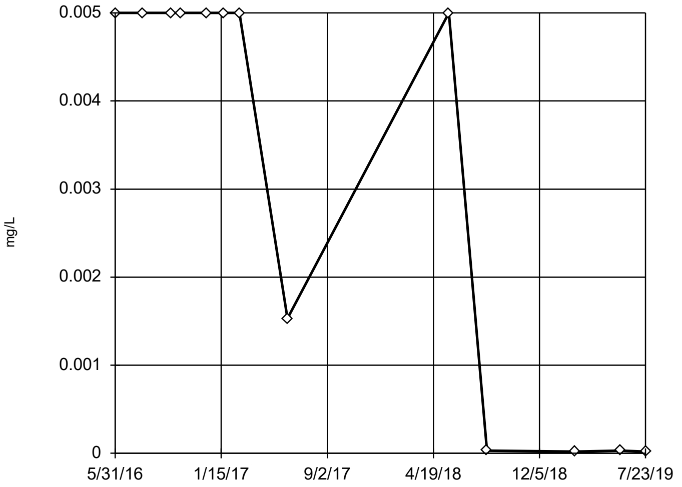
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Antimony, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

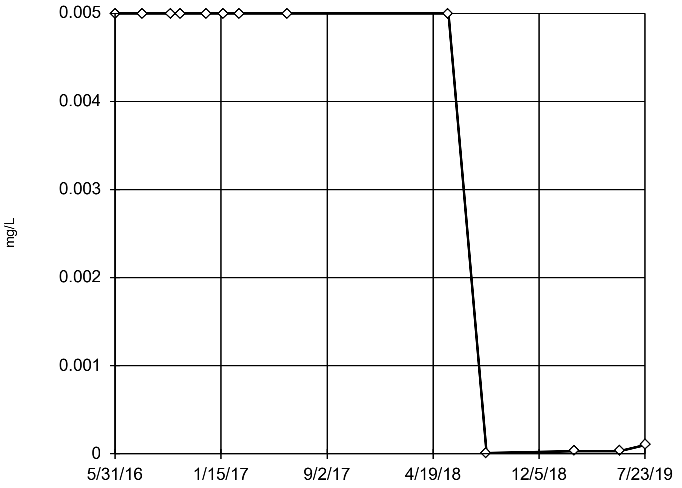
High cutoff = 0.07097, low cutoff = -0.03618, based on IQR multiplier of 3.

Constituent: Antimony, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

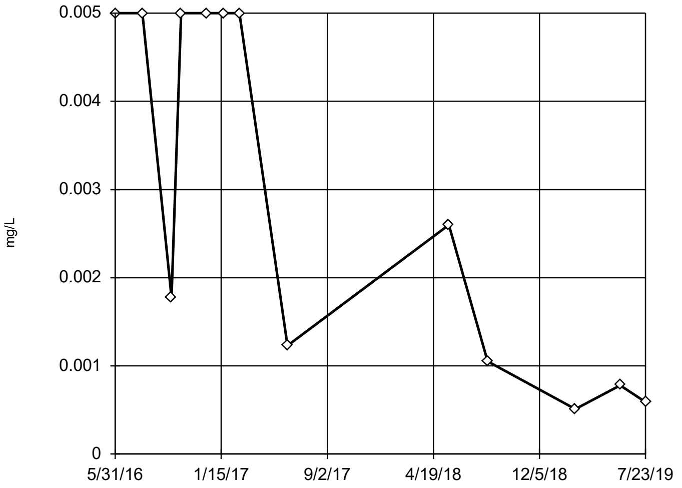
High cutoff = 3804, low cutoff = 7.2e-11, based on IQR multiplier of 3.

Constituent: Antimony, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

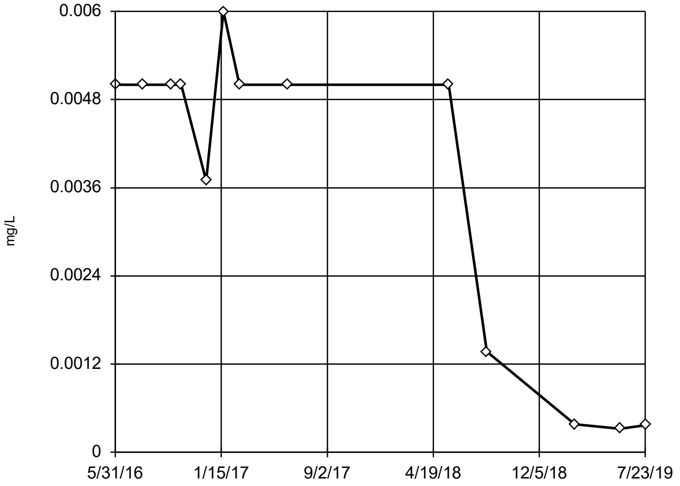
High cutoff = 0.8432, low cutoff = 0.000005366, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

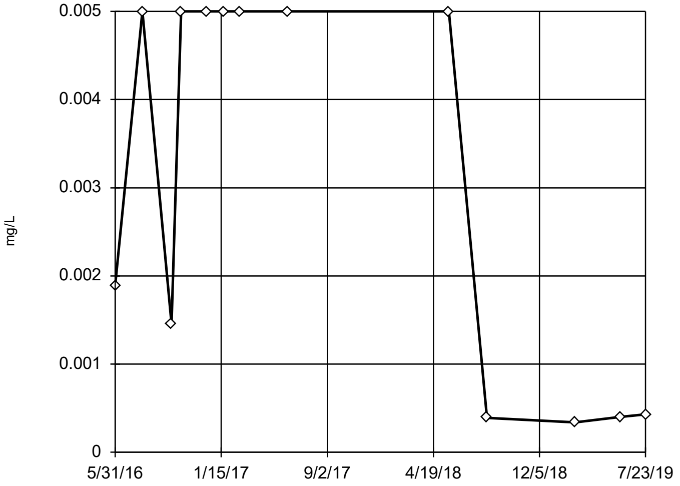
High cutoff = 0.007916, low cutoff = -0.007177, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

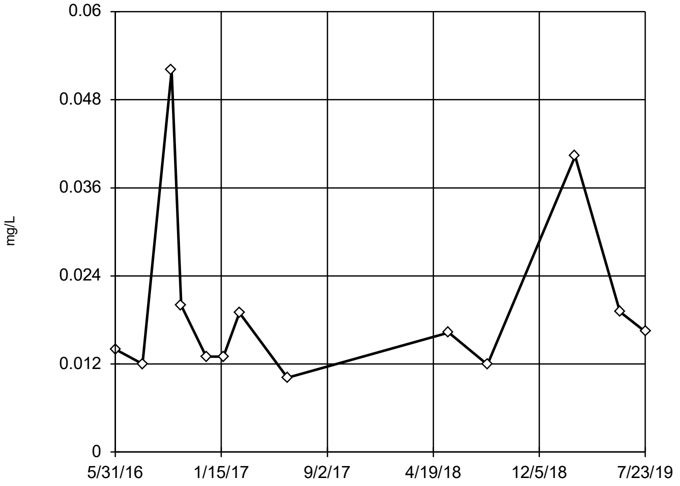
High cutoff = 8.762, low cutoff = 2.4e-7, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

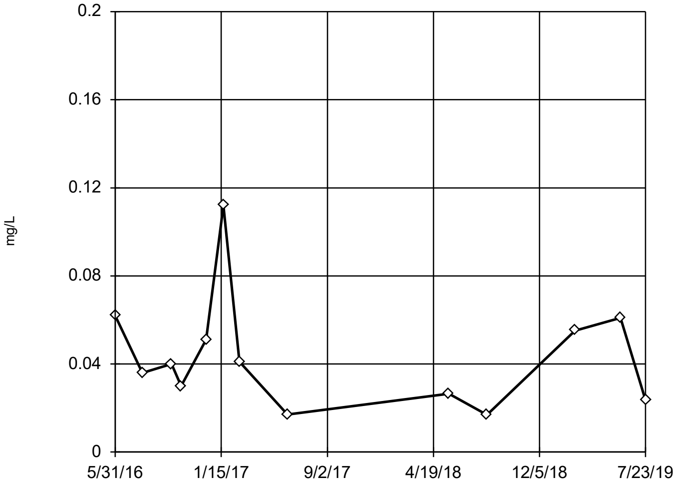
High cutoff = 0.07489, low cutoff = 0.00326, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

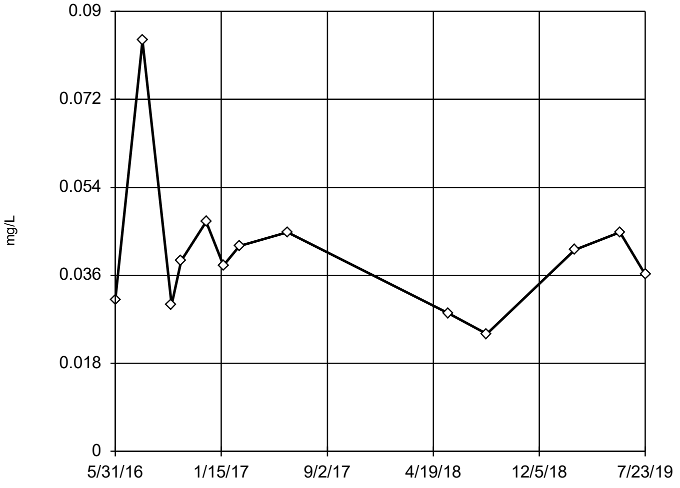
High cutoff = 0.7226, low cutoff = 0.002007, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

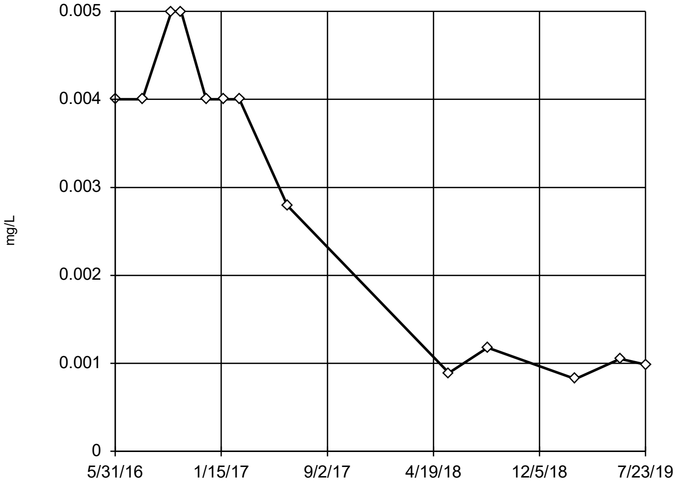
High cutoff = 0.1422, low cutoff = 0.009609, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

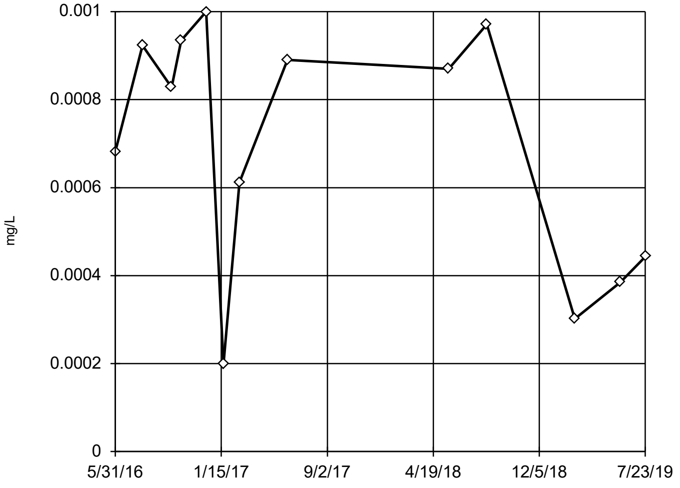
High cutoff = 0.007803, low cutoff = -0.006622, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

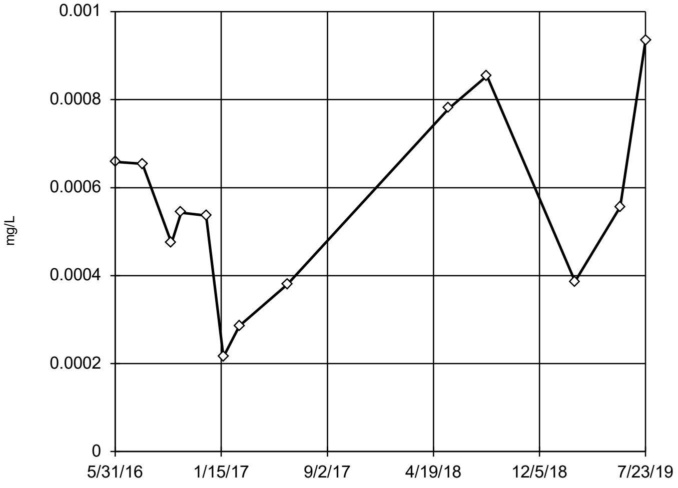
High cutoff = 0.00144, low cutoff = -0.001284, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

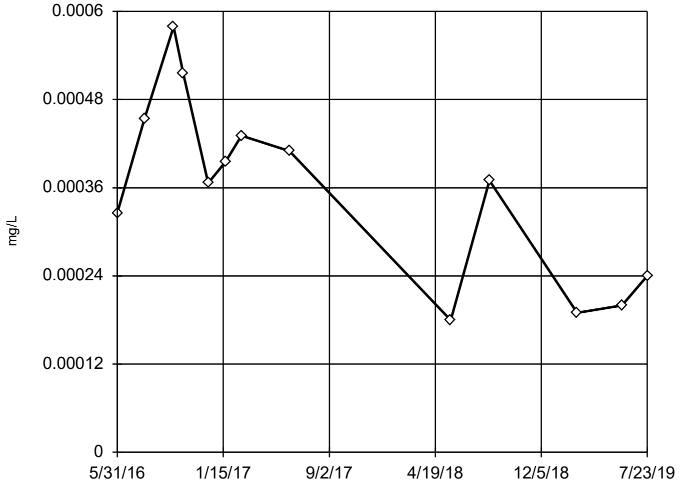
High cutoff = 0.002345, low cutoff = -0.000004208, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-11



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

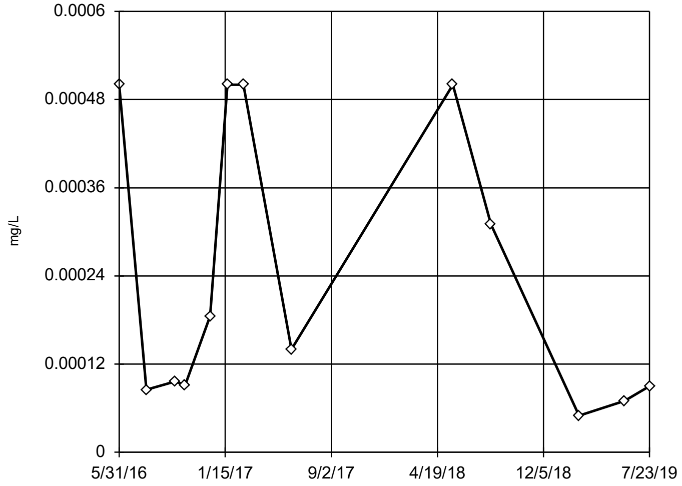
High cutoff = 0.001109, low cutoff = -0.0004469, based on IQR multiplier of 3.

Constituent: Cadmium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

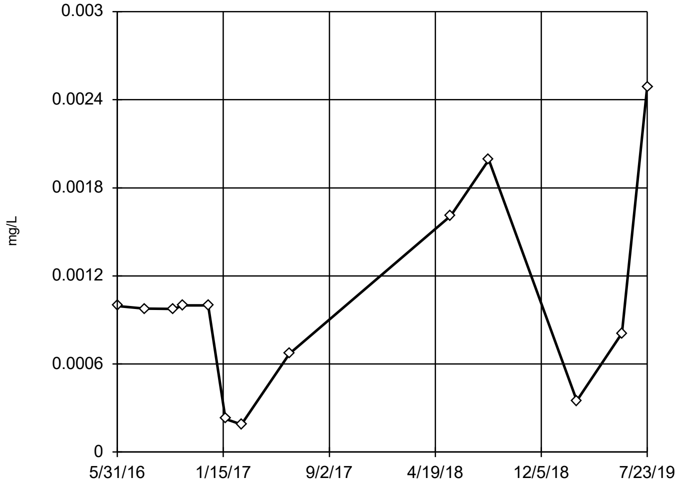
High cutoff = 0.09341, low cutoff = 4.7e-7, based on IQR multiplier of 3.

Constituent: Cadmium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

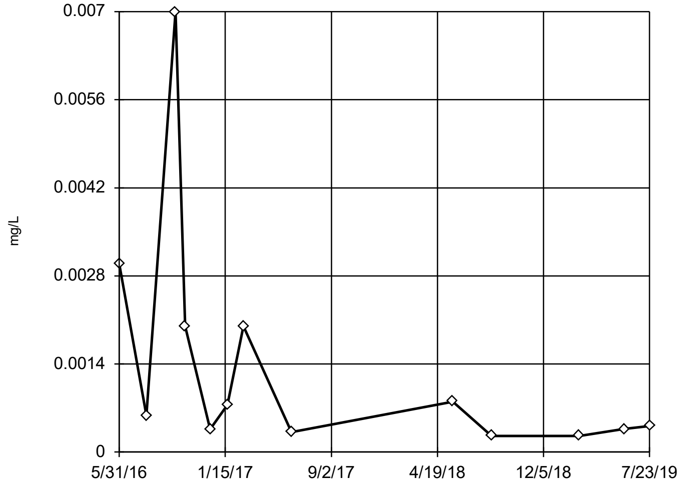
High cutoff = 0.005869, low cutoff = -0.0003399, based on IQR multiplier of 3.

Constituent: Cadmium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

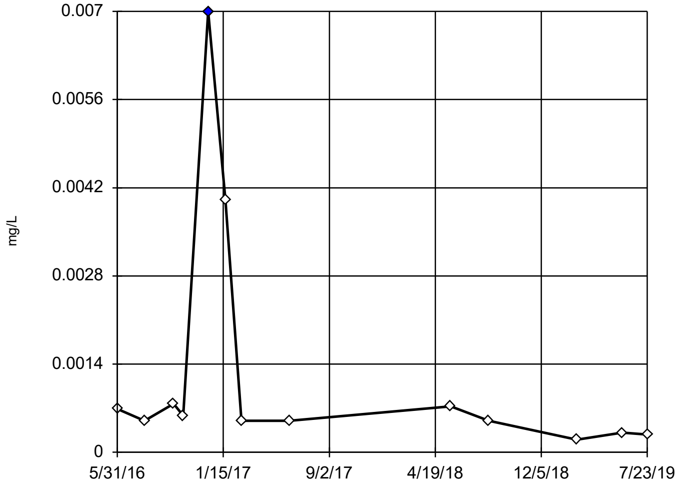
High cutoff = 0.4005, low cutoff = 0.000001707, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

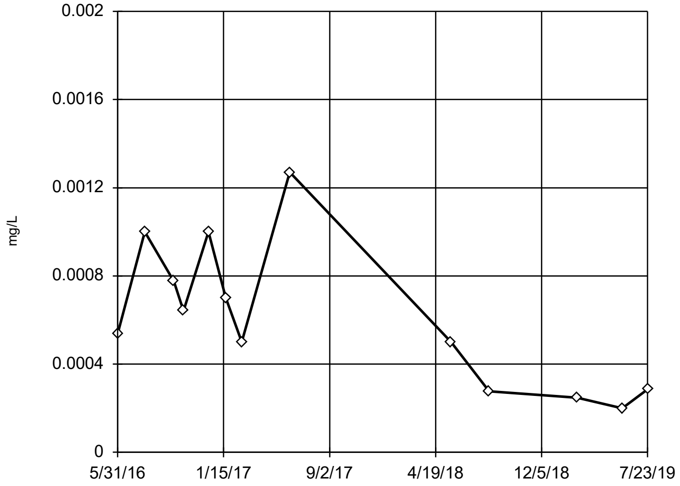
High cutoff = 0.005201, low cutoff = 0.00005681, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

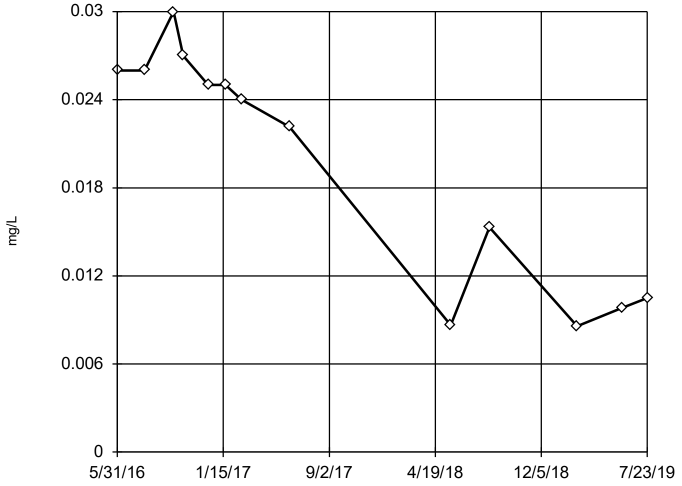
High cutoff = 0.006562, low cutoff = -0.00001716, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

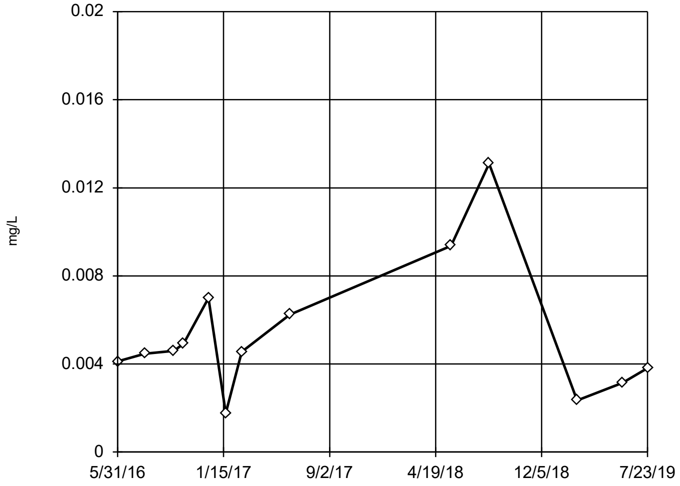
High cutoff = 0.03661, low cutoff = -0.03395, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



n = 13

No outliers found. Tukey's method selected by user.

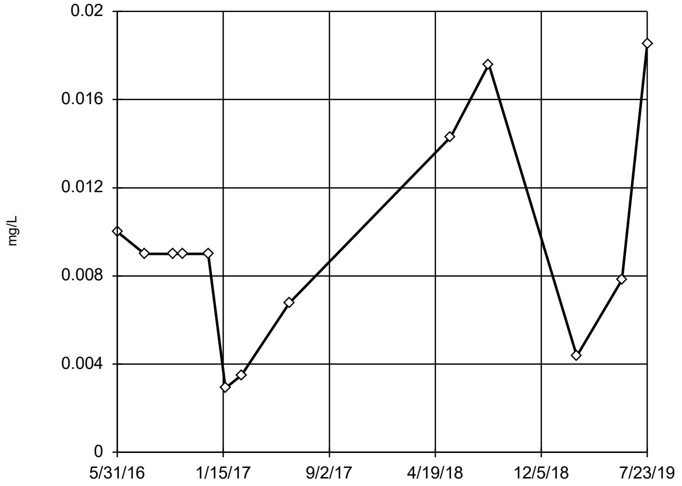
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04571, low cutoff = 0.0005016, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Tukey's Outlier Screening

AD-14



n = 13

No outliers found. Tukey's method selected by user.

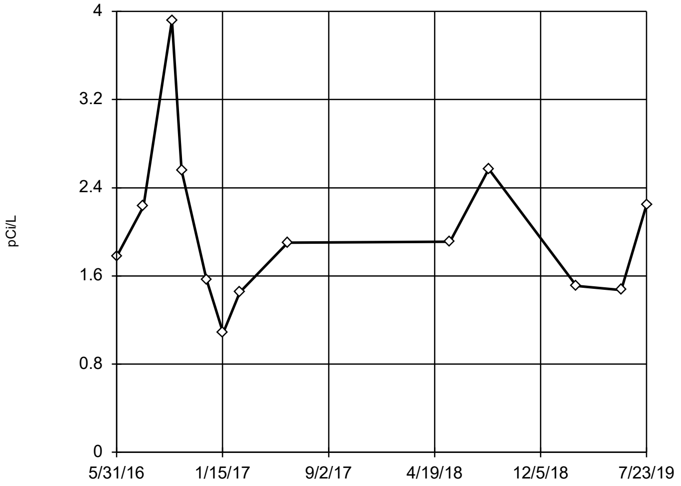
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05805, low cutoff = 0.000006095, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/20/2019 1:20 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Tukey's Outlier Screening

AD-11



n = 13

No outliers found. Tukey's method selected by user.

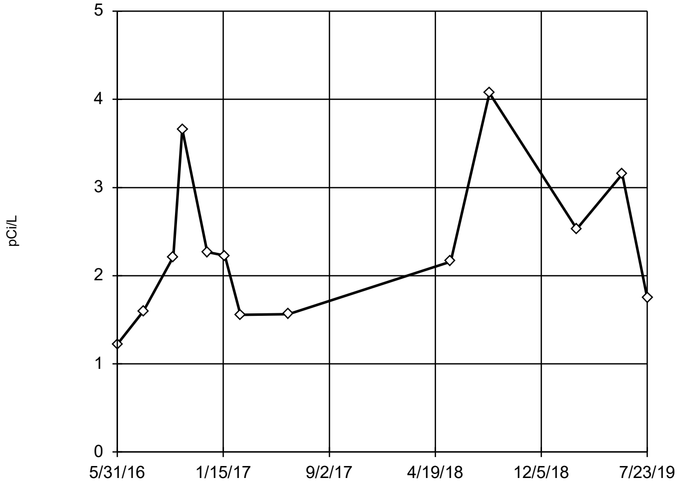
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 9.966, low cutoff = 0.3588, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:20 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Tukey's Outlier Screening

AD-13



n = 13

No outliers found. Tukey's method selected by user.

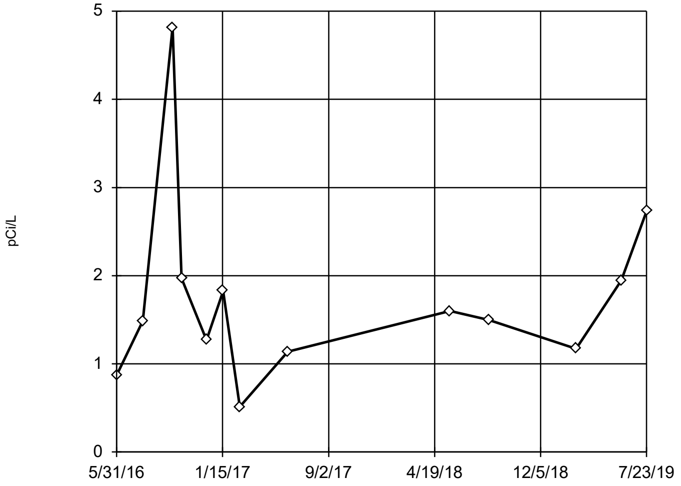
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 16.01, low cutoff = 0.279, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:20 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Tukey's Outlier Screening

AD-14



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).

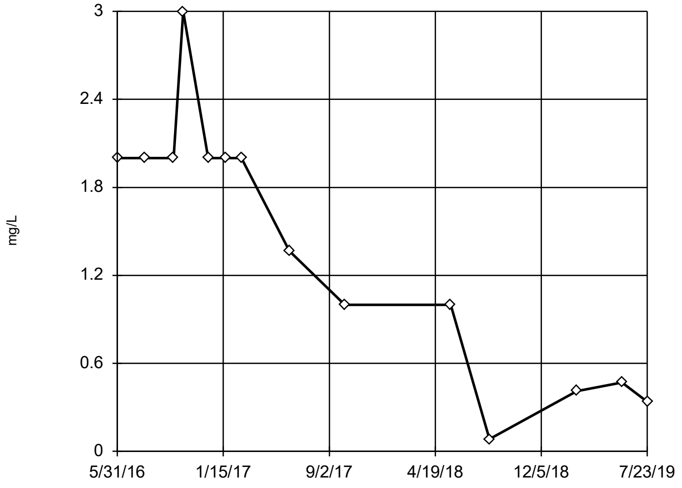
High cutoff = 9.585, low cutoff = 0.2358, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/20/2019 1:20 PM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-11



n = 14

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

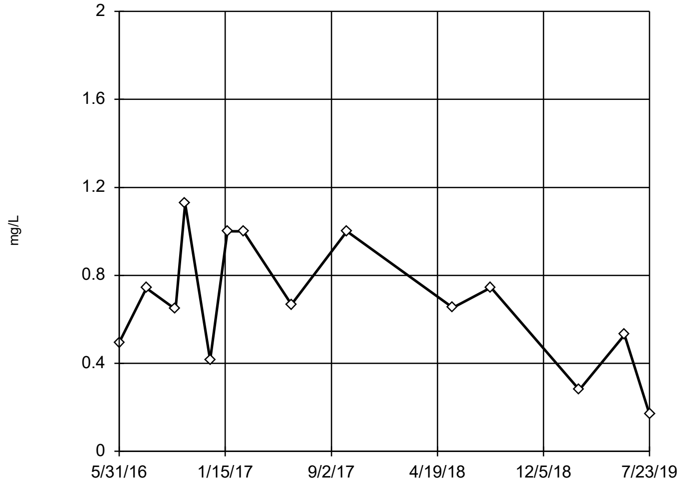
High cutoff = 6.68, low cutoff = -4.24, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



n = 14

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

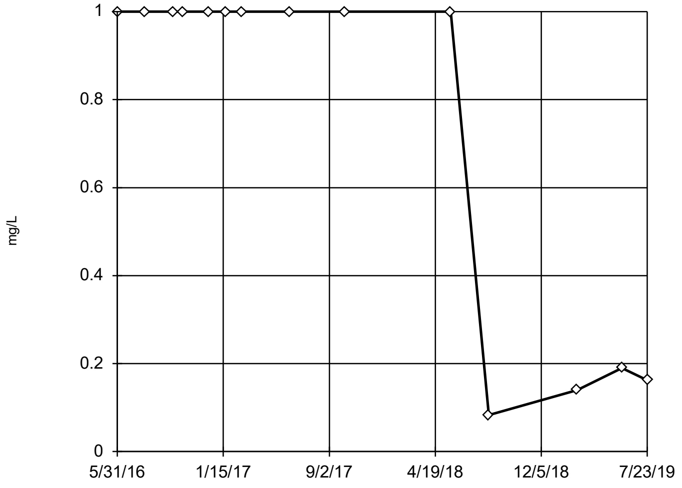
High cutoff = 2.635, low cutoff = -1.181, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

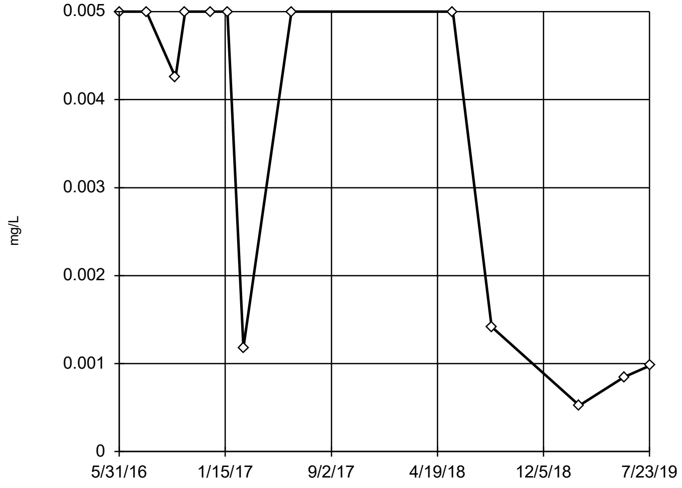
High cutoff = 185.2, low cutoff = 0.0009474, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-11



n = 13

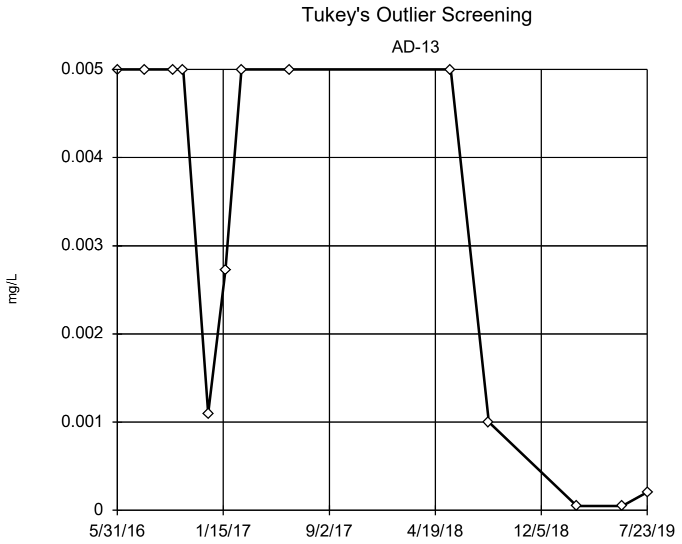
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.5038, low cutoff = 0.00001066, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 13

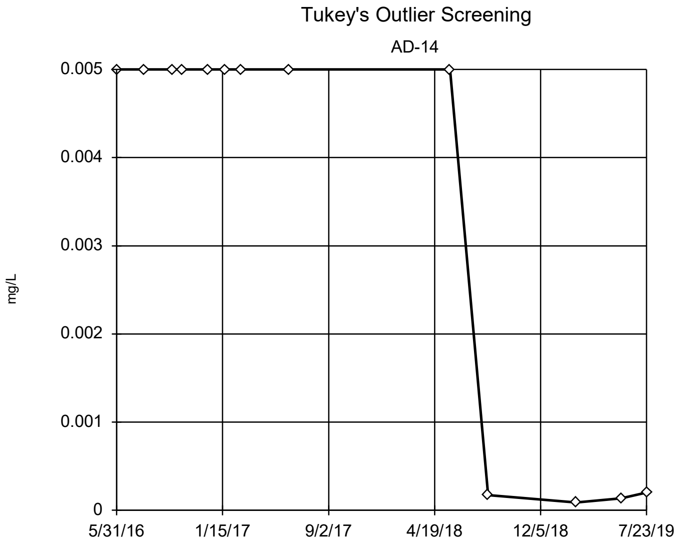
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04579, low cutoff = -0.01448, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 13

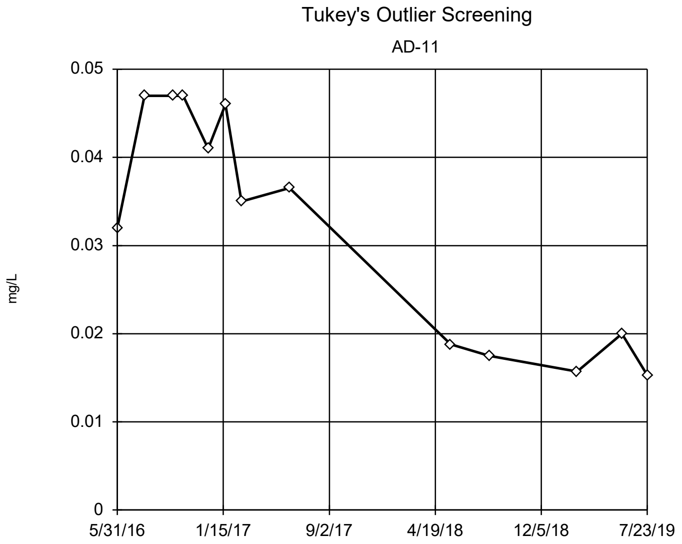
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 96.27, low cutoff = 9.7e-9, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/20/2019 1:20 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 13

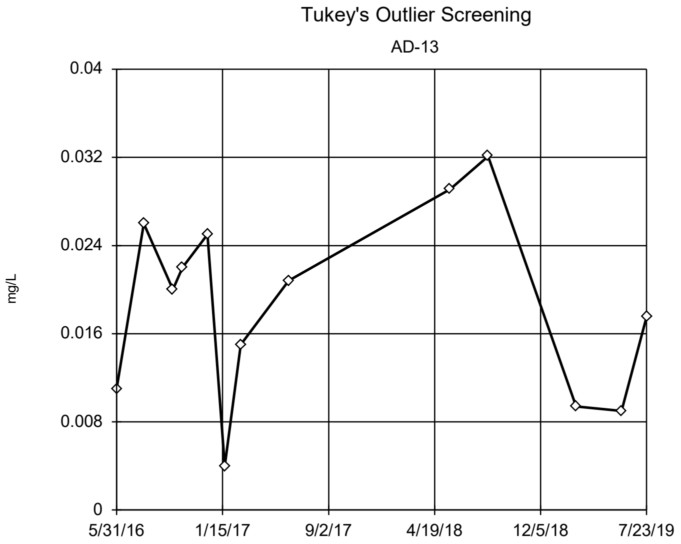
No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.1316, low cutoff = -0.0669, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

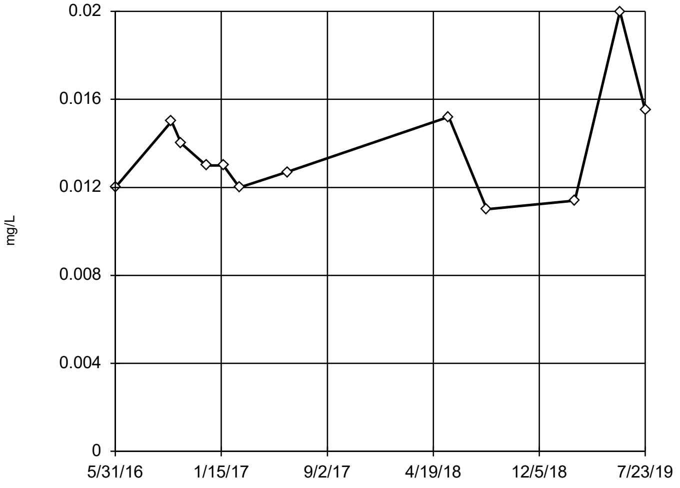
High cutoff = 0.0714, low cutoff = -0.0357, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

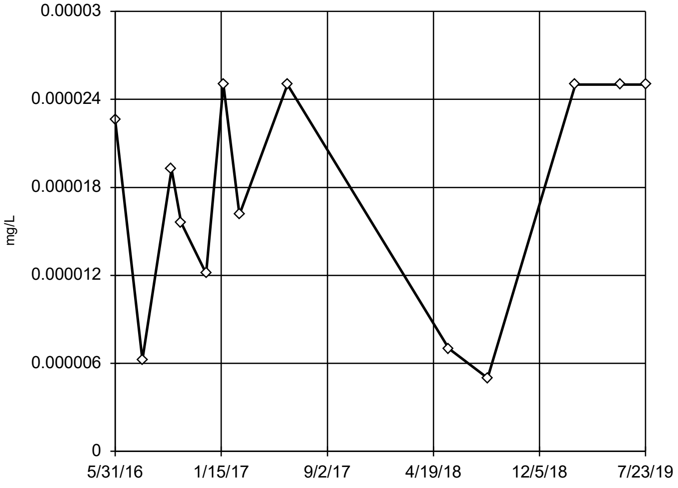
High cutoff = 0.03008, low cutoff = 0.006023, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-11



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

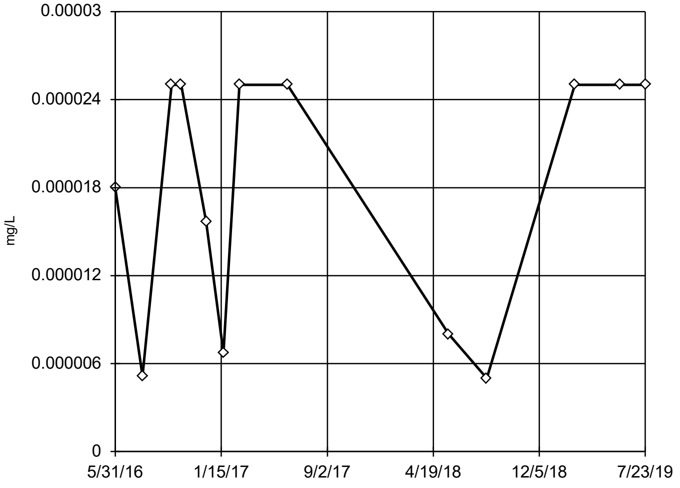
High cutoff = 0.00007132, low cutoff = -0.00003676, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

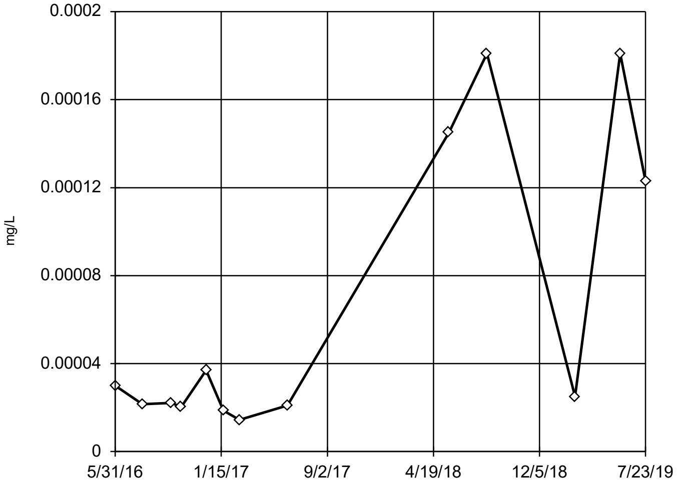
High cutoff = 0.0000779, low cutoff = -0.00004554, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

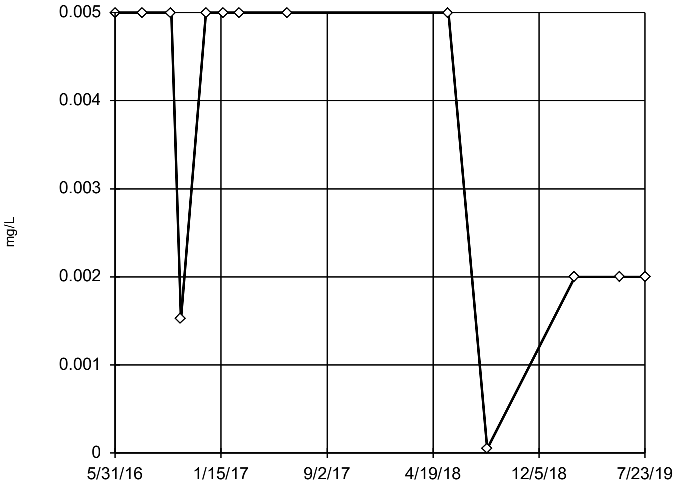
High cutoff = 0.0363, low cutoff = 7.6e-8, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-11



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

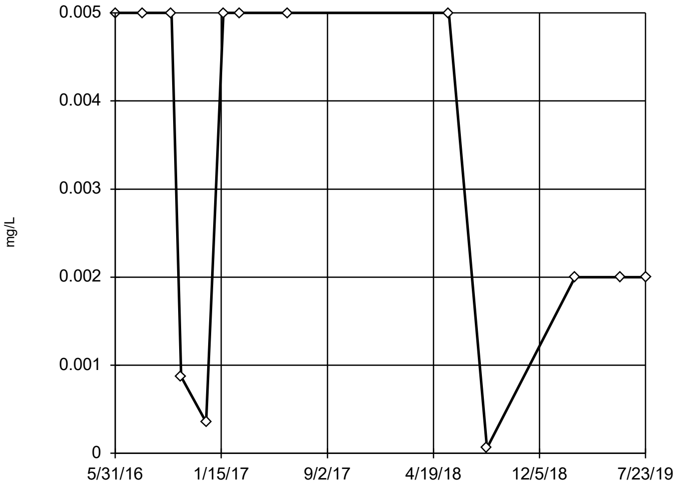
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Molybdenum, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

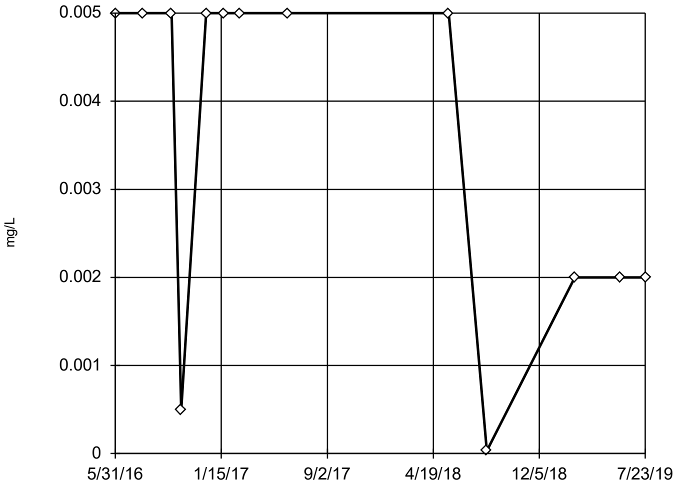
High cutoff = 0.02941, low cutoff = -0.004055, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



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).

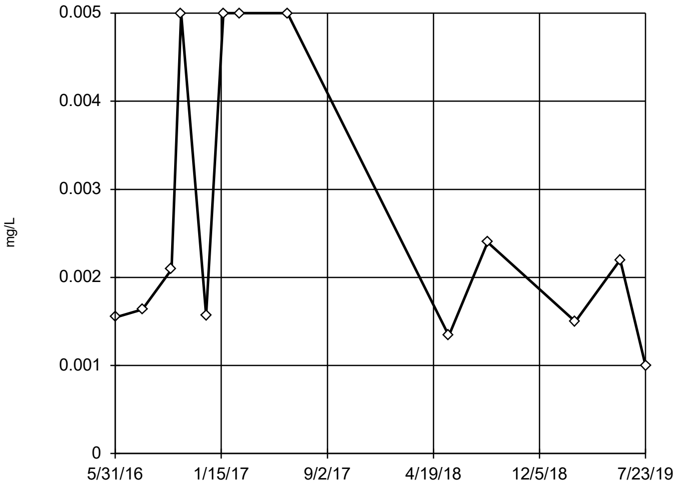
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Molybdenum, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

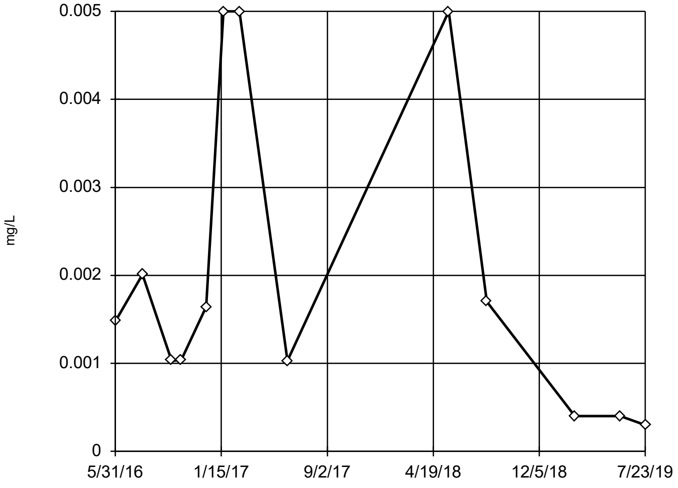
High cutoff = 0.1769, low cutoff = 0.00004305, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



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).

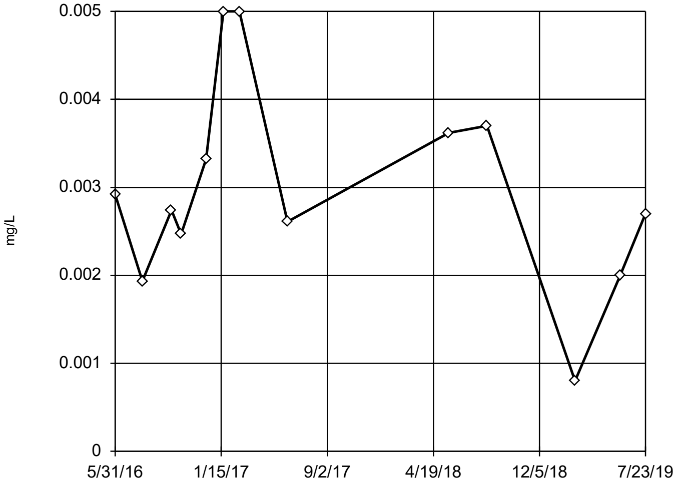
High cutoff = 0.3819, low cutoff = 0.000005328, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-14



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

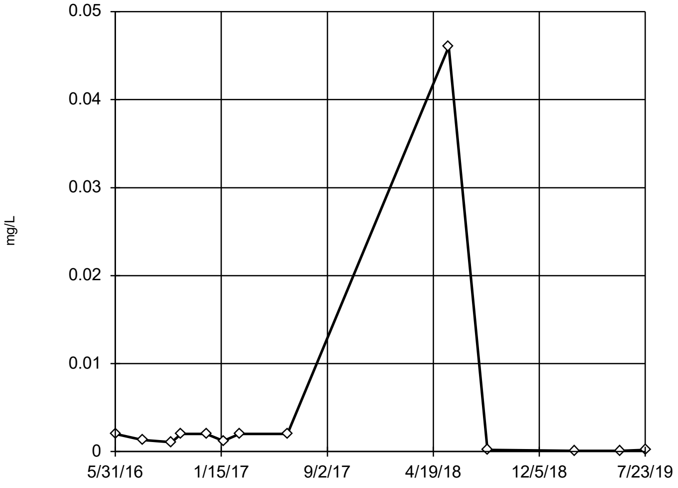
High cutoff = 0.007936, low cutoff = -0.002042, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-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).

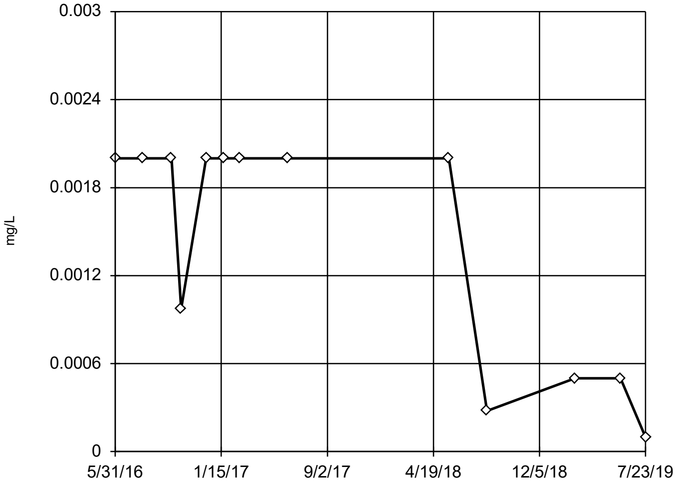
High cutoff = 2, low cutoff = 2.0e-7, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-13



n = 13

No outliers found. Tukey's method selected by user.

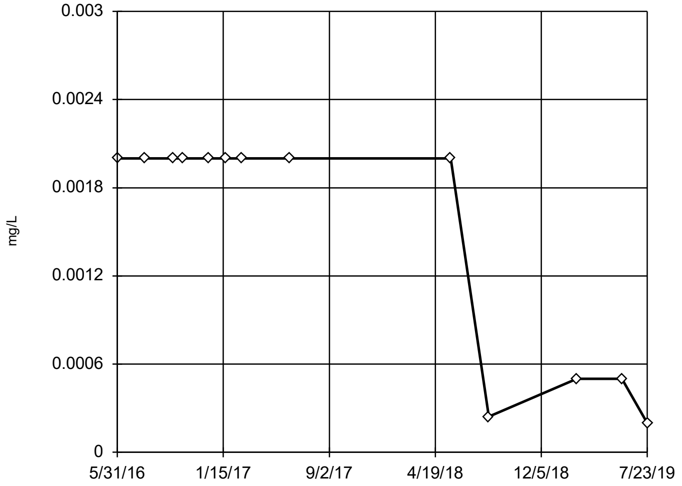
Data were cube root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Thallium, total Analysis Run 11/20/2019 1:21 PM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Tukey's Outlier Screening

AD-14



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 both the lower and upper quartiles represent reporting limits.

Constituent: Thallium, total   Analysis Run 11/20/2019 1:21 PM   View: Interwell AIV

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Mann-Whitney - Significant Results

Welsh LF   Client: Geosyntec   Data: Welsh LF   Printed 12/8/2019, 3:23 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Chloride, total (mg/L)	**AD-5 (bg)**	**2.589**	**Yes**	**Yes**	**Mann-W**
Sulfate, total (mg/L)	**AD-11**	**-2.633**	**Yes**	**Yes**	**Mann-W**

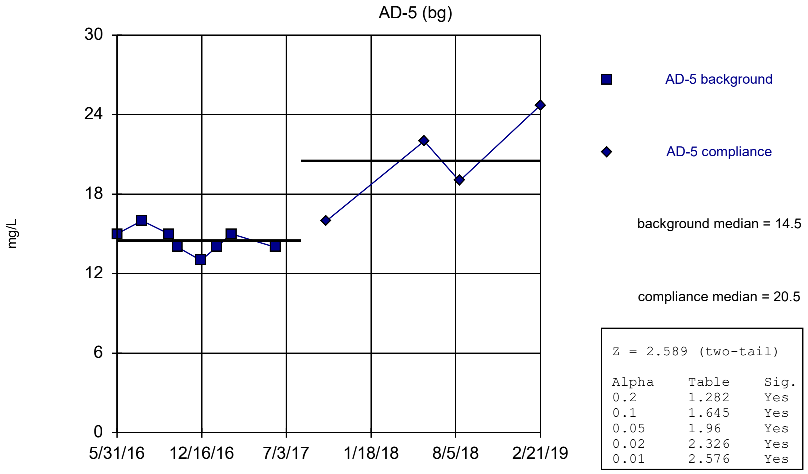
Mann-Whitney - All Results

Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/8/2019, 3:23 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Calcium, total (mg/L)	AD-5 (bg)	-2.123	No	No	Mann-W
Calcium, total (mg/L)	AD-11	-1.444	No	No	Mann-W
Calcium, total (mg/L)	AD-13	1.104	No	No	Mann-W
Calcium, total (mg/L)	AD-14	1.021	No	No	Mann-W
Calcium, total (mg/L)	AD-1 (bg)	-1.274	No	No	Mann-W
Calcium, total (mg/L)	AD-17 (bg)	-0.9358	No	No	Mann-W
Chloride, total (mg/L)	**AD-5 (bg)**	**2.589**	**Yes**	**Yes**	**Mann-W**
Chloride, total (mg/L)	AD-11	-0.1073	No	No	Mann-W
Chloride, total (mg/L)	AD-13	-0.7194	No	No	Mann-W
Chloride, total (mg/L)	AD-14	1.306	No	No	Mann-W
Chloride, total (mg/L)	AD-1 (bg)	-1.051	No	No	Mann-W
Chloride, total (mg/L)	AD-17 (bg)	1.366	No	No	Mann-W
Sulfate, total (mg/L)	AD-5 (bg)	-1.531	No	No	Mann-W
Sulfate, total (mg/L)	**AD-11**	**-2.633**	**Yes**	**Yes**	**Mann-W**
Sulfate, total (mg/L)	AD-13	1.444	No	No	Mann-W
Sulfate, total (mg/L)	AD-14	0.9207	No	No	Mann-W
Sulfate, total (mg/L)	AD-1 (bg)	0.6866	No	No	Mann-W
Sulfate, total (mg/L)	AD-17 (bg)	-0.08507	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-5 (bg)	-1.953	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-11	-2.123	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-13	0.5944	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-14	0.7144	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-1 (bg)	-1.786	No	No	Mann-W
Total Dissolved Solids (mg/L)	AD-17 (bg)	0.9341	No	No	Mann-W

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)



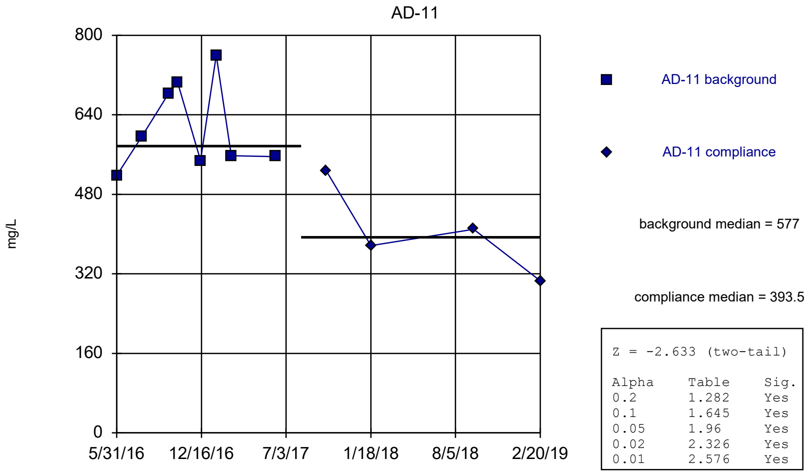
```
Z = 2.589 (two-tail)

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: Chloride, total Analysis Run 12/8/2019 3:10 PM View: Mann Whitney
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)



```
Z = -2.633 (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: Sulfate, total Analysis Run 12/8/2019 3:10 PM View: Mann Whitney
Welsh LF Client: Geosyntec Data: Welsh LF

Intrawell Prediction Limit Summary

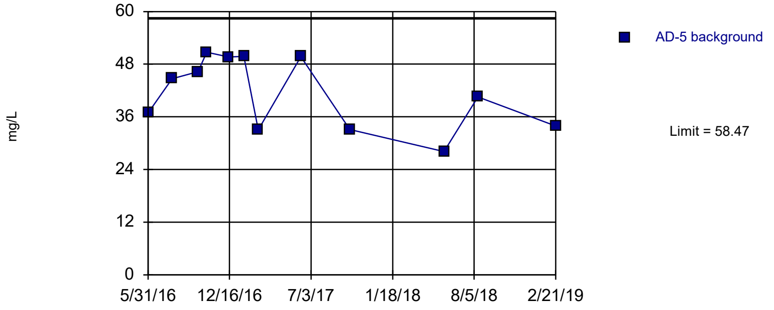
Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/8/2019, 3:34 PM

Constituent	Well	Upper Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-5	58.47	n/a	12	41.36	8.1	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-11	17.13	n/a	12	3.021	0.5295	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-13	28.43	n/a	12	2.755	1.22	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-14	12.23	n/a	12	5.119	3.367	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-1	206	n/a	12	3.196	1.283	0	None	x^(1/3)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	206.7	n/a	12	193.3	6.384	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-5	24.25	n/a	12	4.039	0.4191	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-11	14.32	n/a	11	3.256	0.2425	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-13	24	n/a	11	13.72	4.724	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-14	11.47	n/a	12	5.636	2.764	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-1	9	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Chloride, total (mg/L)	AD-17	45.62	n/a	12	35.02	5.02	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-5	318.3	n/a	12	154	77.83	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-11	829.3	n/a	12	545.4	134.4	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-13	421.9	n/a	12	228.4	91.62	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-14	188.9	n/a	11	4.854	0.4062	0	None	x^(1/3)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-1	70.37	n/a	12	3.801	0.2145	0	None	ln(x)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	1445	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Total Dissolved Solids (mg/L)	AD-5	542	n/a	12	351.4	90.26	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-11	1326	n/a	12	831.9	233.8	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-13	880.8	n/a	12	493.9	183.2	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-14	369.2	n/a	11	273.3	44.1	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	AD-1	612	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Total Dissolved Solids (mg/L)	AD-17	1872	n/a	12	1664	98.5	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



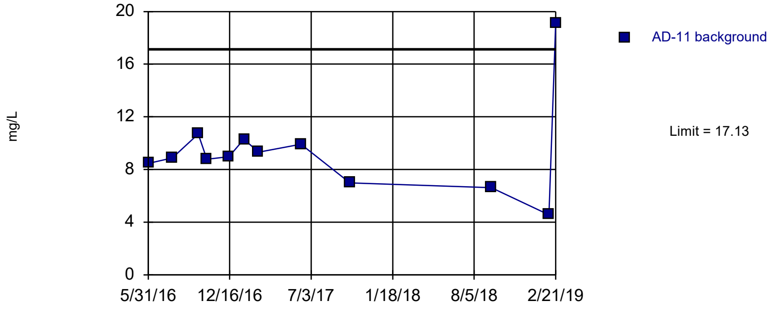
Background Data Summary: Mean=41.36, Std. Dev.=8.1, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8897, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-11



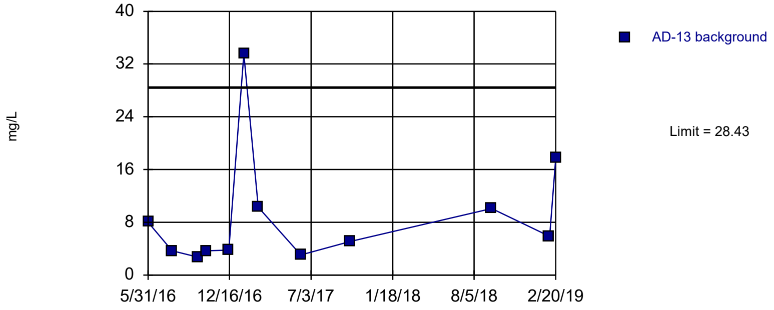
Background Data Summary (based on square root transformation): Mean=3.021, Std. Dev.=0.5295, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.868, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-13



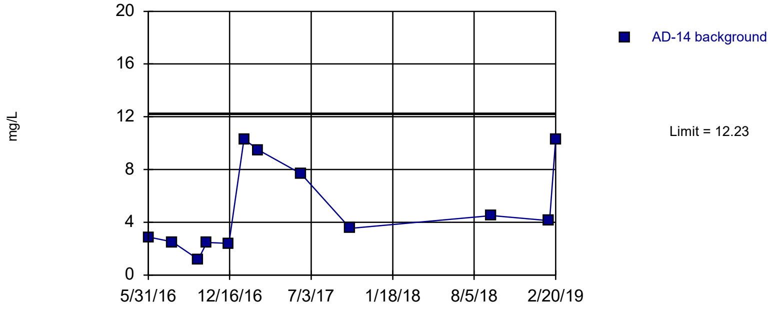
Background Data Summary (based on square root transformation): Mean=2.755, Std. Dev.=1.22, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8264, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-14



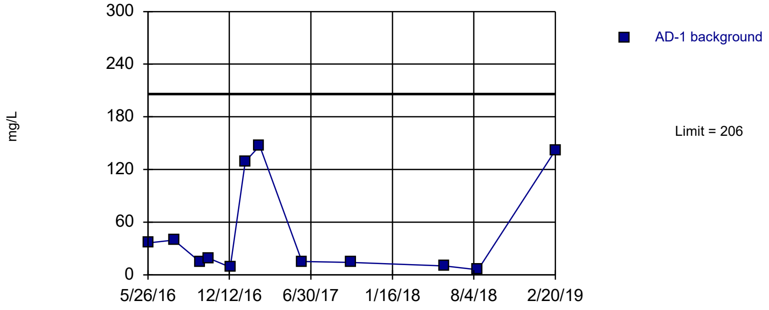
Background Data Summary: Mean=5.119, Std. Dev.=3.367, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8416, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



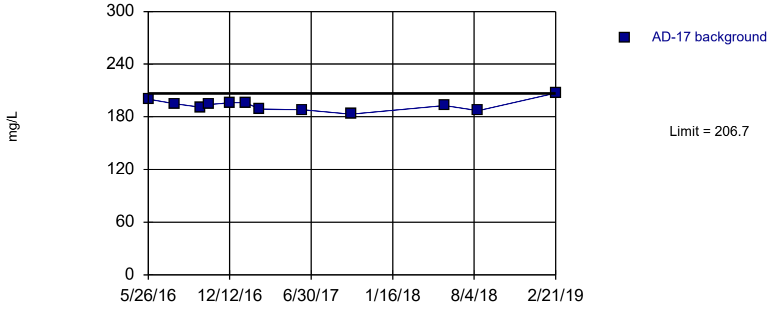
Background Data Summary (based on cube root transformation): Mean=3.196, Std. Dev.=1.283, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8246, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



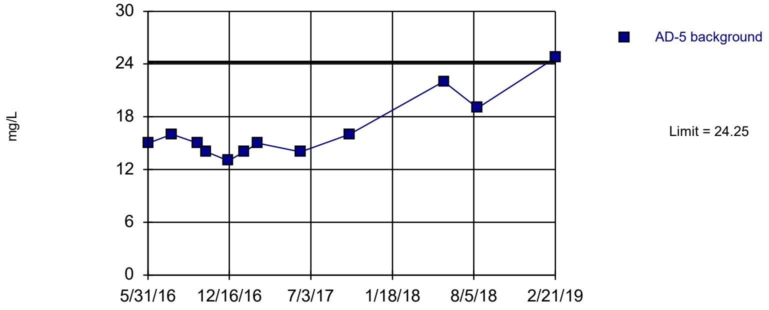
Background Data Summary: Mean=193.3, Std. Dev.=6.384, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9698, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



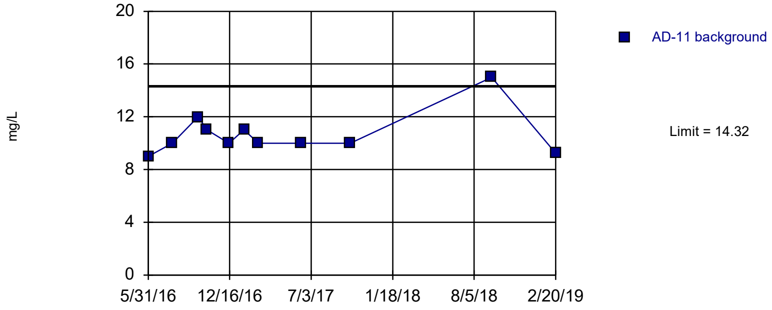
Background Data Summary (based on square root transformation): Mean=4.039, Std. Dev.=0.4191, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8217, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-11



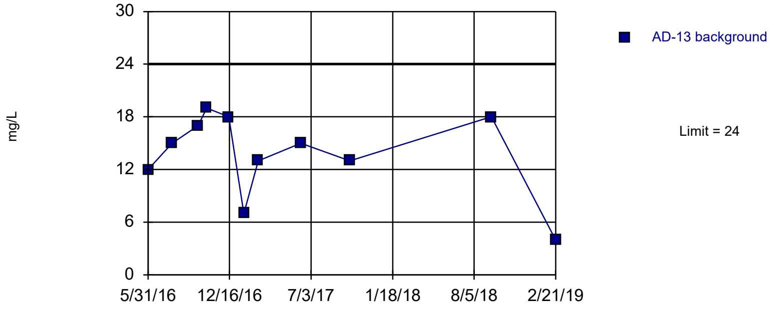
Background Data Summary (based on square root transformation): Mean=3.256, Std. Dev.=0.2425, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8026, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-13



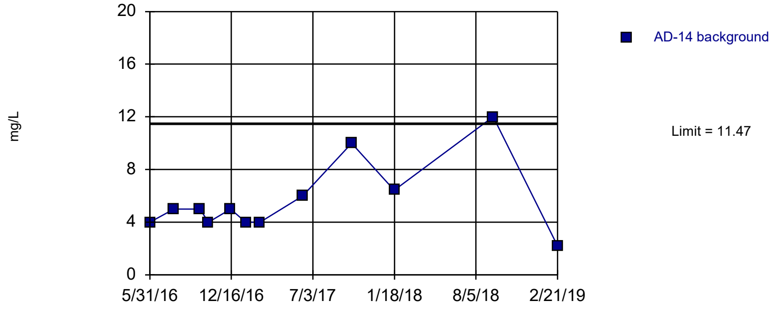
Background Data Summary: Mean=13.72, Std. Dev.=4.724, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8963, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-14



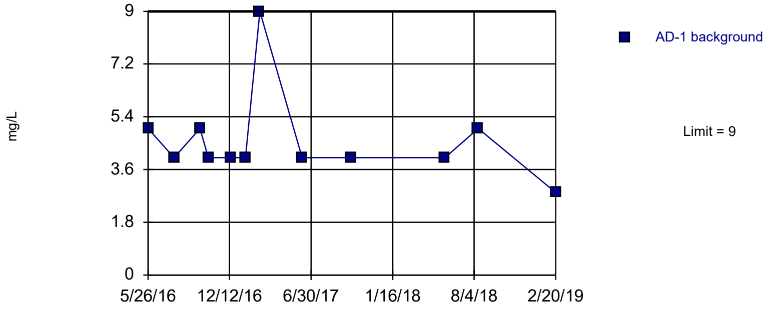
Background Data Summary: Mean=5.636, Std. Dev.=2.764, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8278, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



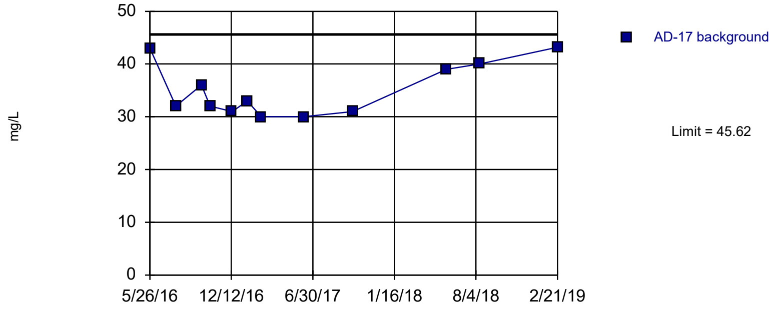
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)

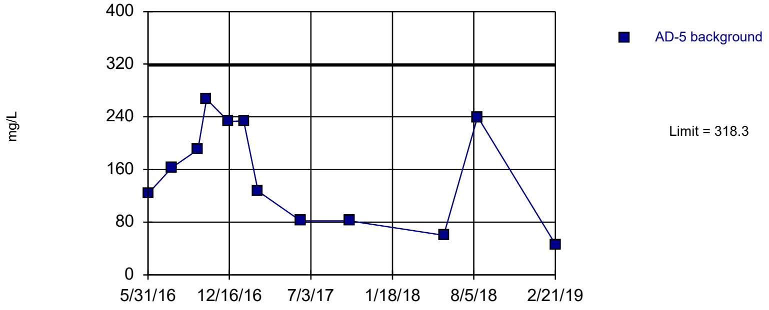


Background Data Summary: Mean=35.02, Std. Dev.=5.02, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8477, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Prediction Limit

Intrawell Parametric, AD-5 (bg)

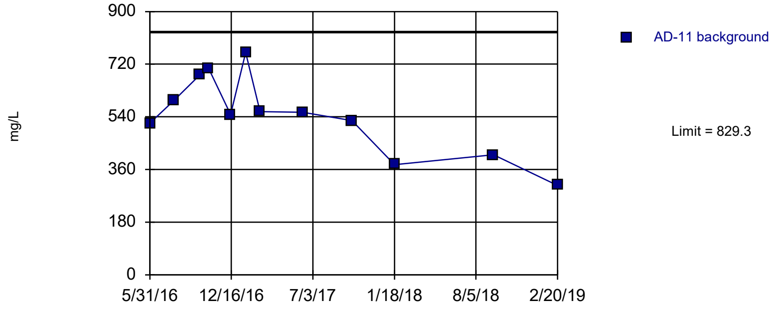


Background Data Summary: Mean=154, Std. Dev.=77.83, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.919, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Prediction Limit

Intrawell Parametric, AD-11

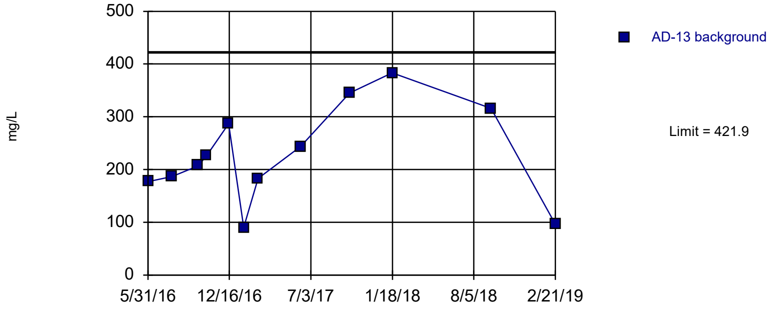


Background Data Summary: Mean=545.4, Std. Dev.=134.4, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9632, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Prediction Limit

Intrawell Parametric, AD-13

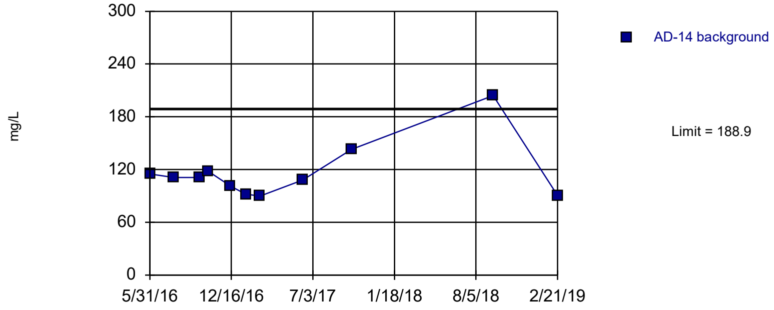


Background Data Summary: Mean=228.4, Std. Dev.=91.62, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9622, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Prediction Limit

Intrawell Parametric, AD-14



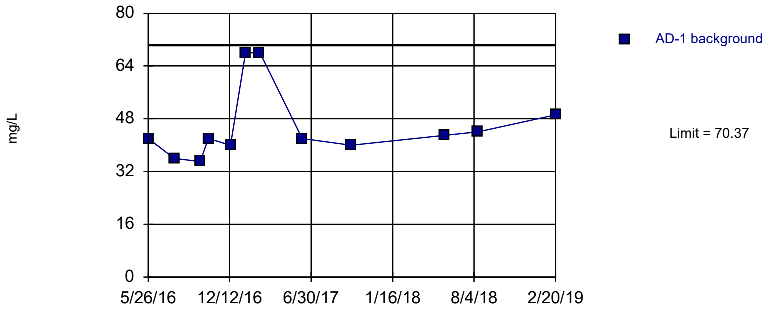
Background Data Summary (based on cube root transformation): Mean=4.854, Std. Dev.=0.4062, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8065, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-1 (bg)



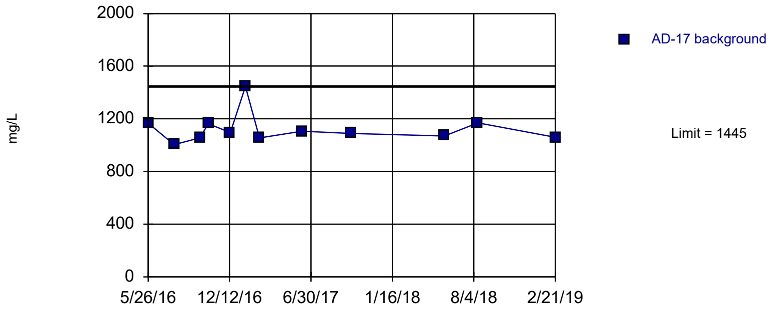
Background Data Summary (based on natural log transformation): Mean=3.801, Std. Dev.=0.2145, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.812, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-17 (bg)



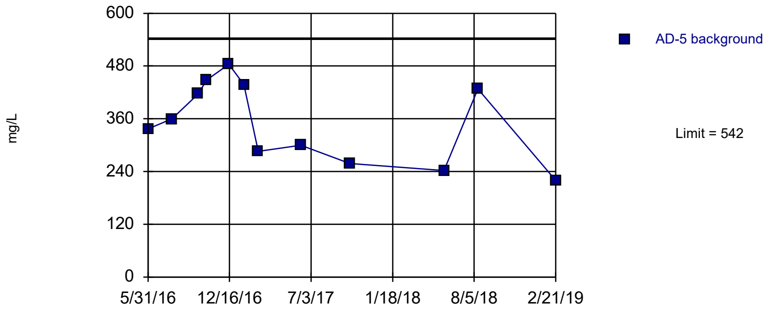
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-5 (bg)



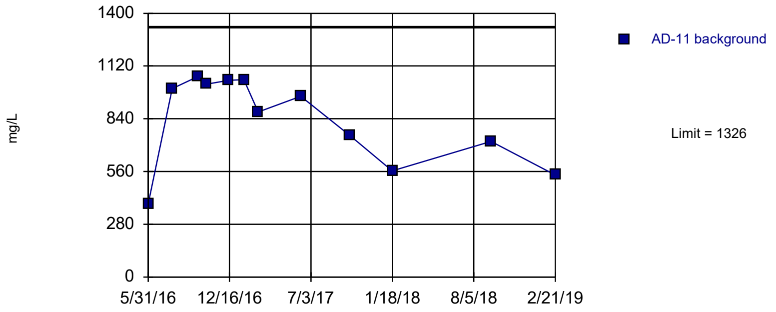
Background Data Summary: Mean=351.4, Std. Dev.=90.26, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9333, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-11



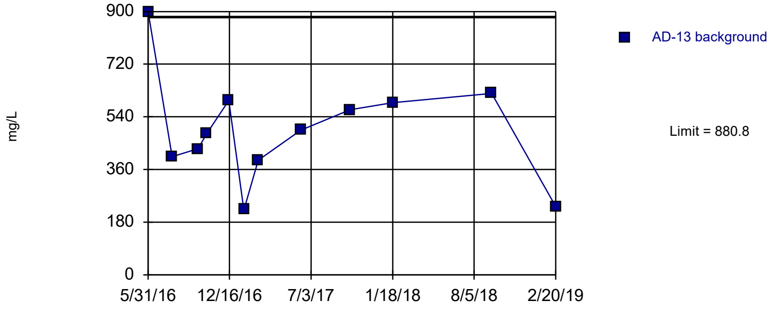
Background Data Summary: Mean=831.9, Std. Dev.=233.8, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8746, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-13



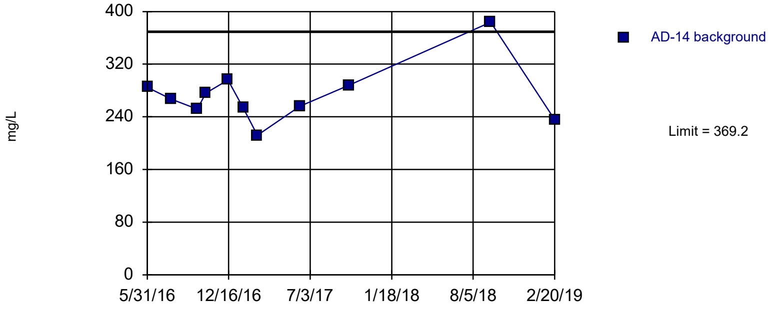
Background Data Summary: Mean=493.9, Std. Dev.=183.2, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9408, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-14



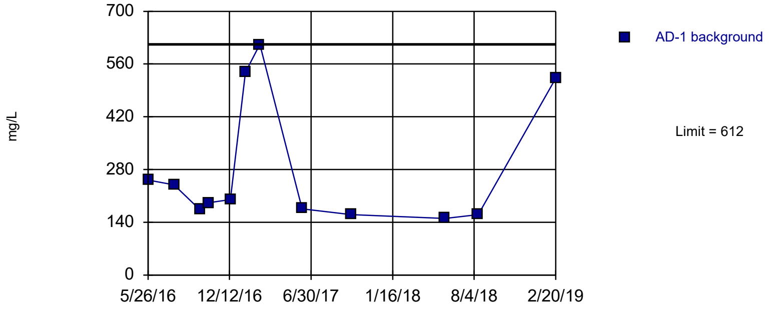
Background Data Summary: Mean=273.3, Std. Dev.=44.1, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8716, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-1 (bg)



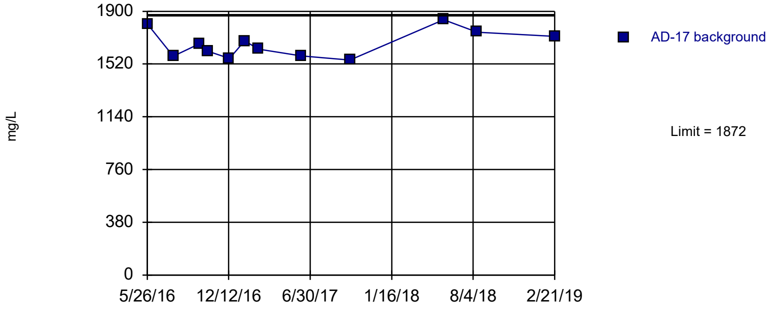
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17 (bg)



Background Data Summary: Mean=1664, Std. Dev.=98.5, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9253, 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 Analysis Run 12/8/2019 3:31 PM View: PL's - Intrawell
Welsh LF Client: Geosyntec Data: Welsh LF

Trend Test Summary Table - All Results (No Significant)

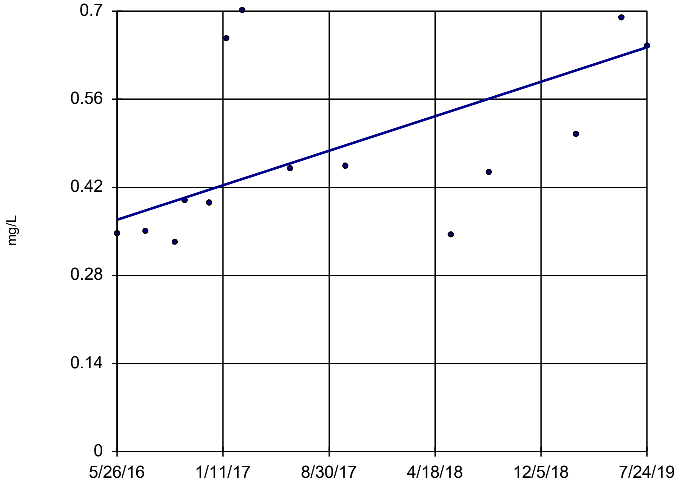
Welsh Landfill Client: Geosyntec Data: Welsh LF Printed 11/22/2019, 4:51 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-1 (bg)	0.08662	41	48	No	14	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-17 (bg)	0.01085	21	48	No	14	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-5 (bg)	0	3	48	No	14	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-1 (bg)	0	-34	-48	No	14	78.57	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-17 (bg)	0	0	48	No	14	50	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-5 (bg)	0	-17	-48	No	14	64.29	n/a	n/a	0.01	NP
pH, field (SU)	AD-1 (bg)	0.01649	4	48	No	14	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-17 (bg)	-0.05848	-9	-48	No	14	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-5 (bg)	0.07449	23	48	No	14	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-1 (bg)



n = 14

Slope = 0.08662
units per year.

Mann-Kendall
statistic = 41
critical = 48

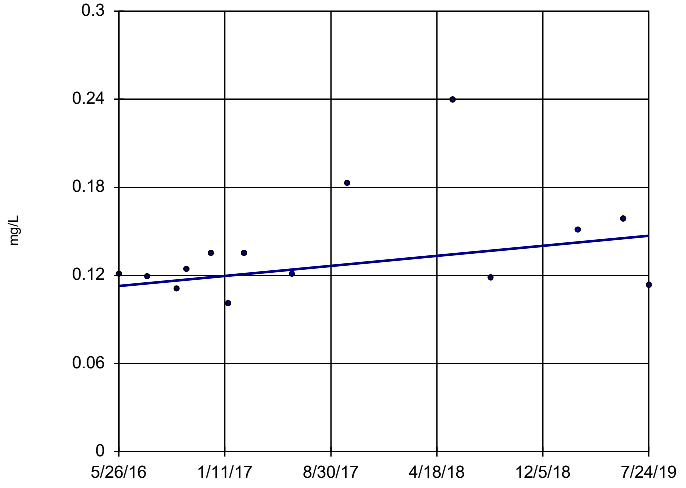
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 11/22/2019 4:51 PM   View: Interwell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-17 (bg)



n = 14

Slope = 0.01085
units per year.

Mann-Kendall
statistic = 21
critical = 48

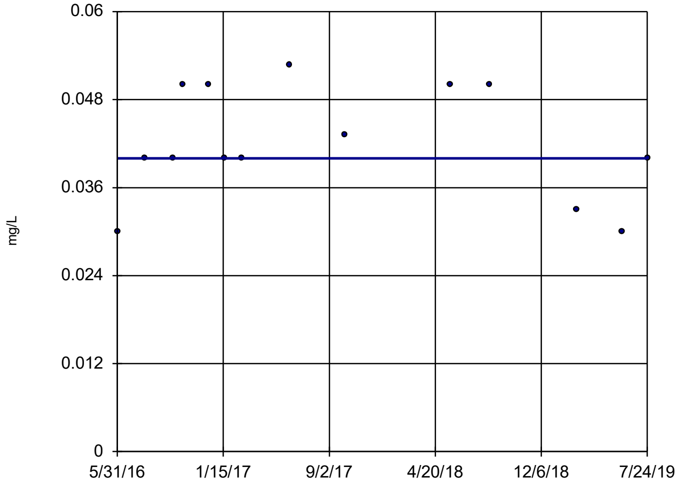
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 11/22/2019 4:51 PM   View: Interwell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-5 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = 3
critical = 48

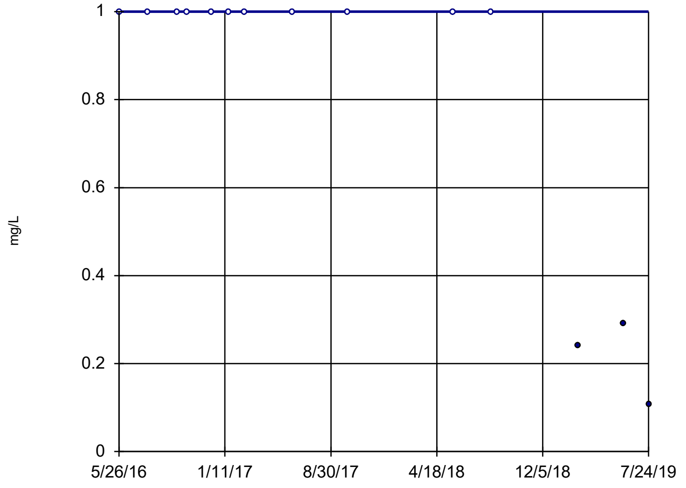
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 11/22/2019 4:51 PM   View: Interwell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-1 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = -34
critical = -48

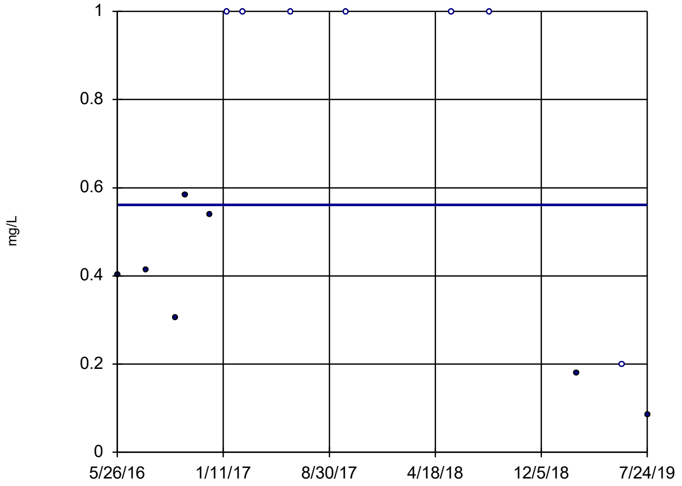
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total   Analysis Run 11/22/2019 4:51 PM   View: Interwell AIII
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-17 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 48

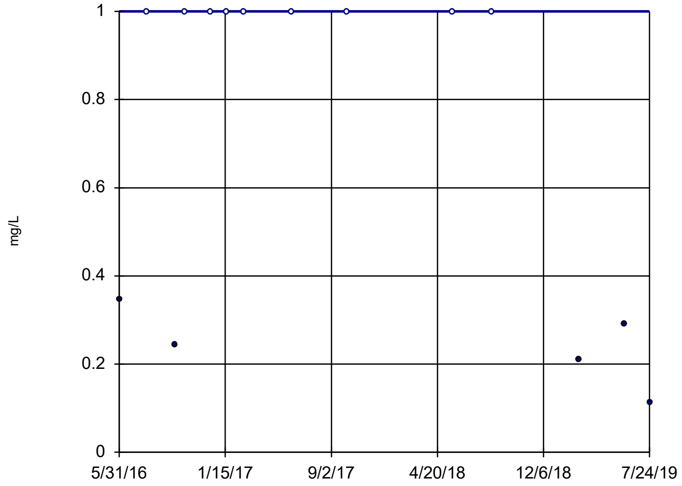
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 11/22/2019 4:51 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-5 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = -17
critical = -48

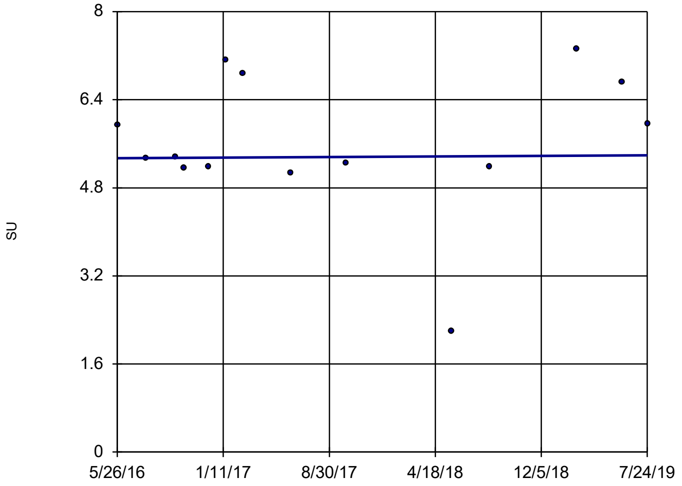
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 11/22/2019 4:51 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-1 (bg)



n = 14

Slope = 0.01649
units per year.

Mann-Kendall
statistic = 4
critical = 48

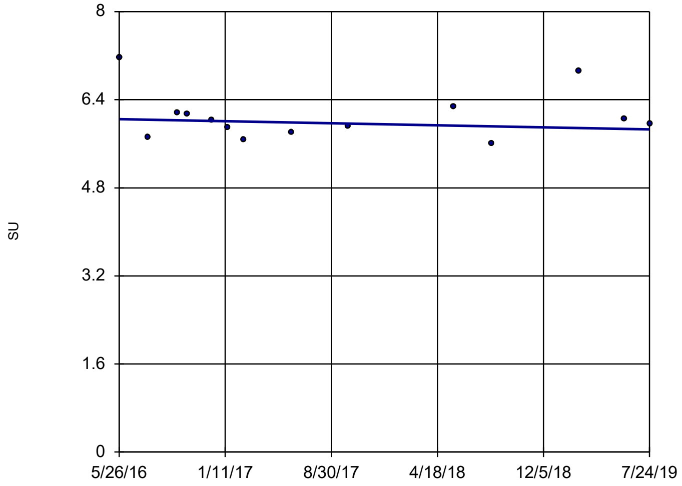
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 11/22/2019 4:51 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-17 (bg)



n = 14

Slope = -0.05848
units per year.

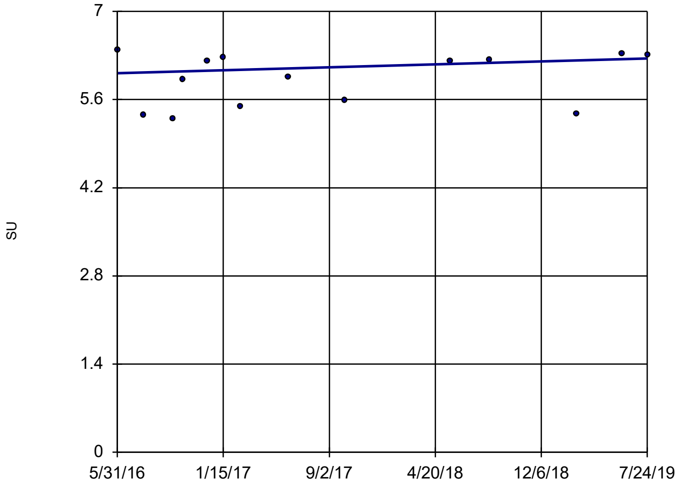
Mann-Kendall
statistic = -9
critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 11/22/2019 4:51 PM View: Interwell AIII
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sen's Slope Estimator

AD-5 (bg)



n = 14

Slope = 0.07449
units per year.

Mann-Kendall
statistic = 23
critical = 48

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: pH, field   Analysis Run 11/22/2019 4:51 PM   View: Interwell AIII

Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Interwell Prediction Limit Summary

Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/8/2019, 3:44 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	0.7	n/a	n/a	36	n/a	n/a	0	n/a	n/a	0.001409	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	n/a	0.583	n/a	n/a	42	n/a	n/a	64.29	n/a	n/a	0.001066	NP Inter (NDs) 1 of 2
pH, field (SU)	n/a	7.109	4.327	n/a	36	34.63	9.009	0	None	x^2	0.001253	Param Inter 1 of 2

Tolerance Limit Summary Table

Welsh LF Client: Geosyntec Data: Welsh LF Printed 12/5/2019, 12:30 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.00317	39	n/a	n/a	71.79	n/a	n/a	0.1353	NP Inter(normality)
Arsenic, total (mg/L)	n/a	0.005	39	n/a	n/a	48.72	n/a	n/a	0.1353	NP Inter(normality)
Barium, total (mg/L)	n/a	0.6226	39	-2.778	1.08	0	None	ln(x)	0.05	Inter
Beryllium, total (mg/L)	n/a	0.0007877	39	0.0565	0.0168	10.26	None	x^(1/3)	0.05	Inter
Cadmium, total (mg/L)	n/a	0.00646	39	n/a	n/a	30.77	n/a	n/a	0.1353	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.004	38	n/a	n/a	23.68	n/a	n/a	0.1424	NP Inter(normality)
Cobalt, total (mg/L)	n/a	0.0748	39	n/a	n/a	0	n/a	n/a	0.1353	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	4.113	39	2.091	0.9476	0	None	No	0.05	Inter
Fluoride, total (mg/L)	n/a	0.583	42	n/a	n/a	64.29	n/a	n/a	0.116	NP Inter(normality)
Lead, total (mg/L)	n/a	0.003384	39	n/a	n/a	69.23	n/a	n/a	0.1353	NP Inter(normality)
Lithium, total (mg/L)	n/a	0.394	39	n/a	n/a	2.564	n/a	n/a	0.1353	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000033	39	n/a	n/a	53.85	n/a	n/a	0.1353	NP Inter(normality)
Molybdenum, total (mg/L)	n/a	0.00243	39	n/a	n/a	69.23	n/a	n/a	0.1353	NP Inter(normality)
Selenium, total (mg/L)	n/a	0.005	39	n/a	n/a	41.03	n/a	n/a	0.1353	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.001251	39	n/a	n/a	87.18	n/a	n/a	0.1353	NP Inter(NDs)

Confidence Interval Summary Table - All Results (No Significant)

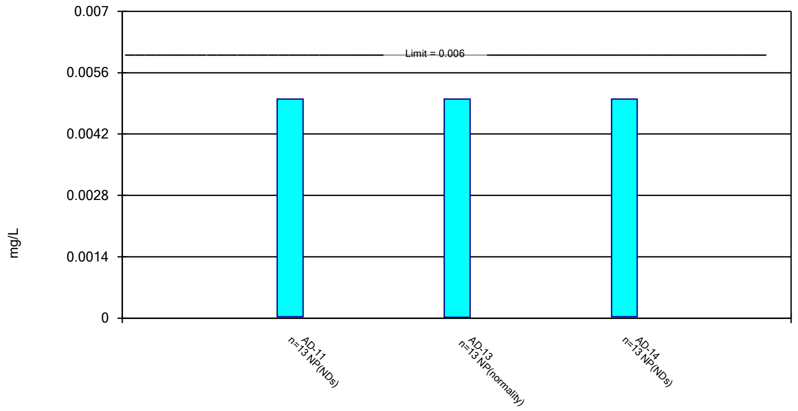
Welsh Landfill   Client: Geosyntec   Data: Welsh LF   Printed 11/25/2019, 9:47 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-11	0.005	0.00003	0.006	No	13	84.62	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-13	0.005	0.00002	0.006	No	13	61.54	No	0.01	NP (normality)
Antimony, total (mg/L)	AD-14	0.005	0.00003	0.006	No	13	76.92	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-11	0.005	0.00059	0.01	No	13	46.15	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-13	0.006	0.00037	0.01	No	13	53.85	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-14	0.005	0.00039	0.01	No	13	53.85	No	0.01	NP (normality)
Barium, total (mg/L)	AD-11	0.0403	0.0119	2	No	13	0	No	0.01	NP (normality)
Barium, total (mg/L)	AD-13	0.05991	0.02574	2	No	13	0	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-14	0.04972	0.03072	2	No	13	0	x^(1/3)	0.01	Param.
Beryllium, total (mg/L)	AD-11	0.005	0.00089	0.004	No	13	0	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-13	0.0009026	0.000488	0.004	No	13	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-14	0.0007186	0.0003981	0.004	No	13	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-11	0.0004523	0.000264	0.0065	No	13	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-13	0.0005	0.00007	0.0065	No	13	30.77	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-14	0.00152	0.0005231	0.0065	No	13	0	No	0.01	Param.
Chromium, total (mg/L)	AD-11	0.001255	0.000329	0.1	No	12	0	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-13	0.0007718	0.000283	0.1	No	12	25	No	0.01	NP (normality)
Chromium, total (mg/L)	AD-14	0.001025	0.000423	0.1	No	13	15.38	No	0.01	Param.
Cobalt, total (mg/L)	AD-11	0.0259	0.01533	0.075	No	13	0	x^2	0.01	Param.
Cobalt, total (mg/L)	AD-13	0.007241	0.003164	0.075	No	13	0	sqrt(x)	0.01	Param.
Cobalt, total (mg/L)	AD-14	0.013	0.005734	0.075	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-11	2.556	1.474	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-13	2.944	1.668	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-14	2.395	1.022	5	No	13	0	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-11	2	0.338	4	No	13	23.08	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-13	0.964	0.4729	4	No	14	21.43	No	0.01	Param.
Fluoride, total (mg/L)	AD-14	1	0.162	4	No	14	78.57	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-11	0.005	0.000847	0.015	No	13	53.85	No	0.01	NP (normality)
Lead, total (mg/L)	AD-13	0.005	0.000204	0.015	No	13	53.85	No	0.01	NP (normality)
Lead, total (mg/L)	AD-14	0.005	0.000137	0.015	No	13	69.23	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-11	0.047	0.0157	0.39	No	13	0	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-13	0.02486	0.01221	0.39	No	13	0	No	0.01	Param.
Lithium, total (mg/L)	AD-14	0.01567	0.01179	0.39	No	12	0	No	0.01	Param.
Mercury, total (mg/L)	AD-11	0.000025	0.00000624	0.002	No	13	46.15	No	0.01	NP (normality)
Mercury, total (mg/L)	AD-13	0.000025	0.00000515	0.002	No	13	61.54	No	0.01	NP (normality)
Mercury, total (mg/L)	AD-14	0.000145	0.00001863	0.002	No	13	7.692	No	0.01	NP (normality)
Molybdenum, total (mg/L)	AD-11	0.005	0.001519	0.1	No	13	84.62	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-13	0.005	0.0003533	0.1	No	13	76.92	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-14	0.005	0.000497	0.1	No	13	84.62	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-11	0.005	0.00134	0.05	No	13	30.77	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-13	0.005	0.0004	0.05	No	13	23.08	No	0.01	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-14	0.004072	0.002084	0.05	No	13	15.38	No	0.01	Param.
Thallium, total (mg/L)	AD-11	0.002	0.0001	0.002	No	12	41.67	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-13	0.002	0.000277	0.002	No	13	76.92	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-14	0.002	0.000242	0.002	No	13	84.62	No	0.01	NP (NDs)

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

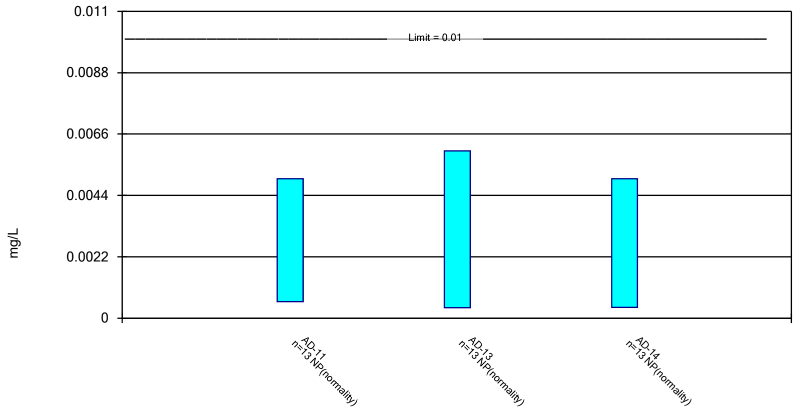


Constituent: Antimony, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

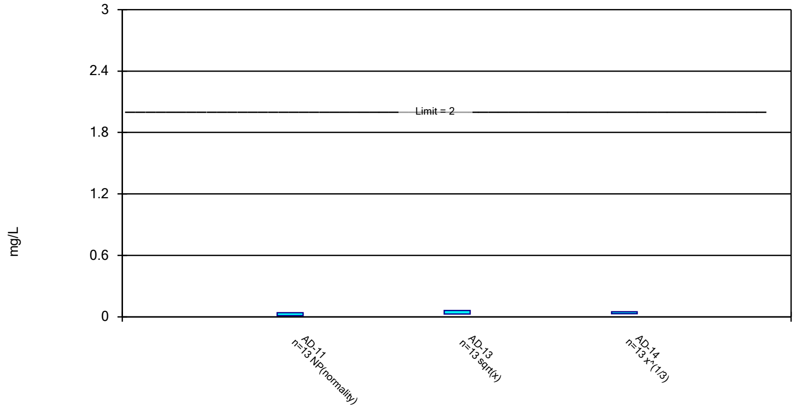


Constituent: Arsenic, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

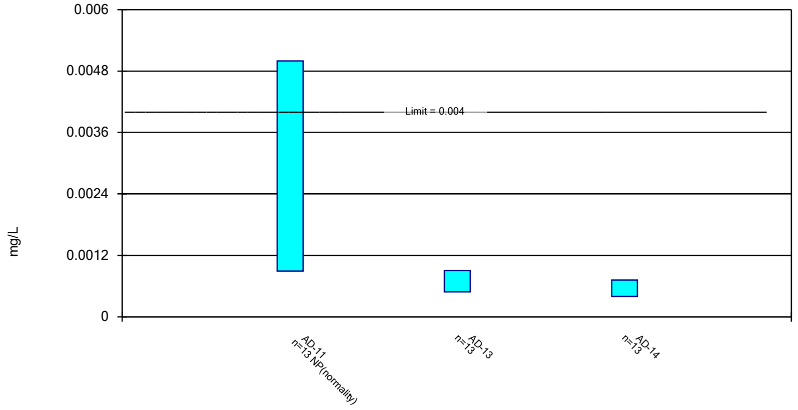


Constituent: Barium, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

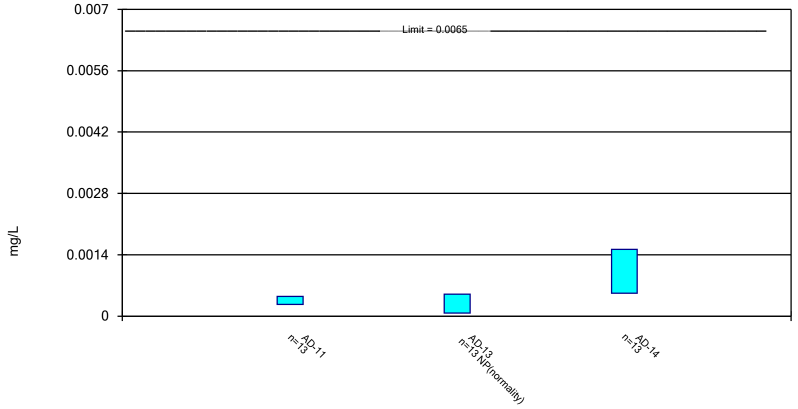


Constituent: Beryllium, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

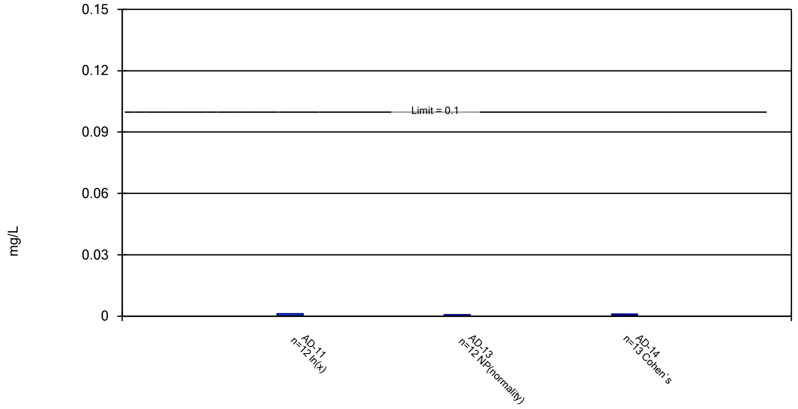


Constituent: Cadmium, total Analysis Run 11/25/2019 9:45 AM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

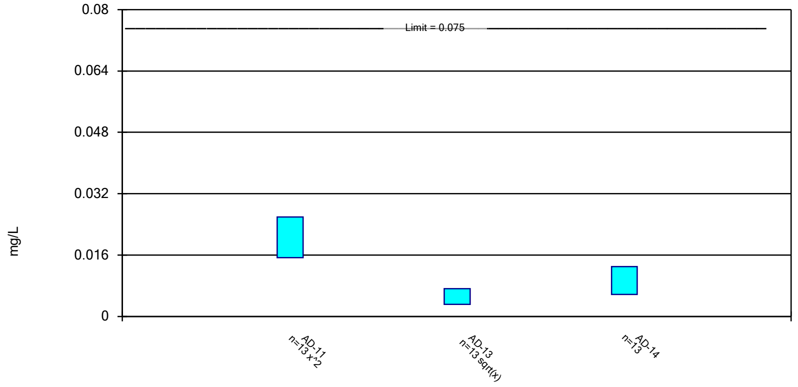


Constituent: Chromium, total Analysis Run 11/25/2019 9:45 AM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

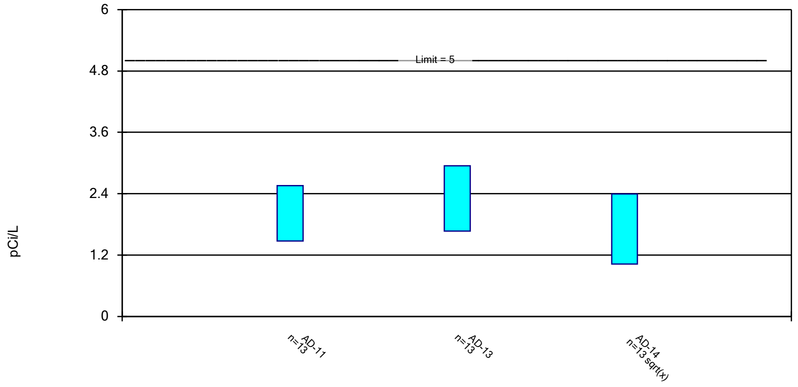


Constituent: Cobalt, total Analysis Run 11/25/2019 9:45 AM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

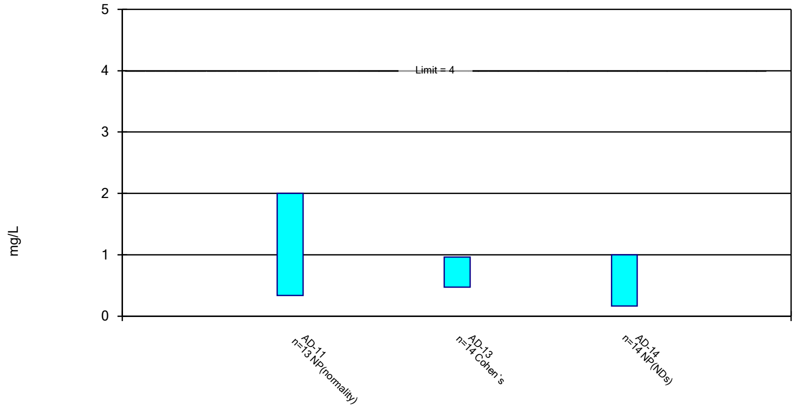


Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 9:45 AM View: Interwell AIV
Welsh Landfill Client: Geosyntec Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

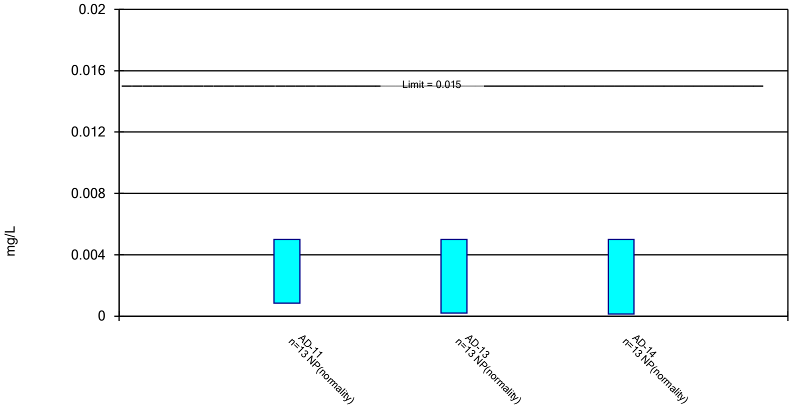


Constituent: Fluoride, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

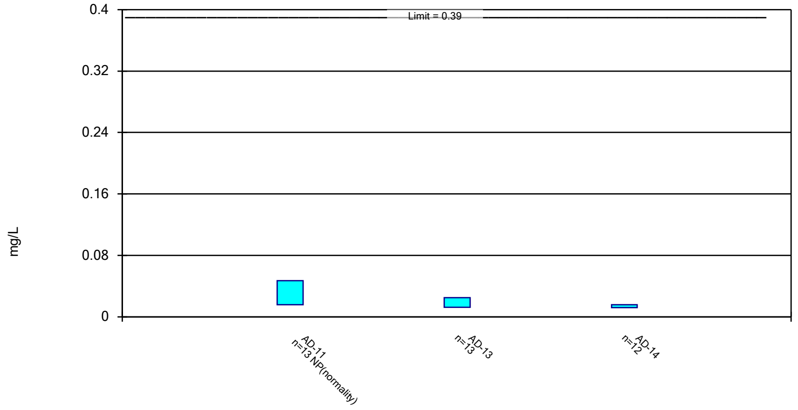


Constituent: Lead, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

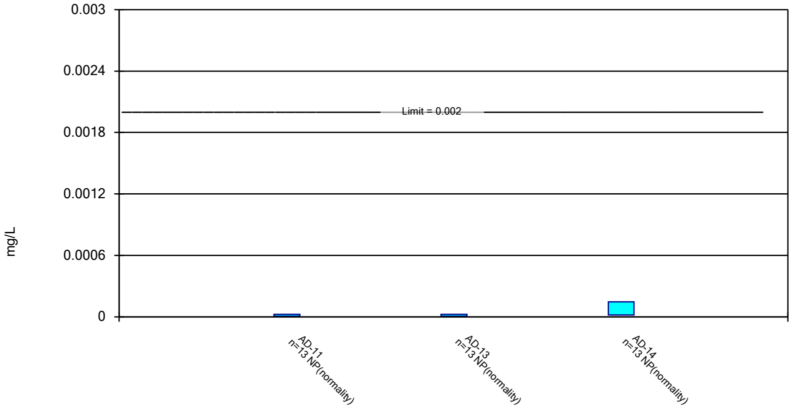


Constituent: Lithium, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

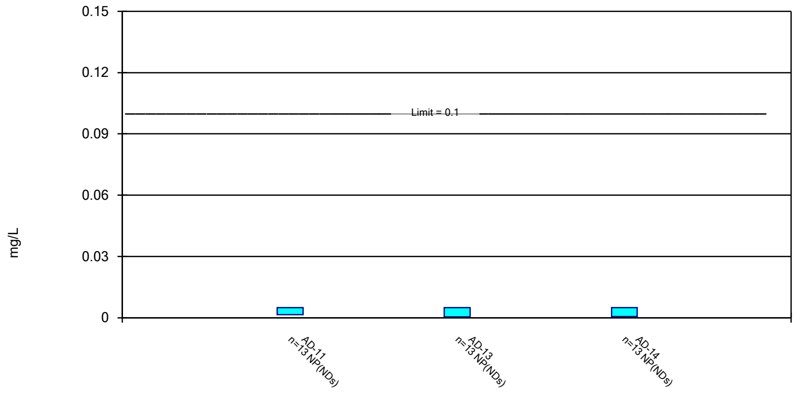


Constituent: Mercury, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

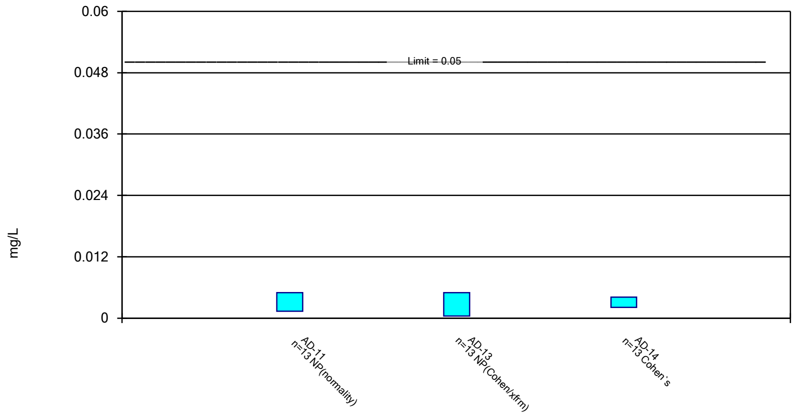


Constituent: Molybdenum, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . 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.

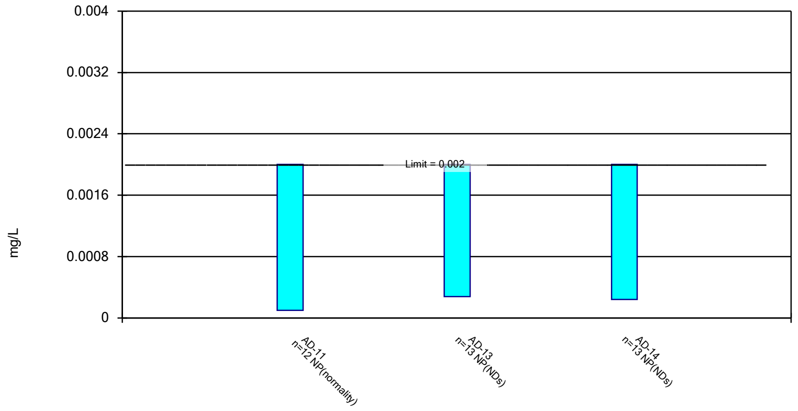


Constituent: Selenium, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total   Analysis Run 11/25/2019 9:45 AM   View: Interwell AIV
Welsh Landfill   Client: Geosyntec   Data: Welsh LF

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.

APPENDIX IV

Notices of groundwater monitoring programs are included in this appendix.

APPENDIX V- NA

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

Appendix D
Groundwater Monitoring Well Network Evaluation Reports

Infrastructure · Water · Environment · Buildings

Imagine the result

American Electric Power Service Corporation

Primary Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

J. Robert Welsh Power Plant
1187 County Road 4865
Titus County
Pittsburg, Texas

August 22, 2017

ARCADIS

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

Kenneth Brandner

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

Matthew J Lamb /KSB

Matthew J. Lamb
Project Manager

John Holm /DPL

John Holm, P.E.
Professional Engineer

Primary Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

J. Robert Welsh Power Plant
1187County Road 4865
Titus County
Pittsburg, Texas

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AEP

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OH015976.0011

Date:
August 22, 2017

Tables

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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 Primary Bottom Ash Pond (CCR Unit) at the AEP Generating Plant (Plant) located at 1187 County Road 4865 in Pittsburg, Titus County, Texas (**Figure 1**). One of the CCR requirements includes an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit.

Three regulated CCR units associated with the Plant were identified for review, which include the Primary Bottom Ash Pond, landfill, and bottom ash storage pond (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the Primary Bottom Ash Pond (Site).

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Primary Bottom Ash Pond 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 Welsh Generating Plant Primary Bottom Ash Pond.

2.1 Facility Location Description

The AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The Primary Bottom Ash Pond CCR unit is located southwest of the Plant and directly west of the Welsh Reservoir (**Figures 1** and **2**).

2.2 Description of Primary Bottom Ash Pond CCR Unit

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

2.2.1 Embankment Configuration

The Primary Bottom Ash Pond was placed into operation in approximately 1977, and is located in a topographically low area that had been an unnamed intermittent tributary of Swauano Creek prior to development of the Site. The Primary Bottom Ash Pond is bounded by natural ground surface (topographically higher areas) to the north and west, and embankment dikes to the south and east. These dikes are constructed of compacted sandy clay and clayey sand. The embankment dike south of the Primary Bottom Ash Pond includes a drainage canal that receives overflow (clear) water from the Primary Bottom Ash Pond. The water level in the Primary Bottom Ash Pond is controlled by a weir box which discharges into the drainage canal. The clear water in the drainage canal flows east and discharges into the clear water pond.

The Primary Bottom Ash Pond embankment is up to approximately 40 ft in height. Discussions of embankment configuration and timeline, including cross sections through the dikes, was provided in a previous report prepared by ETTL Engineers & Consultants Inc. in 2010 (ETTL, 2010).

2.2.2 Area/Volume

Per the *Hydraulic Analysis of Welsh Power Plant Ash Ponds Report,* dated December 2010 (Freese and Nichols, 2010), the bottom elevation of the Primary Bottom Ash Pond is 300 feet above mean sea level (amsl), the high level overflow weir box bottom elevation is 325 feet MSL, and the storage capacity of the Primary Bottom Ash Pond at elevation 325 feet amsl is 304.2 acre-ft (**Figure 3**).

2.2.3 Construction and Operational History

The AEP J. Robert Welsh Plant began operations in 1977 with three coal-fired generating units (Units 1, 2, and 3). Throughout the life of the generating plant, CCR materials (fly ash, bottom ash, economizer ash) have been generated. All of these byproducts were stored in the Primary Bottom Ash Pond and in the adjacent landfill that was constructed in the late 1970's. In 2000, the 22-acre bottom ash storage pond was installed south of the landfill. The bottom ash storage pond was constructed with a 60-mil high-density polyethylene (HDPE) liner, and receives bottom ash and economizer ash dredged and sluiced from the Primary Bottom Ash Pond (**Figure 2**).

Presently bottom ash and economizer ash from the generating plant are sluiced to the Primary Bottom Ash Pond. Solids settle as the clear liquids flow through a drainage canal into the clear water pond (a non-CCR unit). Water in the clear water pond discharges through a weir box into a 36-inch-diameter pipe, and then into the Welsh Reservoir under Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ00018111000 (**Figure 3**).

2.2.4 Surface Water Control

Surface water flow within the Primary Bottom Ash Pond complex is controlled by a weir and emergency spillway located on the south side of the pond below the embankments. Pond elevation is maintained so that surface water flows through the weir box which has a bottom elevation of 325 feet amsl. The emergency spillway is 90 feet wide with a crest elevation of 334 feet amsl. Clear water flows through the weir (and occasionally the emergency spillway during heavy precipitation events) into a drainage canal along the south side of the pond. The drainage canal discharges into the clear water pond located directly southeast of the Primary Bottom Ash Pond (**Figure 3**).

The perimeter embankments on the south and east sides of the Primary Bottom Ash Pond are located at an approximate elevation of 340 feet amsl. Therefore the perimeter embankments have approximately six feet of freeboard above the emergency spillway.

2.3 Previous Investigations

The initial soils investigation for the site was provided in a 1973 report prepared by McClelland Engineers, Inc. entitled "*Soils Investigation, Welsh Power Plant, Cason, Texas*". This investigation included advancement of soil borings in the Primary Bottom Ash Pond area, and geotechnical soil testing to characterize the area encompassed by the Primary Bottom Ash Pond.

In 2001, five monitoring wells (AD-1 through AD-5) were installed in the area of the Primary Bottom Ash Pond and Bottom Ash Storage Pond to obtain hydrologic data for the uppermost water-bearing unit. Twelve additional monitoring wells (AD-4a, AD-4b, AD-4c, AD-6 through AD-14) were installed in the area of the Primary Bottom Ash Pond, Bottom Ash Storage Pond, and landfill by Eagle Environmental Services in 2009 to obtain more detailed hydrologic data for the uppermost water-bearing unit.

In 2010, ETTL prepared a report entitled "*Geotechnical Investigation, Welsh Power Station, Existing Ash Storage Ponds Embankment Investigation, Pittsburg, Texas*". The objective of this report was to evaluate the stability of the earthen embankments for the Primary Bottom Ash Pond and non-CCR clear water pond (aka "Secondary Ash Pond"). The principal finding of this investigation was that slope stability would be acceptable following a proposed repair to the embankment of the clear water pond. The repair of the embankment of the clear water pond was completed during September 2010.

In 2010, Freese and Nichols performed a *Hydraulic Analysis of the Welsh Power Plant Ash Ponds* (Freese and Nichols, 2010). The report concluded the spillways for the Primary Bottom Ash Pond, clear water pond, and are hydraulically adequate for the full range of storm events from the 10-year to the 100-year storm events.

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant by installation of monitoring wells AD-15 through AD-18 (Auckland Consulting, 2016). Monitoring well completion diagrams are provided in **Appendix A.**

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 Site is located on the outcrop of the Eocene-age Recklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966).

These features are further illustrated on five lines of cross section that were prepared through the Primary Bottom Ash Pond 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

The climate of Titus County, Texas is moist subhumid. The average January temperature is 45˚ Fahrenheit (F), and the average July temperature is 82.9˚F. The mean annual growing season is 228 days (Broom, 1965). Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches according to weatherdb.com.

2.4.2 Regional and Local Geologic Setting

The Site is located on the outcrop of the Eocene-age Recklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966). The Recklaw Formation attains a thickness of approximately 110 feet in Titus County, and is underlain by the Eocene-age Carrizo Sand which consists of fine to coarse sand, silt, and clay (Broom, 1965). In the topographically low areas underling the Welsh Reservoir to the east of the Primary Bottom Ash Pond, Quarternary alluvial sediments associated with Swauano Creek are present (Flawn, 1966).

Detailed regional geologic characterization can be found in several published reports including Texas Water Commission Bulletin 6517 "*Ground-Water Resources of Camp, Franklin, Morris and Titus Counties, Texas*" (Broom, 1965), and The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Texarkana Sheet*" (Flawn, 1966).

Detailed regional and site geologic characterization can be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Welsh Power Station, Existing Ash Storage Ponds Embankment Investigation, Pittsburg, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

The Site is generally less than one-half mile from Swauano Creek, which was dammed near the southern end of the Site during plant development to form the Welsh Reservoir. Groundwater flow direction at the Site is generally from west to east, following surface topography towards the Welsh Reservoir. The Welsh Reservoir is likely a gaining surface water feature, and groundwater elevations on site are higher than the normal stage elevation of the Welsh Reservoir (approximately 320 feet amsl).

The Primary Bottom Ash Pond normal operating level is near the weir box which has a bottom elevation of 325 feet amsl. **Figure 9** and **Figure 10** are a potentiometric surface maps for the uppermost water bearing unit at the Site based on March 2016 water level data, and February 2017 water level data, respectively. 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 area of the Primary Bottom Ash Pond is in a general easterly direction toward the Welsh Reservoir at an average hydraulic gradient of approximately 0.01 foot per foot.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed one water well within a ½-mile radius of the Site (Banks, 2013). The water well is located on-site to the southwest (side gradient) of the Primary Bottom Ash Pond, and was installed for Southwestern Electric Company in 1974 with screens from 515 to 535 feet below ground surface, and plugged at a later date.

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 and monitoring wells installed at the Site show the uppermost aquifer in the area of the Primary Bottom Ash Pond is a fine to medium grained clayey and silty sand stratum with an average thickness of approximately 10 feet that is located between an elevation ranging from approximately 310 and 330 feet amsl (**Appendix A**). The base of the Primary Bottom Ash Pond ranges in elevation from approximately 330 feet amsl on the west to 300 feet amsl on the east. Therefore the uppermost aquifer appears to be in contact with the Primary Bottom Ash Pond and 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 and locally from ash pond use. 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 average saturated thickness (approximately 10 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 2017. The most recent groundwater data set from February 2017 is depicted on **Figure 10**. The groundwater flow is generally easterly towards the Welsh Reservoir.

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 on-Site hydrostratigraphic unit in the area of the Primary Bottom Ash Pond is the fine to medium grained clayey and silty sand stratum that has an average thickness of approximately 10 feet, and is located between an elevation ranging from approximately 310 and 330 feet amsl. This unit is not used locally for groundwater supply or industrial water use, but meets the TCEQ definition of a useable aquifer.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 20, 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 20, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-5 through AD-9 were previously installed at the Site to monitor the uppermost aquifer (fine to medium grained clayey and silty sand stratum) associated with the Primary Bottom Ash Pond. As discussed above in Section 3.1.1, the uppermost aquifer below the Primary Bottom Ash Pond has an average thickness of approximately 10 feet, and is located between an elevation ranging from approximately 310 and 330 feet amsl. In addition to these five monitoring wells, one piezometer (B-2) was installed directly down gradient (east) of the Primary Bottom Ash Pond in 2009 as part of the ETTL geotechnical investigation of the Primary Bottom Ash Pond embankments (ETTL, 2010).

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Sections A-A' (**Figure 4**) and C-C' (**Figure 6**), and the potentiometric surface maps on **Figures 9** and **10**, existing monitoring wells AD-1 and AD-5 are screened in the uppermost aquifer up gradient of the Primary Bottom Ash Pond, and existing monitoring wells AD-8 and AD-9 are screened in the uppermost aquifer down gradient (east) of the Primary Bottom Ash Pond. These four monitoring wells will be utilized as part of the groundwater monitoring system for the Primary Bottom Ash Pond.

Monitoring well AD-17 was completed in the uppermost aquifer southwest of the Primary Bottom Ash Pond during December 2015. As shown on the March 2016 potentiometric surface map (**Figure 9**) and February 2017 potentiometric surface map (**Figure 10**), monitoring well AD-17 is located west of a topographic and hydraulic ridge located on the southwest side of the Primary Bottom Ash Pond and Landfill. Therefore groundwater quality at monitoring well AD-17 is not affected by the Primary Bottom Ash Pond, and monitoring well AD-17 will be utilized as a hydraulically upgradient monitoring well to collect background water quality data. Monitoring well AD-18 is located on the north side of the topographic and hydraulic ridge, and is therefore hydraulically sidegradient relative to the Primary Bottom Ash Pond and Landfill, and will be utilized as a piezometer.

As shown on the soil boring log in **Appendix A** and Geologic Cross Section E-E' (**Figure 8**), piezometer B-2 is located down gradient of the Primary Bottom Ash Pond, but is screened in a clay stratum above the top of the uppermost aquifer. Therefore piezometer B-2 will not be utilized as part of the groundwater monitoring system for the Primary Bottom Ash Pond. This data gap was addressed by installation of new down gradient monitoring well AD-15 adjacent to piezometer B-2 during December 2015 as shown on **Figure 9** and **Figure 10**. With the addition of monitoring wells AD-15 and AD-17 during December 2015, there are no gaps remaining in the groundwater monitoring network for the Primary Bottom Ash Pond.

4. Recommended Monitoring Network and PE Certification

The recommended modifications to the existing groundwater monitoring well network are intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the Primary Bottom Ash Pond (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 Primary Bottom Ash Pond.

4.1 Recommended Monitoring Well Network Distribution

A total of three down gradient well locations (existing monitoring wells AD-8, AD-9, and AD-15) and three up gradient well locations (existing monitoring wells AD-1, AD-5, and AD-17) are recommended to establish a groundwater quality monitoring well network for the Primary Bottom Ash Pond. In addition, existing monitoring wells AD-6, AD-7, and AD-18 may be utilized as piezometers to obtain additional groundwater flow direction and gradient data for the Primary Bottom Ash Pond.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Primary Bottom Ash Pond is summarized on **Table 3** and illustrated on **Figure 11.**

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 averages approximately 10 feet in thickness, and ranges in elevation ranging from approximately 310 and 330 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**), C-C' (**Figure 6**), 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 Primary Bottom Ash Pond was addressed by installation of monitoring wells AD-15 and AD-17 during December 2015. Monitoring wells AD-15 and AD-17 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**.

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

Signature

KENNETH J. BRANDNER
69586

69586
Registration No.

Texas
Registration State

8-22-17
Date

5. References

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Tables

Table 1
Water Level Data
AEP J. Robert Welsh Power Plant - CCR Storage Areas
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Top of Casing Elevation	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen		Bottom of Screen		6/7/2011	12/6/2011	5/2/2012	11/1/2012	5/14/2013	11/19/2013	5/12/2014	11/16/2014	5/12/2015	3/4/2016	5/26/2016	7/27/2016	10/19/2016	12/12/2016	1/17/2017	2/23/2017
									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	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																												
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	357.57	25.0	1/11/01	Sch. 40 PVC	2	15.0	340.57	25.0	330.57	338.46	334.92	337.88	337.18	337.43	336.73	338.03	337.64	340.82	342.83	344.89	342.89	341.23	340.58	341.18	339.74
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	346.16	25.0	4/26/01	Sch. 40 PVC	2	15.0	329.16	25.0	319.16	330.16	329.07	330.00	329.26	329.83	329.70	330.09	329.69	332.56	332.32	---	---	---	---	---	---
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	333.10	17.0	4/26/01	Sch. 40 PVC	2	7.0	324.10	17.0	314.10	323.81	323.19	323.99	323.29	323.77	323.98	324.12	323.28	325.58	325.12	324.59	323.70	323.47	323.78	325.04	324.92
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	342.61	30.0	4/26/01	Sch. 40 PVC	2	19.0	321.61	29.0	311.61	324.81	324.84	324.62	324.40	324.74	325.52	325.44	325.13	327.00	326.90	---	---	---	---	---	---
AD-4a (a)	33.04527	94.84258	340.19	342.85	30.0	9/22/09	Sch. 40 PVC	2	20.0	320.19	30.0	310.19	325.01	324.19	325.24	322.90	324.86	324.68	325.64	325.34	327.19	327.12	---	---	---	---	---	---
AD-4b (a)	33.04531	94.84230	329.55	333.23	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.55	15.0	314.55	324.35	324.32	324.50	324.30	324.30	325.21	325.22	324.90	326.58	326.67	---	---	---	---	---	---
AD-4c (a)	33.04507	94.84244	329.15	333.28	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.15	15.0	314.15	324.18	324.50	324.64	324.37	324.11	325.06	325.01	324.71	326.50	326.19	325.89	324.01	323.76	325.07	326.39	324.89
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	351.00	30.0	1/11/01	Sch. 40 PVC	2	20.0	329.00	30.0	319.00	336.34	336.58	336.82	336.99	336.78	336.47	336.80	336.01	339.07	338.04	337.62	337.24	337.74	337.01	338.34	336.17
AD-6 (a)	33.05235	94.84757	343.31	346.33	33.0	9/23/09	Sch. 40 PVC	2	23.0	320.31	33.0	310.31	333.04	333.02	332.83	333.02	333.11	332.81	333.11	332.81	333.38	334.00	---	---	---	---	---	---
AD-7 (a)	33.05257	94.84219	347.86	350.82	38.0	9/24/09	Sch. 40 PVC	2	28.0	319.86	38.0	309.86	334.32	334.12	334.19	334.20	334.13	334.58	333.77	333.98	334.09	333.61	---	---	---	---	---	---
AD-8 (a)	33.05187	94.84026	337.53	340.01	29.0	9/21/09	Sch. 40 PVC	2	16.0	321.53	26.0	311.53	325.41	324.09	325.69	325.15	325.79	325.75	325.98	325.77	326.05	325.70	325.68	325.05	325.29	325.92	326.76	324.27
AD-9 (a)	33.04995	94.84196	340.32	343.09	35.0	9/21/09	Sch. 40 PVC	2	20.0	320.32	35.0	305.32	328.46	328.53	328.63	328.44	328.74	329.38	NM	330.18	329.98	329.74	329.28	329.53	328.92	329.31	330.50	328.05
AD-10 (a)	33.04881	94.84047	340.23	343.01	35.0	9/22/09	Sch. 40 PVC	2	20.0	320.23	35.0	305.23	323.44	322.55	323.27	323.35	323.51	323.76	323.57	323.88	323.95	323.55	---	---	---	---	---	---
AD-11 (a)	33.04824	94.84177	339.61	342.18	20.0	9/22/09	Sch. 40 PVC	2	10.0	329.61	20.0	319.61	327.99	328.37	327.82	327.93	327.94	328.13	328.20	327.97	328.96	328.13	328.39	328.14	327.87	328.20	328.90	328.25
AD-12 (a)	33.04901	94.84977	366.27	369.33	30.0	9/24/09	Sch. 40 PVC	2	20.0	346.27	30.0	336.27	348.30	348.29	349.86	349.56	349.99	349.65	349.89	350.01	350.65	350.39	---	---	---	---	---	---
AD-13 (a)	33.04918	94.84275	344.12	347.00	20.0	9/22/09	Sch. 40 PVC	2	6.0	338.12	16.0	328.12	332.36	332.24	333.09	332.26	332.68	333.25	333.35	332.01	337.58	334.76	334.54	332.93	332.39	332.84	334.54	331.83
AD-14 (a)	33.04715	94.84256	342.32	345.43	19.0	9/22/09	Sch. 40 PVC	2	8.0	334.32	18.0	324.32	330.40	329.80	331.67	330.34	330.94	331.69	332.12	330.17	336.63	334.83	334.51	331.71	330.94	330.79	332.63	330.87
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	343.29	46.0	12/12/15	Sch. 40 PVC	2	25.5	314.71	45.5	294.71	---	---	---	---	---	---	---	---	---	322.14	321.93	321.28	321.42	321.71	321.64	322.81
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	353.97	21.0	12/10/15	Sch. 40 PVC	2	11.0	339.86	21.0	329.86	---	---	---	---	---	---	---	---	---	337.09	335.84	332.14	331.52	331.43	330.96	330.71
AD-16R(e)	33° 02' 49"	94° 50' 28.9"	350.55	353.49	27.0	4/12/17	Sch. 40 PVC	2	12.0	338.55	27.0	323.55	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	357.10	40.0	12/10/15	Sch. 40 PVC	2	24.0	329.99	39.0	314.99	---	---	---	---	---	---	---	---	---	334.64	334.26	334.30	334.45	334.64	334.05	333.94
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	349.28	29.0	12/11/15	Sch. 40 PVC	2	14.0	332.17	29.0	317.17	---	---	---	---	---	---	---	---	---	343.66	343.26	340.81	339.92	339.38	338.97	340.38
Piezometers																												
B-2 (b)	33° 03.078'	94° 50.449'	339.7	339.7	50.0	10/28/09	Sch. 40 PVC	2	10.0	329.70	20.0	319.70	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-4 (b)	33° 03.011'	94° 50.462'	340.6	340.6	50.0	10/27/09	Sch. 40 PVC	2	8.0	332.60	18.0	322.60	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-5 (b)	33° 02.964'	94° 50.428'	340.0	340.0	50.0	10/27/09	Sch. 40 PVC	2	10.0	330.00	20.0	320.00	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-6 (b)	33° 02.912'	94° 50.462'	340.1	340.1	50.0	10/28/09	Sch. 40 PVC	2	12.0	328.10	22.0	318.10	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

NM - Not measured.
(a) Source: Eagle Environmental Services Well Logs (2009).
(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).
(c) Source: Southwest Electric Power, State of Texas Well Report (2001).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.
(e) Monitoring well installed by ARCADIS on April 12, 2017 as a replacement for monitoring well AD-16.
Groundwater Elevation Source: AEP, Shallow Groundwater Data Summary through February 2017.

Table 2
Well Construction Details
AEP J. Robert Welsh Power Plant - CCR Units
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen		Bottom of Screen	
								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															
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	25.0	1/11/2001	PVC	2	13	343	25	331	15.0	340.57	25.0	330.57
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	25.0	4/26/2001	PVC	2	12	332	25	319	15.0	329.16	25.0	319.16
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	17.0	4/26/2001	PVC	2	5	326	17	314	7.0	324.10	17.0	314.10
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	30.0	4/26/2001	PVC	2	16	325	30	311	19.0	321.61	29.0	311.61
AD-4a (a)	33.04527	94.84258	340.19	30.0	9/22/2009	PVC	2	17	323	30	310	20.0	320.19	30.0	310.19
AD-4b (a)	33.04531	94.84230	329.55	15.0	9/23/2009	PVC	2	4	326	15	315	5.0	324.55	15.0	314.55
AD-4c (a)	33.04507	94.84244	329.15	15.0	9/23/2009	PVC	2	4	325	15	314	5.0	324.15	15.0	314.15
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	30.0	1/11/2001	PVC	2	16	333	30	319	20.0	329.00	30.0	319.00
AD-6 (a)	33.05235	94.84757	343.31	33.0	9/23/2009	PVC	2	21	322	33	310	23.0	320.31	33.0	310.31
AD-7 (a)	33.05257	94.84219	347.86	38.0	9/24/2009	PVC	2	26	322	38	310	28.0	319.86	38.0	309.86
AD-8 (a)	33.05187	94.84026	337.53	29.0	9/21/2009	PVC	2	14	324	29	309	16.0	321.53	26.0	311.53
AD-9 (a)	33.04995	94.84196	340.32	35.0	9/21/2009	PVC	2	18	322	35	305	20.0	320.32	35.0	305.32
AD-10 (a)	33.04881	94.84047	340.23	35.0	9/22/2009	PVC	2	18	322	35	305	20.0	320.23	35.0	305.23
AD-11 (a)	33.04824	94.84177	339.61	20.0	9/22/2009	PVC	2	8	332	20	320	10.0	329.61	20.0	319.61
AD-12 (a)	33.04901	94.84977	366.27	30.0	9/24/2009	PVC	2	18	348	30	336	20.0	346.27	30.0	336.27
AD-13 (a)	33.04918	94.84275	344.12	20.0	9/22/2009	PVC	2	4	340	20	324	6.0	338.12	16.0	328.12
AD-14 (a)	33.04715	94.84256	342.32	19.0	9/22/2009	PVC	2	6	336	18	324	8.0	334.32	18.0	324.32
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	46.0	12/12/15	PVC	2	22	318	45.5	295	25.5	314.71	45.5	294.71
AD-16R	33° 02' 49"	94° 50' 29"	350.55	27.0	4/12/17	PVC	2	10	341	27	324	12.0	338.55	27.0	323.55
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	40.0	12/10/15	PVC	2	22	332	39	315	24.0	329.99	39.0	314.99
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	29.0	12/11/15	PVC	2	12	334	29	317	14.0	332.17	29.0	317.17
Piezometers															
B-2 (b)	33° 03.078'	94° 50.449'	339.7	50.0	10/28/2009	PVC	2	8	332	20	320	10.0	329.70	20.0	319.70
B-4 (b)	33° 03.011'	94° 50.462'	340.6	50.0	10/27/2009	PVC	2	8	333	18	323	8.0	332.60	18.0	322.60
B-5 (b)	33° 02.964'	94° 50.428'	340.0	50.0	10/27/2009	PVC	2	5	335	20	320	10.0	330.00	20.0	320.00
B-6 (b)	33° 02.912'	94° 50.462'	340.1	50.0	10/28/2009	PVC	2	4	336	22	318	12.0	328.10	22.0	318.10
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	21.0	12/10/15	PVC	2	9	342	21	330	11.0	339.86	21.0	329.86

General Notes:
Elevation in feet above mean sea level.

Footnotes:
(a) Source: Eagle Environmental Services Well Logs (2009).
(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).
(c) Source: Southwest Electric Power, State of Texas Well Report (2001).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP J. Robert Welsh Power Plant - Primary Bottom Ash Pond
Pittsburg, Titus 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-1	Existing	Uppermost Water-Bearing Unit	South of Primary Bottom Ash Pond	Upgradient	340.6	330.6	10	Existing well installed in 2001; well will be utilitzed to establish backgroud water quality
AD-5	Existing	Uppermost Water-Bearing Unit	NW of Primary Bottom Ash Pond	Upgradient	329.0	319.0	10	Existing well installed in 2001; well will be utilitzed to establish backgroud water quality
AD-17	Existing	Uppermost Water-Bearing Unit	SW of Primary Bottom Ash Pond	Upgradient	330.0	315.0	15	New monitoring well installed during December 2015 in uppermost shallow aquifer southwest of Primary Bottom Ash Pond - upgradient; well will be utilized to establish background water quality
Downgradient								
AD-8	Existing	Uppermost Water-Bearing Unit	E of Primary Bottom Ash Pond	Down gradient	321.5	311.5	10	Existing well installed in 2009; uppermost shallow aquifer adjacent to the Primary Bottom Ash Pond - downgradient
AD-9	Existing	Uppermost Water-Bearing Unit	E of Primary Bottom Ash Pond	Down gradient	320.3	305.3	15	Existing well installed in 2009; uppermost shallow aquifer adjacent to the Primary Bottom Ash Pond - downgradient
AD-15	Existing	Uppermost Water-Bearing Unit	E of Primary Bottom Ash Pond	Down gradient	314.7	294.7	20	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the Primary Bottom Ash Pond - downgradient
Piezometers								
AD-6	Existing	Uppermost Water-Bearing Unit	N of Primary Bottom Ash Pond	Side gradient	320.3	310.3	10	Existing well installed in 2009; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-7	Existing	Uppermost Water-Bearing Unit	N of Primary Bottom Ash Pond	Side gradient	319.9	309.9	10	Existing well installed in 2009; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-18	Existing	Uppermost Water-Bearing Unit	W of Primary Bottom Ash Pond	Side gradient	332.2	317.2	15	New well installed during December 2015 in uppermost shallow aquifer sidegradient of Primary Bottom Ash Pond; will be utilized to obtain water level data for uppermost water-bearing unit

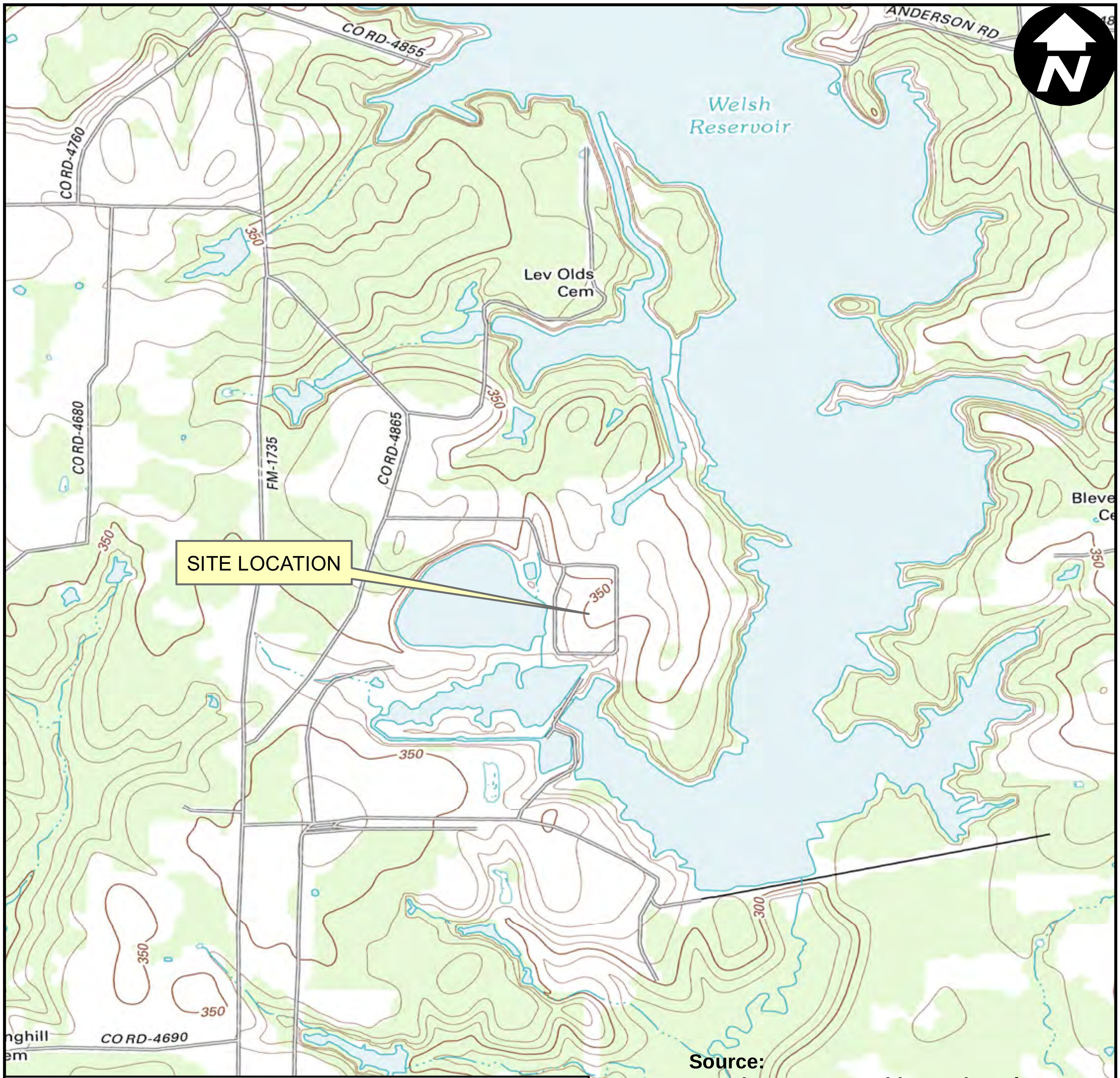
Footnotes:

a. Target elevations are an estimated range.

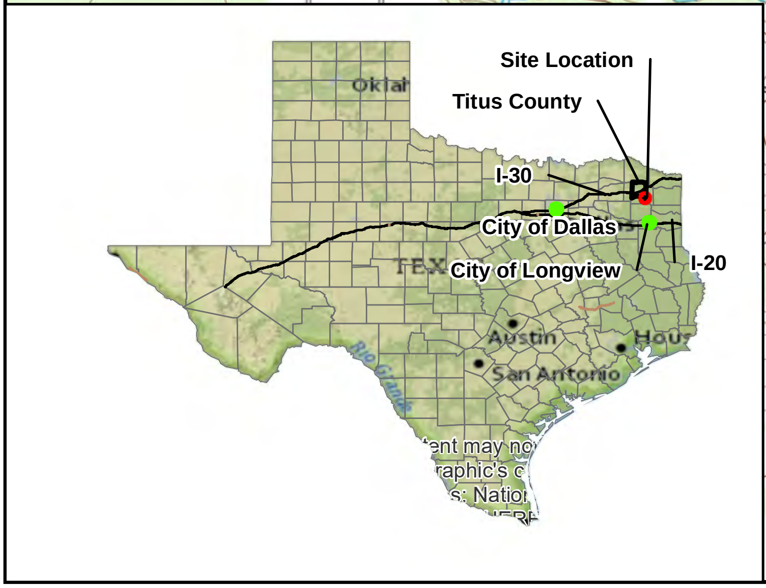
Acronyms and Abbreviations:

U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Cason, Texas, 2013



J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

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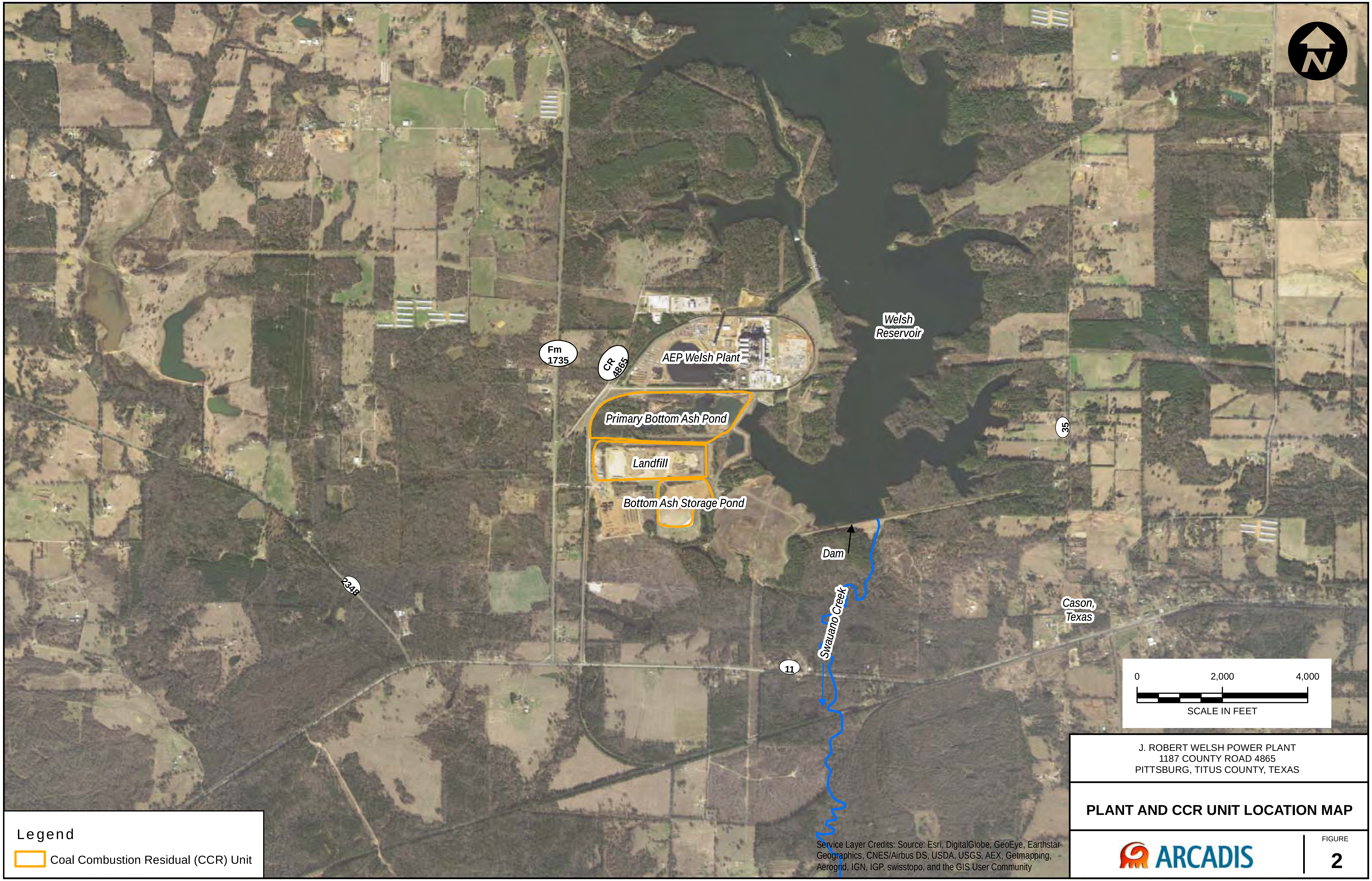


Legend

🟧 Coal Combustion Residual (CCR) Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

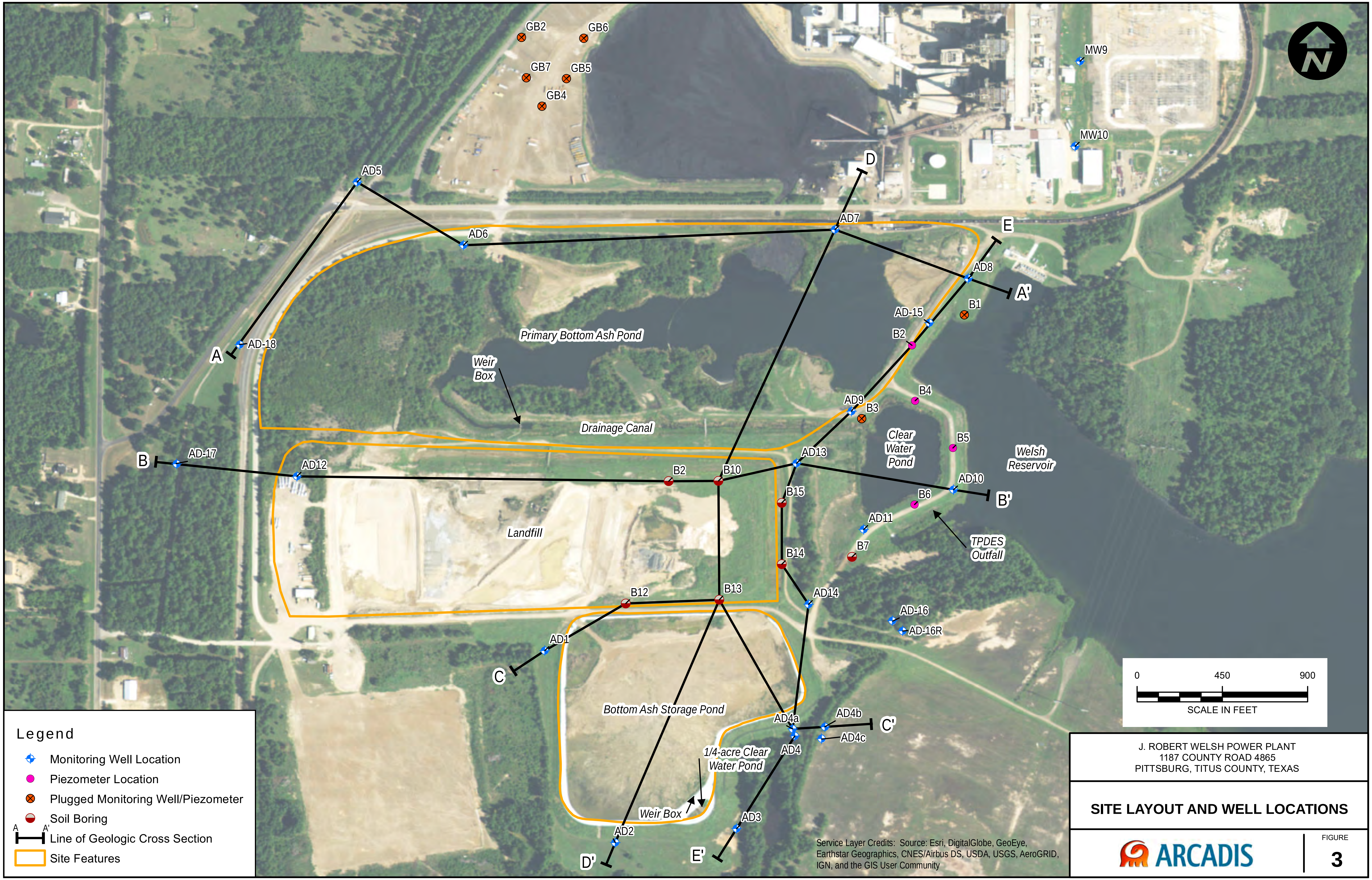
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 2 - CCR location.mxd



Legend

- ✦ Monitoring Well Location
- ● Piezometer Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◐ Soil Boring
- A ⊢⊣ A' Line of Geologic Cross Section
- ▭ Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

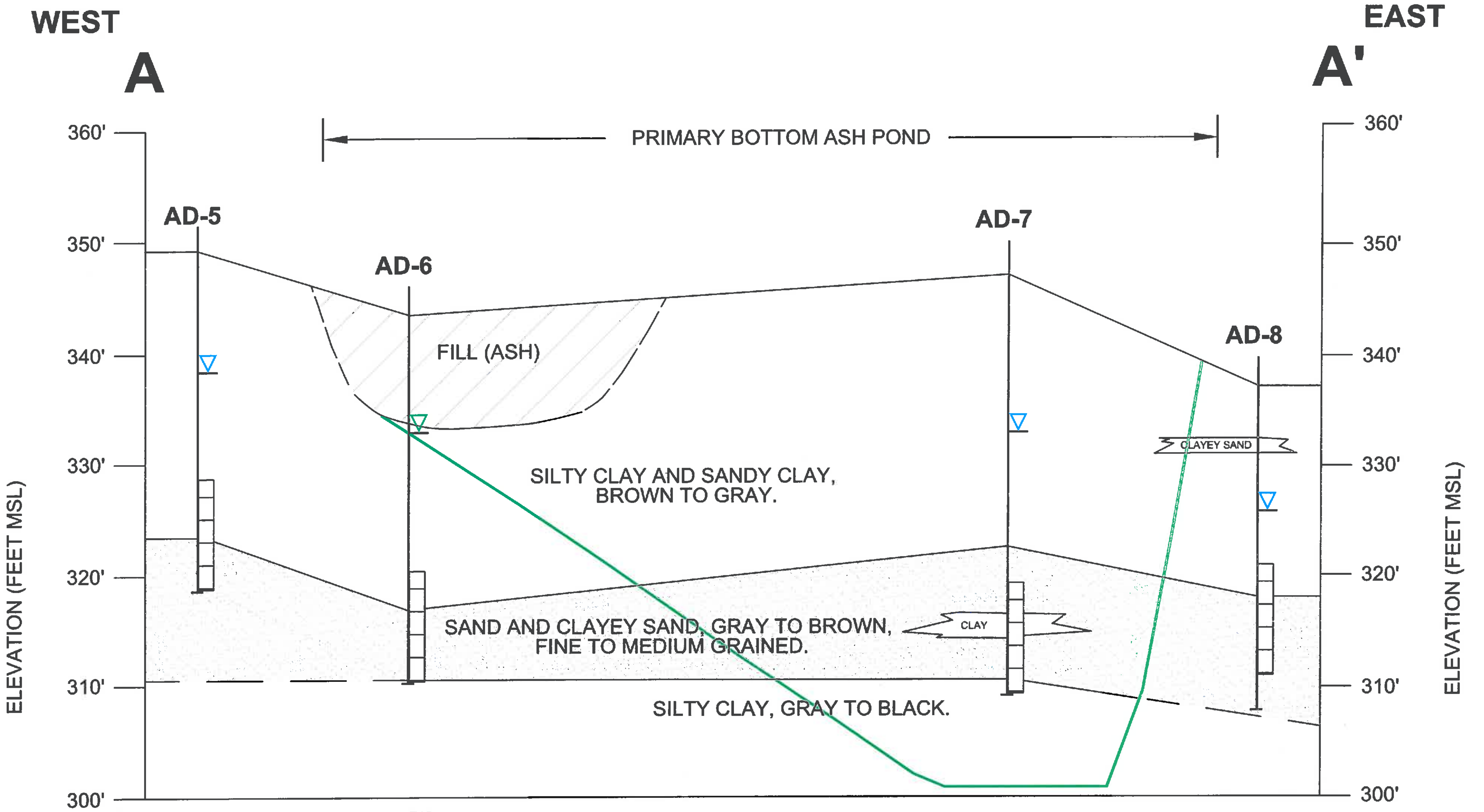
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 3 - site layout.mxd



Kenneth J. Brandner
Geology
1787

8-22-17

0 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
—	PROJECTED BASE OF ASH POND (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond WELL Network Evaluation\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 8/26/2015 9:53 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE:
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CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 3/11/2016 10:41 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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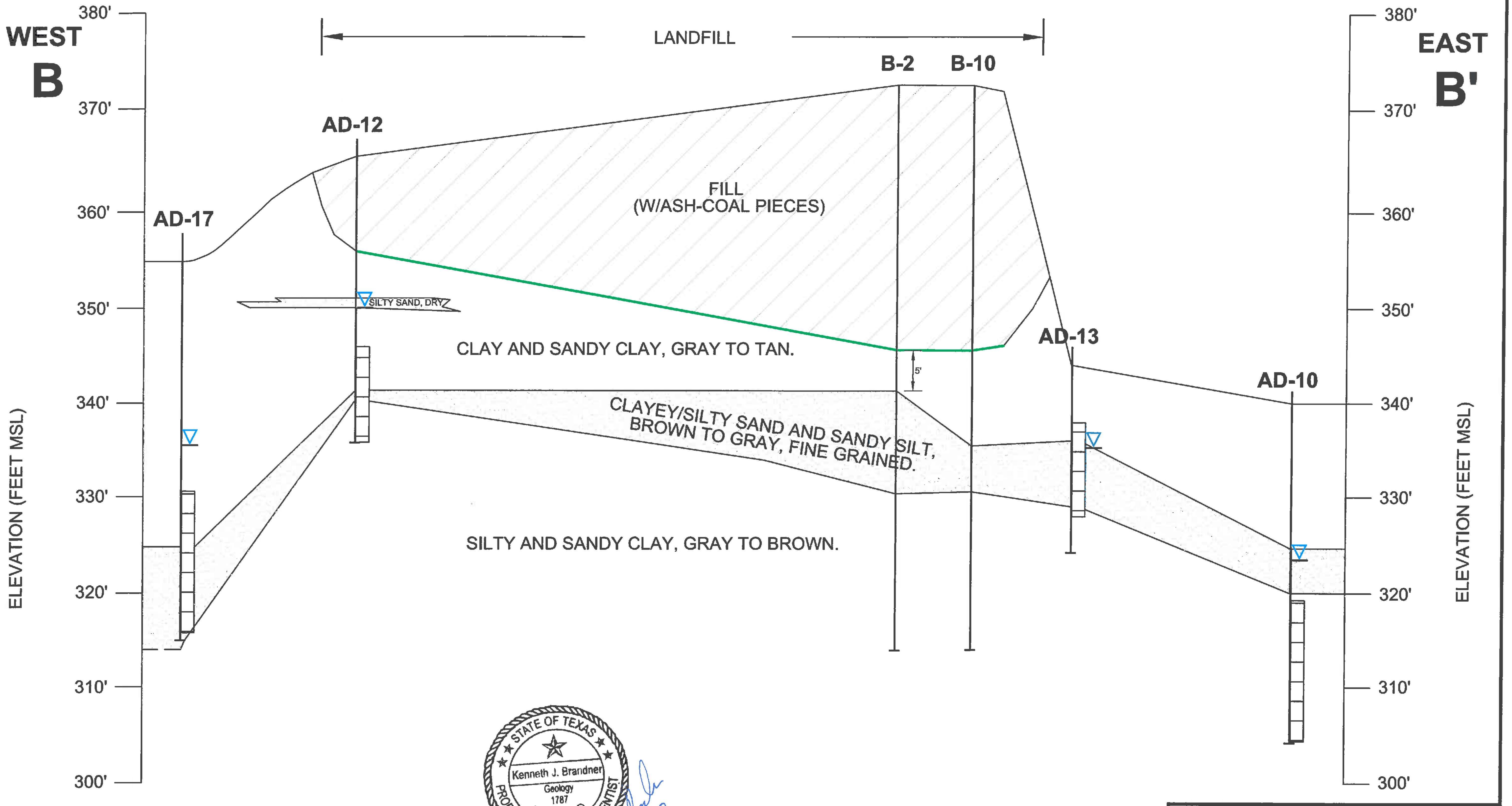


Kenneth J. Brandner
Geology
1787

8-22-17

0 300'
HORIZONTAL SCALE

NOTE: BASE OF LANDFILL ELEVATION TAKEN FROM "WELSH POWER PLANT- UNIT 1 FLY ASH STORAGE AREA PHASE I" DRAWING ID WEPX-88, DATED 12/3/76.

LEGEND

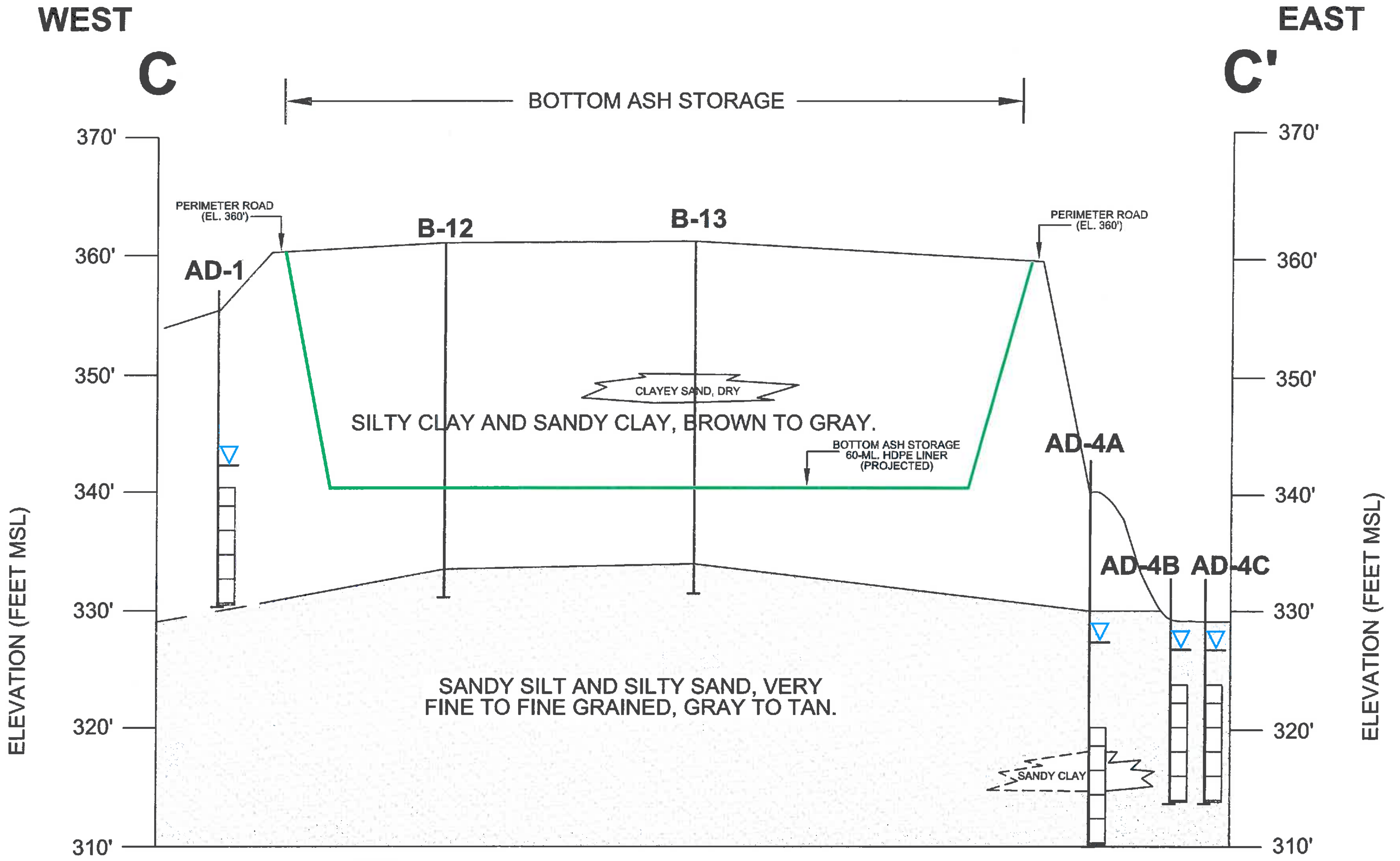
⌸	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
🟩	BASE OF LANDFILL (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5



Kenneth J. Brandner
Geology
1787

8-22-17

0 200'
HORIZONTAL SCALE

NOTE: BASE OF BOTTOM ASH STORAGE HAS A 60-ML. HDPE LINER AT ELEVATION 340.0', TAKEN FROM FREESE AND NICHOLS "HYDRAULIC ANALYSIS OF WELSH POWER PLANT ASH PONDS, AMERICAN ELECTRIC POWER COMPANY", DATED DECEMBER 2010.

LEGEND

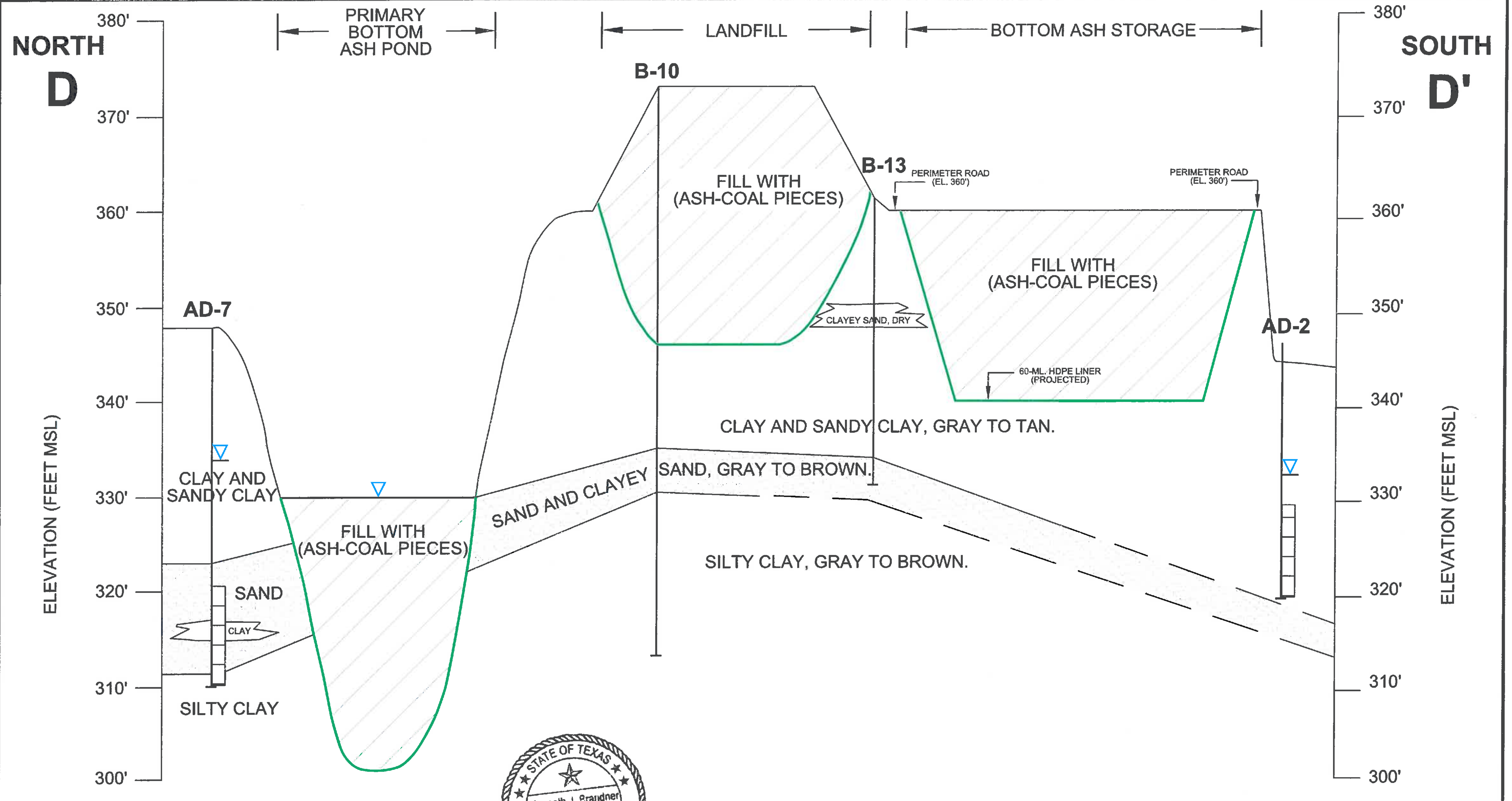
⌸	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
—	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6



Kenneth J. Brandner
Geology
1787

Kenneth J. Brandner 8-22-17

LEGEND

▯ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (5/12/15)

🟩 BASE OF CCR UNIT

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

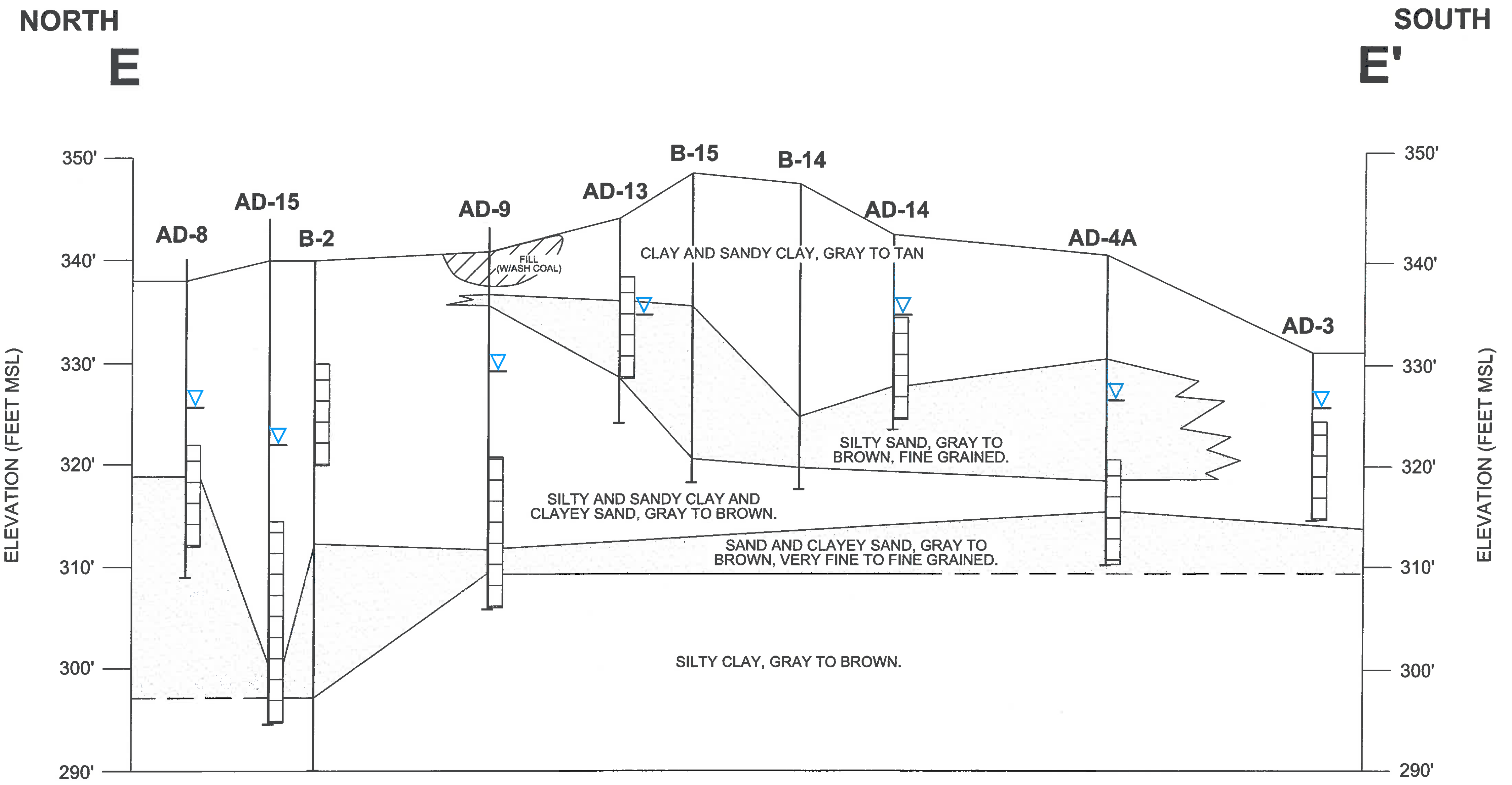
0 300'
HORIZONTAL SCALE

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION D - D'

ARCADIS

FIGURE
7



0 ▬▭ 300'
HORIZONTAL SCALE

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

8-22-17

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
—	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION E - E'

ARCADIS

FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 3/11/2016 12:06 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: —
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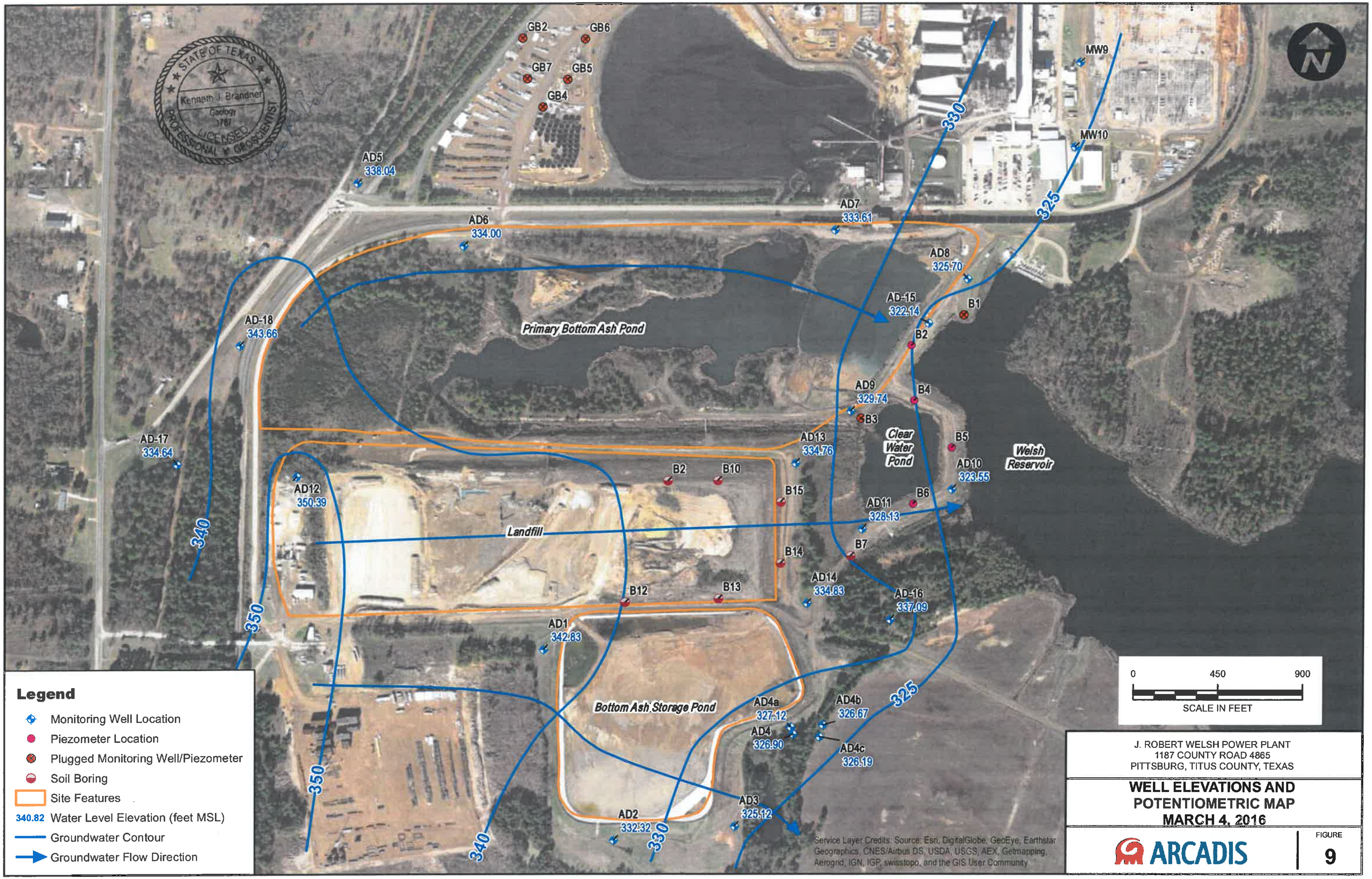


Kenneth J. Brandner
Geology
1787

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

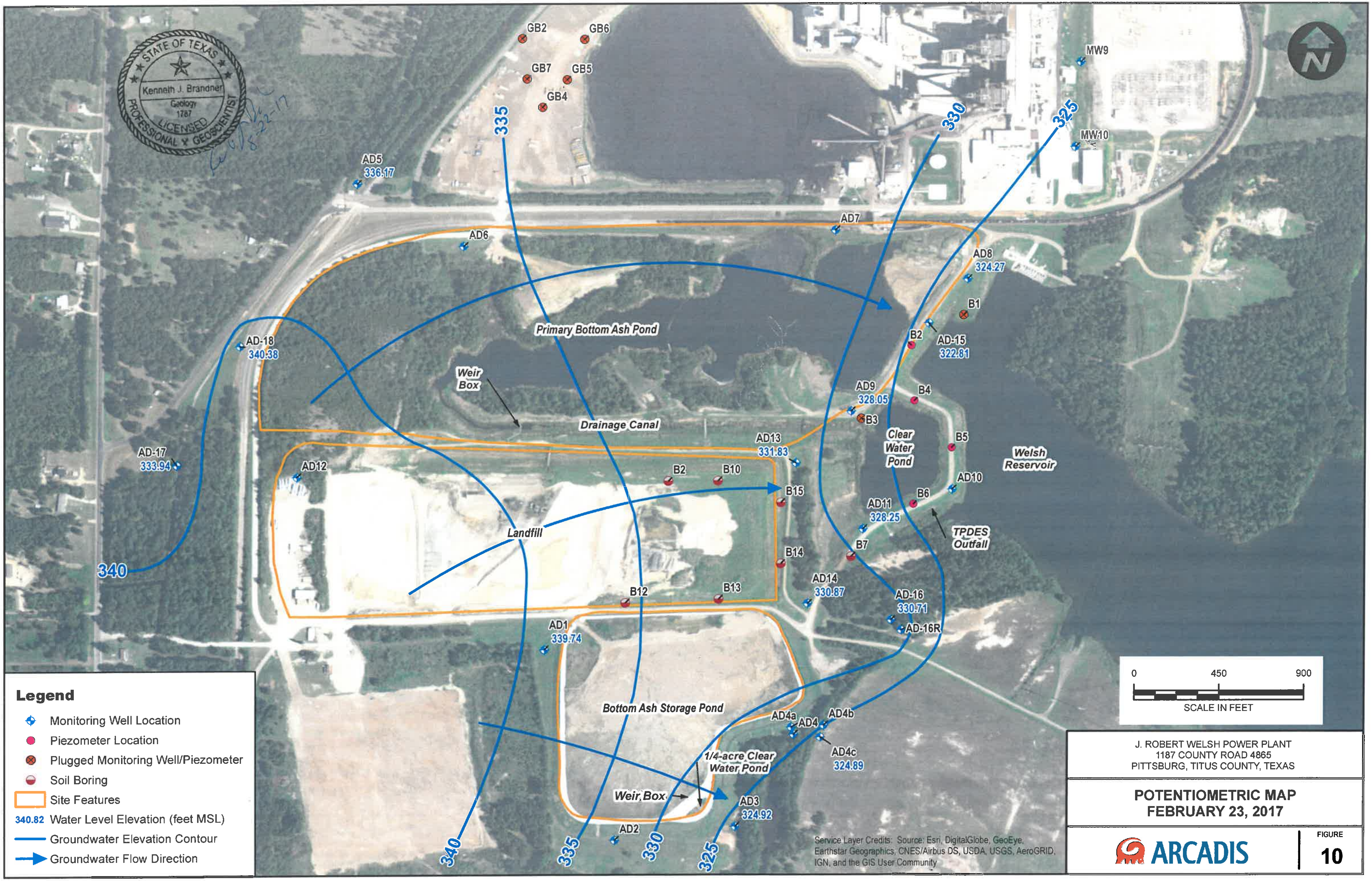
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP
MARCH 4, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 9 - Mar2016_POT.mxd



Kenneth J. Brandner
Geology
1787
8-22-17

Legend

- ⊕ Monitoring Well Location
- ● Piezometer Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◒ Soil Boring
- ▭ Site Features
- 340.82 Water Level Elevation (feet MSL)
- — Groundwater Elevation Contour
- → Groundwater Flow Direction

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

POTENTIOMETRIC MAP
FEBRUARY 23, 2017

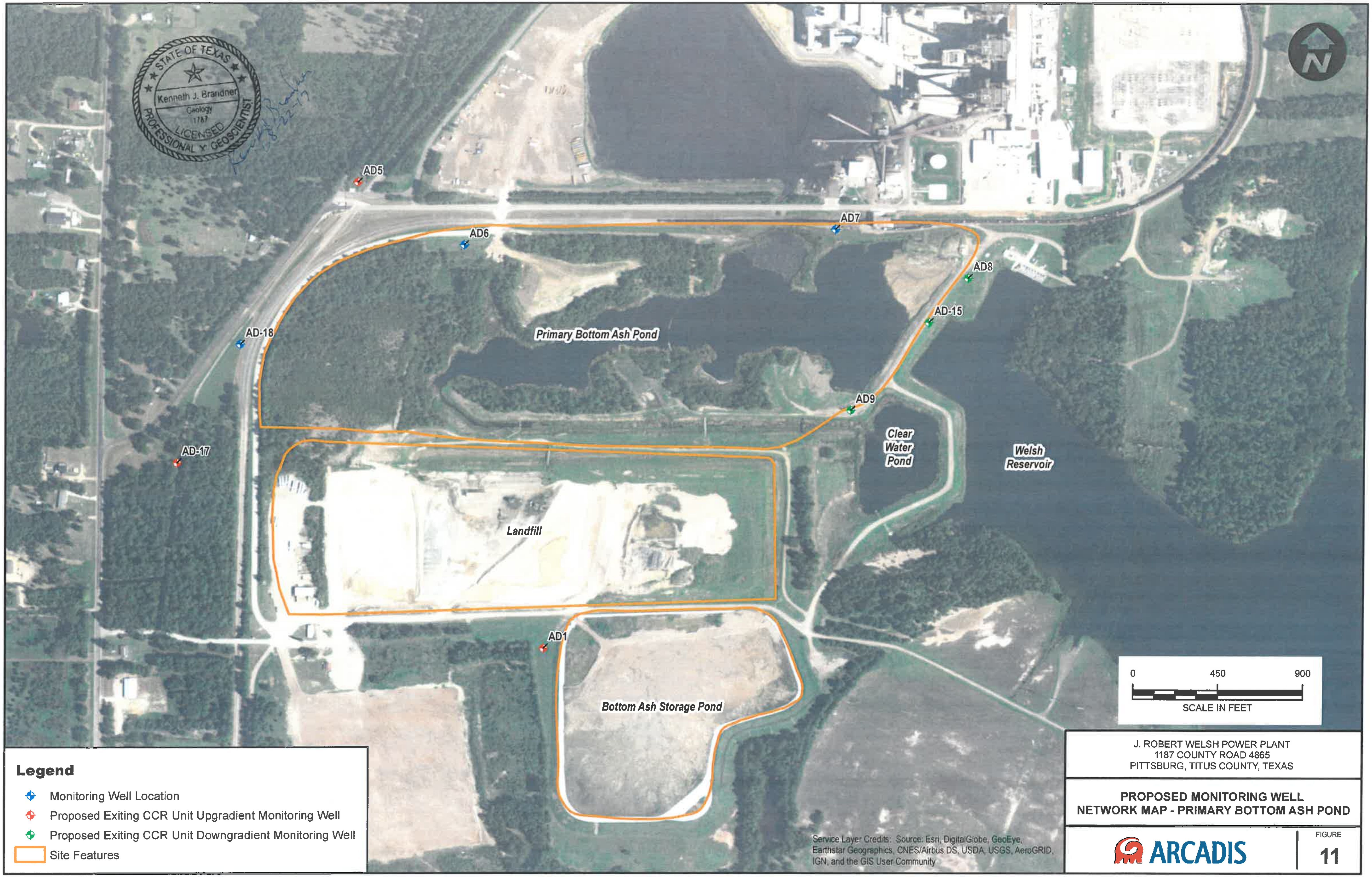
ARCADIS

FIGURE
10

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 10 - Feb2017_POT.mxd

Kenneth J. Brandner
Geology
1787

08-22-17



Legend

- 🔷 Monitoring Well Location
- 🔶 Proposed Exiting CCR Unit Upgradient Monitoring Well
- 🔷 Proposed Exiting CCR Unit Downgradient Monitoring Well
- 🟧 Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PROPOSED MONITORING WELL
NETWORK MAP - PRIMARY BOTTOM ASH POND

ARCADIS

FIGURE
11

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Ash Pond report\fig 11 - proposed wells_v2.mxd

ARCADIS

Appendix A

Boring/Well Construction Logs

AD-1

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) TX (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4, Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell

If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'48"N
94°50'47"W

6) WELL LOG:
Date Drilling:
Started 1-11 19 2001
Completed 1-11 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	25

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

From (ft.)	To (ft.)	Description and color of formation material
0	25	gray silty Clay with some hard red streaks

AP-1

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______

If Gravel Packed give interval ... from 13 ft. to 25 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	15	sch 40
2	N	#10 slot screen	15	25	sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 13 ft. to 0 ft. No. of sacks used 6-50#
ft. to ______ ft. No. of sacks used ______
Method used bentonite
Cemented by ______
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level 12'8" ft. below land surface Date 1-11-01
Artesian flow ______ gpm. Date ______

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ______ (Type or print) WELL DRILLER'S LICENSE NO. TX-52694-M

ADDRESS ______ (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M. [illegible] (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-2

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell

If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'37"N
94°50'44"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 2001
Completed 4/26 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	25

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

From (ft.)	To (ft.)	Description and color of formation material
0	2	top soil
2	5	red & gray clay w/ silt
5	10	red & gray clay w/ silt
10	25	gray silty clay w/ tan streaks
		AP-2

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______

If Gravel Packed give interval ... from 12 ft. to 25 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	15	Sch 40
2	N	#10 slot screen	15	25	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 12 ft. to 2 ft. No. of sacks used 5-50#
______ ft. to ______ ft. No. of sacks used ______
Method used bentonite pellets
Cemented by ______
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: NA
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ______ (Type or print) WELL DRILLER'S LICENSE NO. TX-52694-M

ADDRESS ______ (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-3

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

County Camp ~~Titus~~

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell

If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'38"N
94°50'37"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 ~~19~~ 2001
Completed 4/26 ~~19~~ 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	17

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0	12	gray silt clay w/ tan streaks
12	15	very stiff gray/blood red clay
15	17	very stiff gray clay w/ red nodules and tan streaks

AP-3

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other

If Gravel Packed give interval ... from 5 ft. to 17 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	7	Sch 40
2	N	#10 slot screen	7	17	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 2 ft. to 5 ft. No. of sacks used 2 1/2 - 50*
_____ ft. to _____ ft. No. of sacks used _____
Method used bentonite pellets
Cemented by _____
Distance to septic system field lines or other concentrated contamination _____ ft.
Method of verification of above distance _____

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level _____ ft. below land surface Date _____
Artesian flow _____ gpm. Date _____

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other _____
Depth to pump bowls, cylinder, jet, etc., _____ ft.

14) WELL TESTS: NA
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: _____ gpm with _____ ft. drawdown after _____ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? _____ Depth of strata _____
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME _____ (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS _____ (Street or RFD) (City) (State) (Zip)

(Signed) _____ (Licensed Well Driller) (Signed) _____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-4

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check):
☒ New Well ☐ Deepening
☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33° 02' 43" N
94° 50' 33" W
N

6) WELL LOG:
Date Drilling:
Started 4/26 19 2001
Completed 4/26 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	30

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0	5	red silty clay with gray streaks
5 -	30	gray silty clay with red streaks

AD-4

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other
If Gravel Packed give interval ... from 16 ft. to 30 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	19	Sch 40
2	N	#10 Slot Screen	19	29	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 16 ft. to 2 ft. No. of sacks used 8-50#
ft. to ft. No. of sacks used
Method used bentonite pellets
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ft. below land surface Date
Artesian flow gpm. Date

12) PACKERS: NA Type Depth

13) TYPE PUMP:
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other NA
Depth to pump bowls, cylinder, jet, etc., ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-4A**
TOTAL DEPTH:	**30'**
TOP OF CASING ELEV.:	**342.85 ft. NGVD**
GROUND SURFACE ELEV.:	**340.19 ft. NGVD**

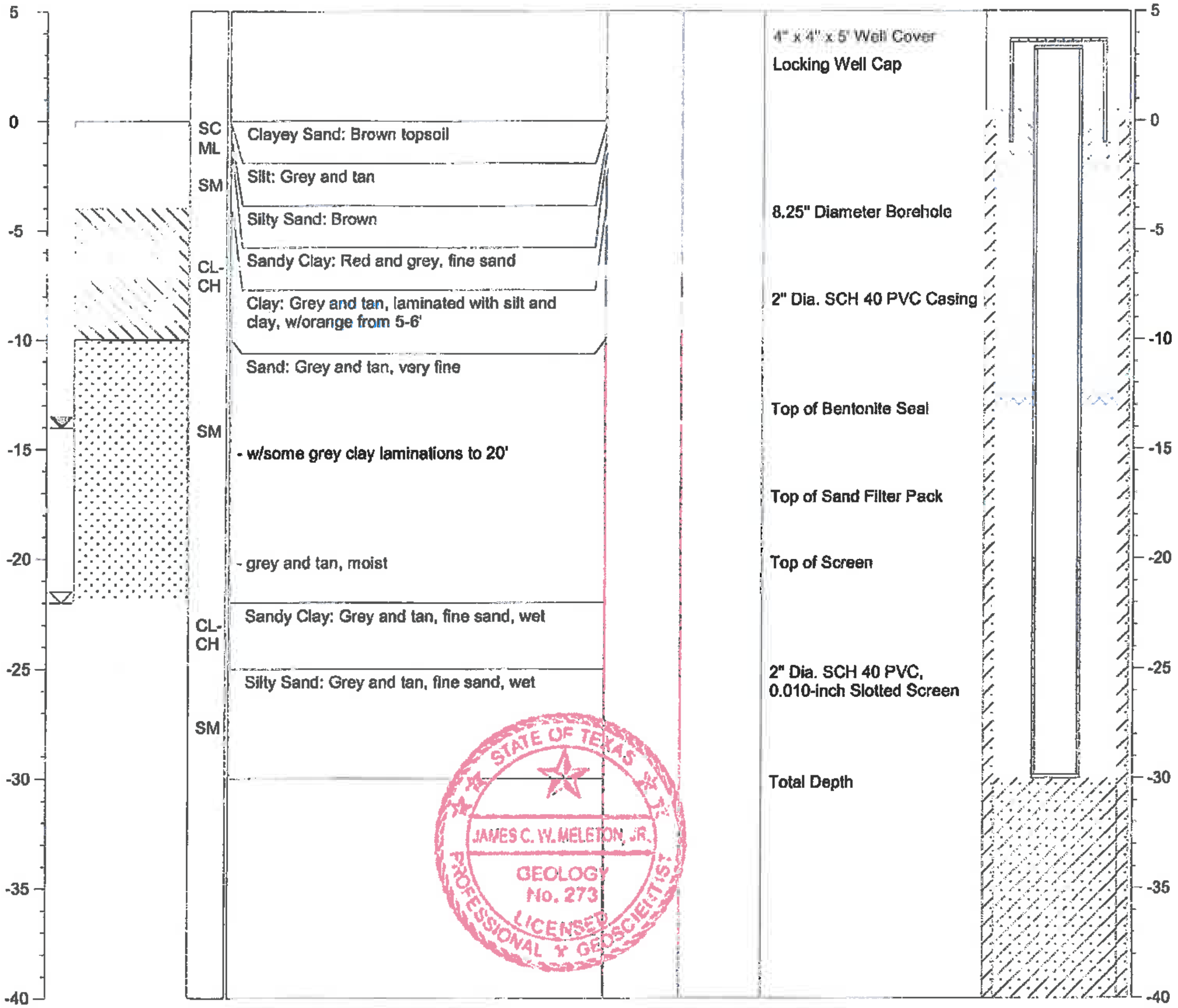
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04527**
Longitude: 94.84258

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Clayey Sand: Brown topsoil

Silt: Grey and tan

Silty Sand: Brown

Sandy Clay: Red and grey, fine sand

Clay: Grey and tan, laminated with silt and clay, w/orange from 5-6'

Sand: Grey and tan, very fine

- w/some grey clay laminations to 20'

- grey and tan, moist

Sandy Clay: Grey and tan, fine sand, wet

Silty Sand: Grey and tan, fine sand, wet

4" x 4" x 5' Well Cover

Locking Well Cap

8.25" Diameter Borehole

2" Dia. SCH 40 PVC Casing

Top of Bentonite Seal

Top of Sand Filter Pack

Top of Screen

2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen

Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
PROFESSIONAL LICENSED GEOSCIENTIST

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SOIL BORING LOG

BORING/WELL NO.:	**AD-4B**
TOTAL DEPTH:	**15'**
TOP OF CASING ELEV.:	**333.23 ft. NGVD**
GROUND SURFACE ELEV.:	**329.55 ft. NGVD**

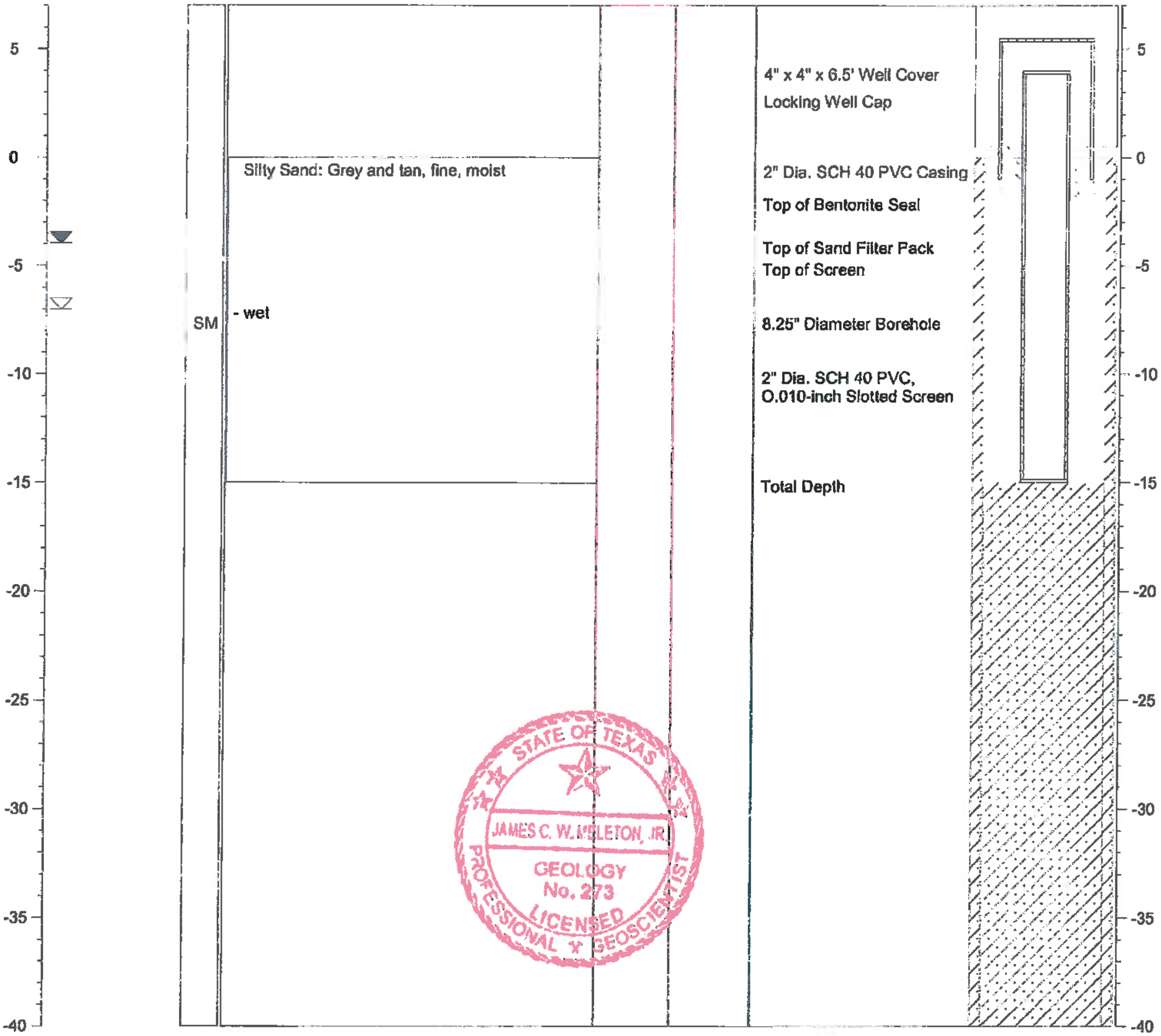
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DILLED:	**9/23/09**

NOTES: **Latitude: 33.04531**
Longitude: 94.84230

▼ Water level during drilling
▽ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



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SOIL BORING LOG

BORING/WELL NO.:	**AD-4C**
TOTAL DEPTH:	**15'**
TOP OF CASING ELEV.:	**333.28 ft. NGVD**
GROUND SURFACE ELEV.:	**329.15 ft. NGVD**

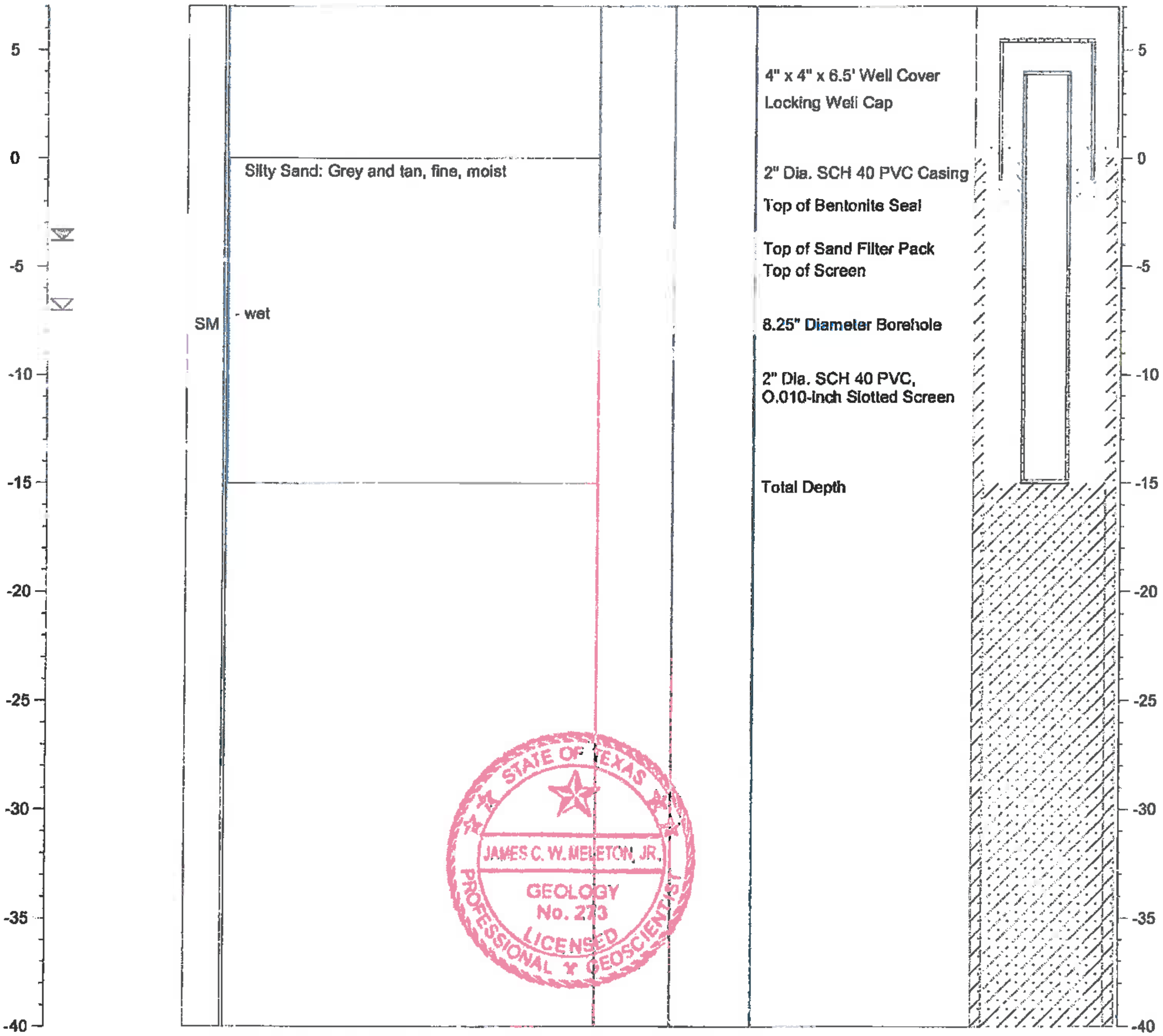
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/23/09**

NOTES: **Latitude: 33.04507**
Longitude: 94.84244

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Silty Sand: Grey and tan, fine, moist

- wet

4" x 4" x 6.5' Well Cover
Locking Well Cap
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
8.25" Diameter Borehole
2" Dia. SCH 40 PVC,
0.010-Inch Slotted Screen
Total Depth

STATE OF TEXAS
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PROFESSIONAL GEOSCIENTIST

AD-5

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt.4, Box 221 (Street or RFD) Pittsburg (City) TX (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt.4, Box 221 (Street, RFD or other) Pittsburg (City) TX (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) 33°03'13"N
94°51'00"W

6) WELL LOG:
Date Drilling:
Started 1-11 19 2001
Completed 1-11 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	30

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ____

From (ft.)	To (ft.)	Description and color of formation material
0	10	red & gray clay with orange streaks
10	20	gray/black clay with tan clay
20	25	stiff clay with lignite streak
25	30	fine gray sand

AD-5

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ____
If Gravel Packed give interval ... from 16 ft. to 30 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	20	Sch 40
2	N	#10 slot screen	20	30	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 16 ft. to 0 ft. No. of sacks used ____
____ ft. to ____ ft. No. of sacks used ____
Method used bentonite
Cemented by ____
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

✓10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level 11' 9" ft. below land surface Date 1-11-01
Artesian flow ____ gpm. Date ____

12) PACKERS: NA Type Depth

13) TYPE PUMP:
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS:
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

✓15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ____ (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS ____ (Street or RFD) (City) (State) (Zip)

(Signed) ____ (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

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ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-6**
TOTAL DEPTH:	**33'**
TOP OF CASING ELEV.:	**346.33 ft. NGVD**
GROUND SURFACE ELEV.:	**343.31 ft. NGVD**

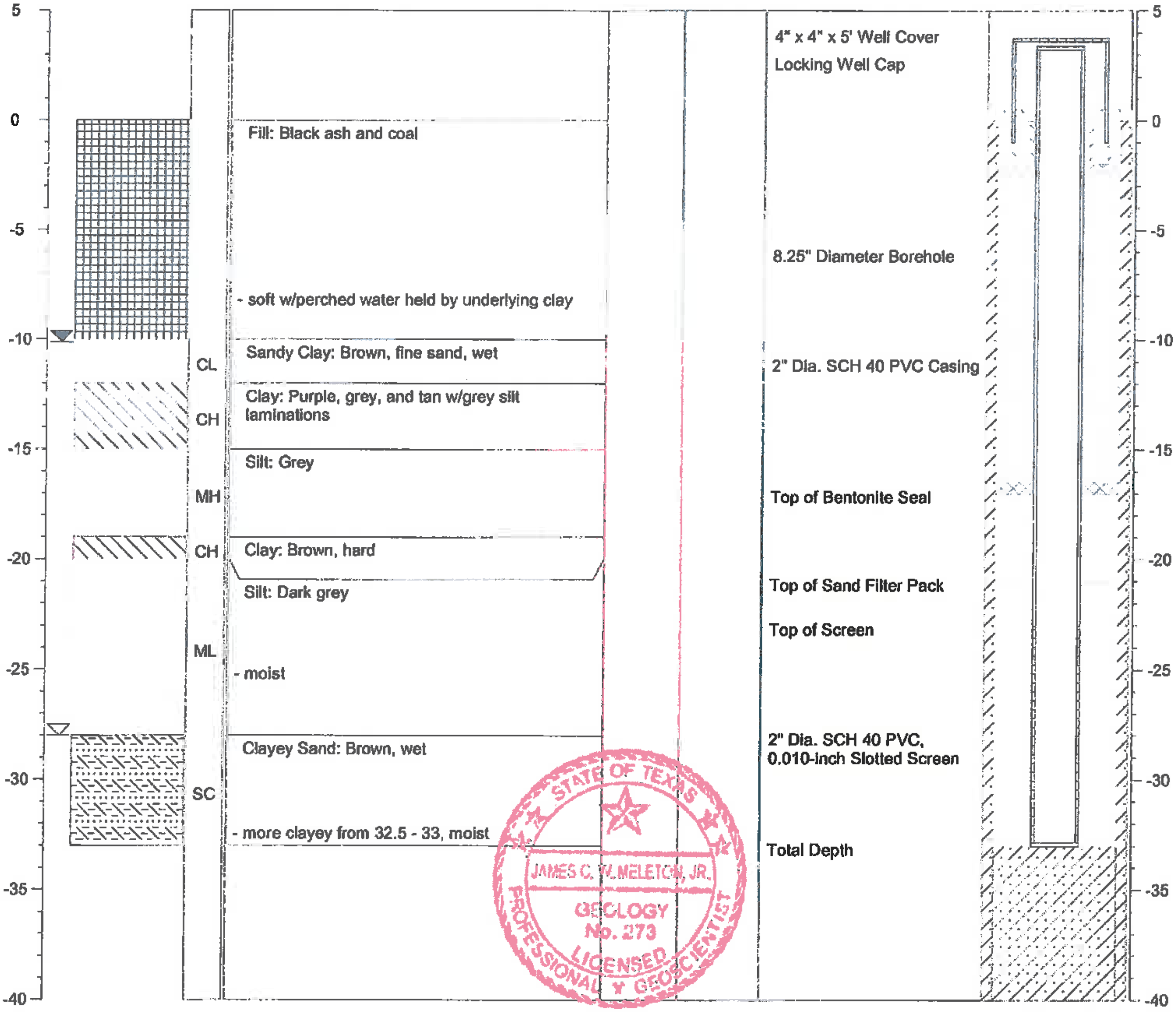
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/23/09**

NOTES: **Latitude: 33.05235**
Longitude: 94.84757

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
	Fill: Black ash and coal
	- soft w/perched water held by underlying clay
CL	Sandy Clay: Brown, fine sand, wet
CH	Clay: Purple, grey, and tan w/grey silt laminations
MH	Silt: Grey
CH	Clay: Brown, hard
ML	Silt: Dark grey
	- moist
SC	Clayey Sand: Brown, wet
	- more clayey from 32.5 - 33, moist

WELL DESCRIPTION

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED PROFESSIONAL GEOSCIENTIST

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OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-7**
TOTAL DEPTH:	**38'**
TOP OF CASING ELEV.:	**350.82 ft. NGVD**
GROUND SURFACE ELEV.:	**347.86 ft. NGVD**

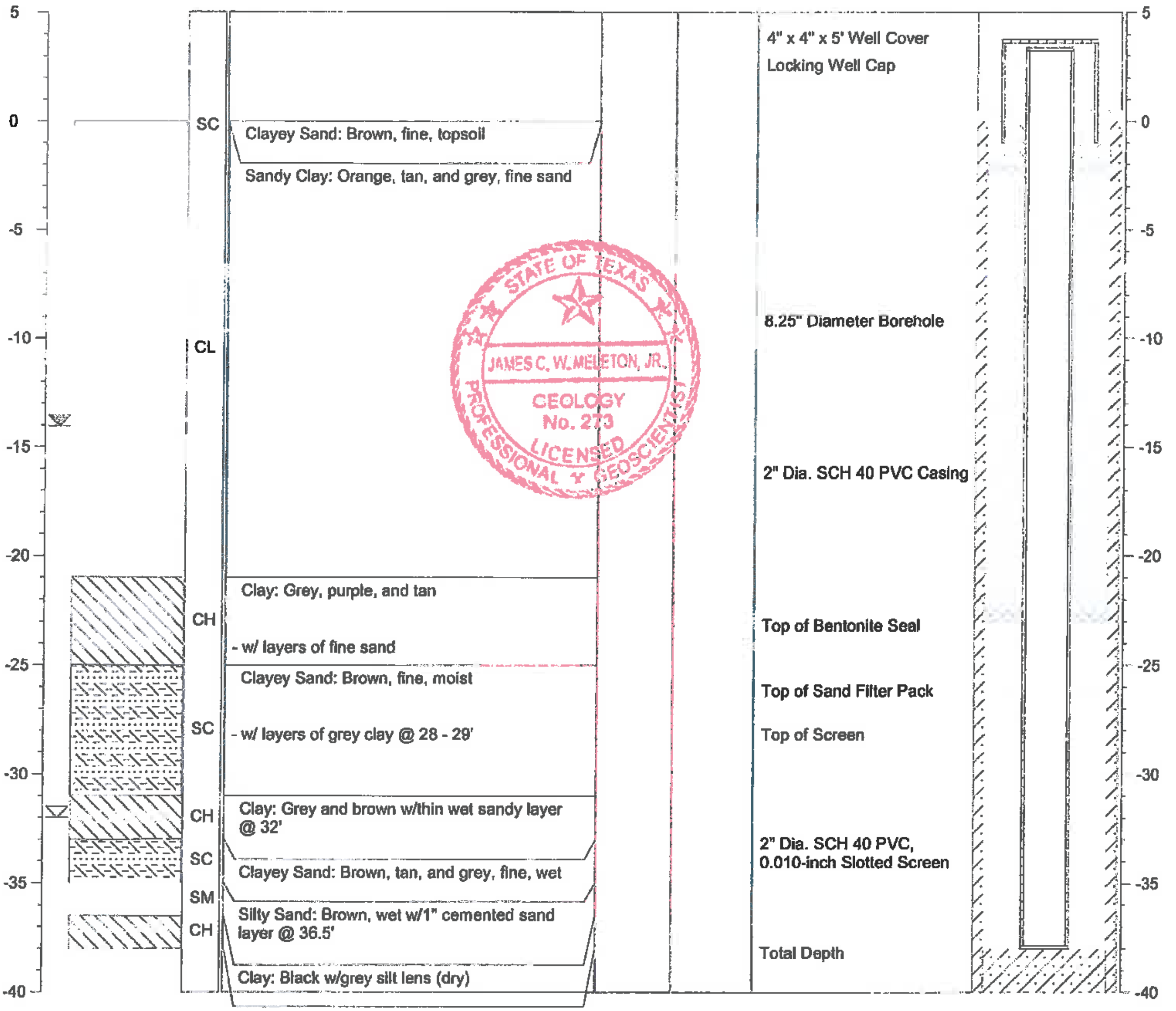
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/24/09**

NOTES: **Latitude: 33.05257**
Longitude: 94.84219

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



SC — Clayey Sand: Brown, fine, topsoil

CL — Sandy Clay: Orange, tan, and grey, fine sand

CH — Clay: Grey, purple, and tan
- w/ layers of fine sand

SC — Clayey Sand: Brown, fine, moist
- w/ layers of grey clay @ 28 - 29'

CH — Clay: Grey and brown w/thin wet sandy layer @ 32'

SC — Clayey Sand: Brown, tan, and grey, fine, wet

SM — Silty Sand: Brown, wet w/1" cemented sand layer @ 36.5'

CH — Clay: Black w/grey silt lens (dry)

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
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SOIL BORING LOG

BORING/WELL NO.:	**AD-8**
TOTAL DEPTH:	**29'**
TOP OF CASING ELEV.:	**340.01 ft. NGVD**
GROUND SURFACE ELEV.:	**337.53 ft. NGVD**

CLIENT:	**AEP**
PROJECT:	**Ash Disposal Area**
SITE LOCATION:	**Welsh Power Plant**
PROJECT NO.:	**S-08-0109**
LOGGED BY:	**James Meleton, Jr.**

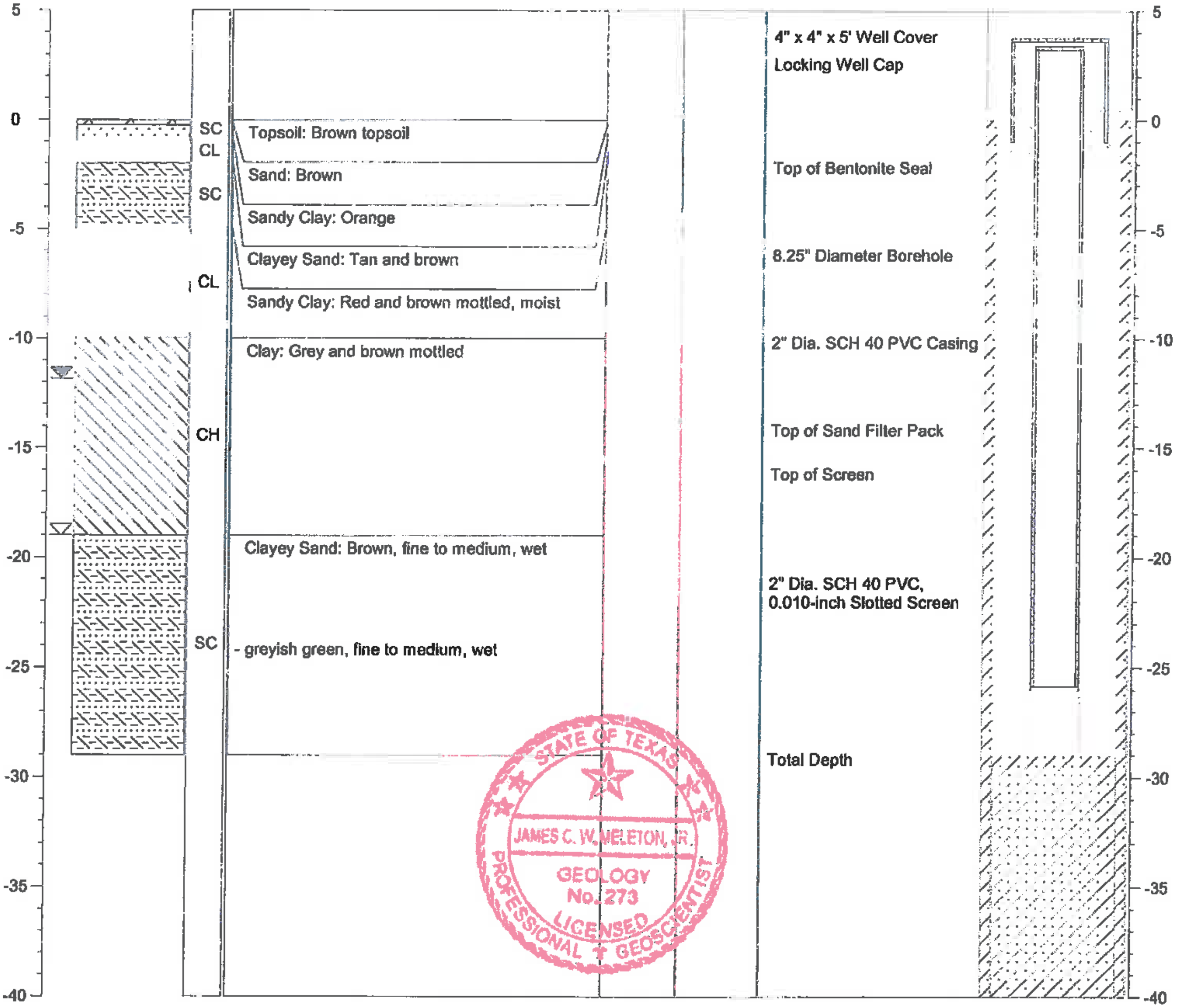
DRILLING CO.:	**WEST Drilling**
DRILLER:	**Tom McCullough**
METHOD OF DRILLING:	**Hollow-stem Auger**
SAMPLING METHODS:	**Split-spoon**
DATE DRILLED:	**9/21/09**

NOTES: **Latitude: 33.05187**
Longitude: 94.84026

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



SC Topsoil: Brown topsoil
CL Sand: Brown
SC Sandy Clay: Orange
Clayey Sand: Tan and brown
CL Sandy Clay: Red and brown mottled, moist
CH Clay: Grey and brown mottled
SC Clayey Sand: Brown, fine to medium, wet
- greyish green, fine to medium, wet

4" x 4" x 5' Well Cover
Locking Well Cap
Top of Bentonite Seal
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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No. 273

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SOIL BORING LOG

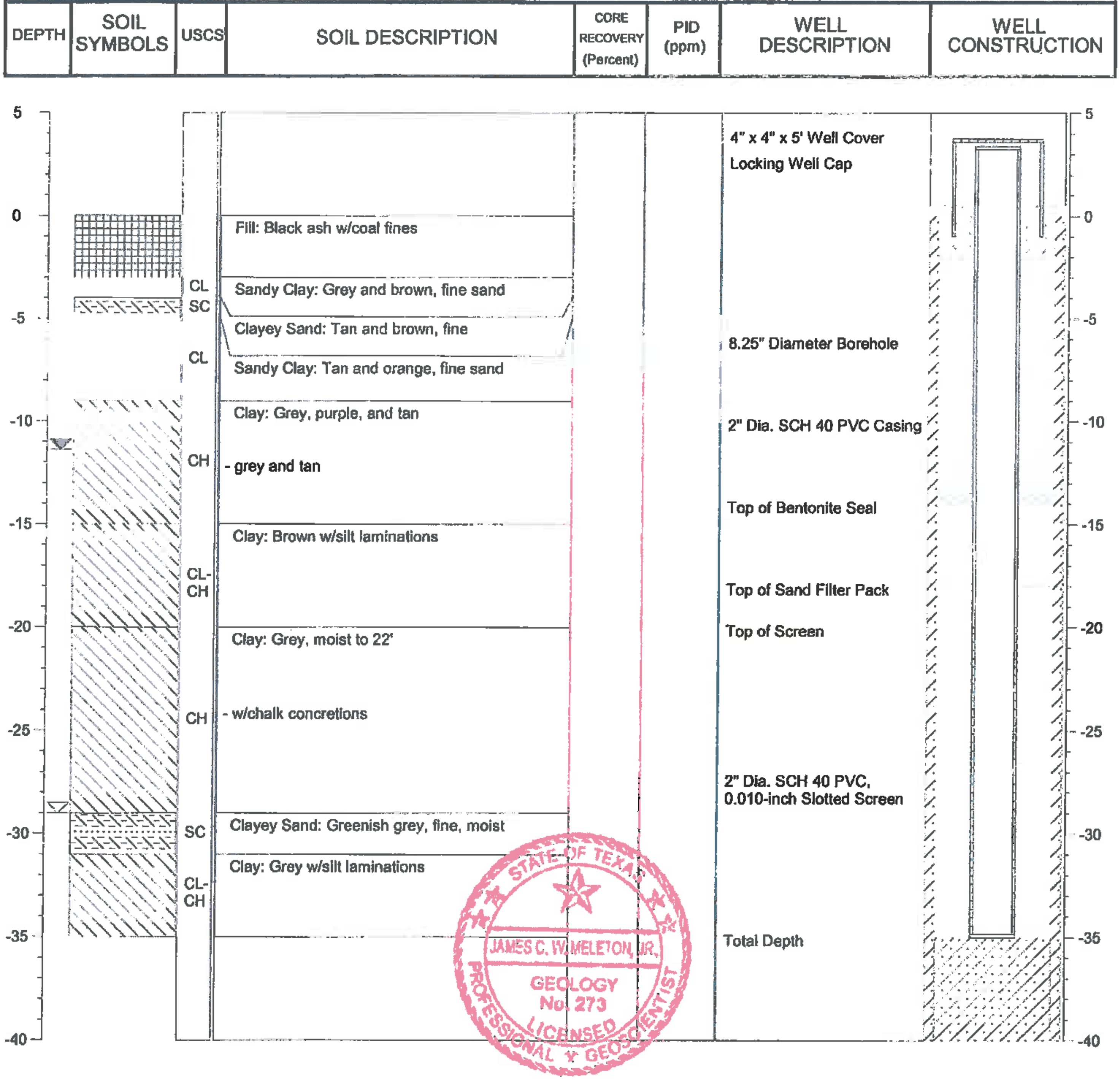
BORING/WELL NO.:	**AD-9**
TOTAL DEPTH:	**35'**
TOP OF CASING ELEV.:	**343.09 ft. NGVD**
GROUND SURFACE ELEV.:	**340.32 ft. NGVD**

CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/21/09**

NOTES: **Latitude: 33.04995**
Longitude: 94.84196

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



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SOIL BORING LOG

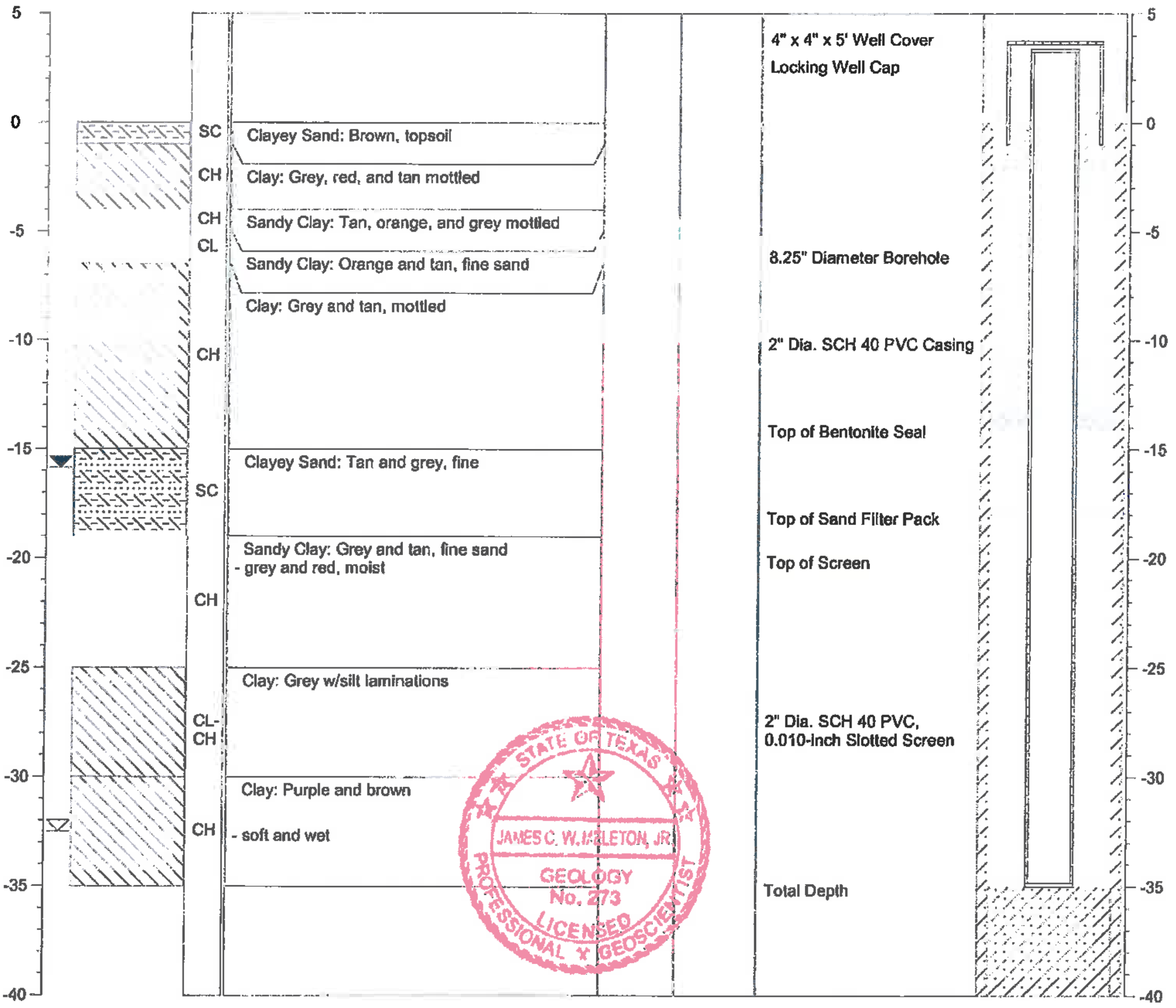
BORING/WELL NO.:	**AD-10**
TOTAL DEPTH:	**35'**
TOP OF CASING ELEV.:	**343.01 ft. NGVD**
GROUND SURFACE ELEV.:	**340.23 ft. NGVD**

CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04881**
Longitude: 94.84047

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
CH	Clay: Grey, red, and tan mottled
CH CL	Sandy Clay: Tan, orange, and grey mottled
	Sandy Clay: Orange and tan, fine sand
CH	Clay: Grey and tan, mottled
SC	Clayey Sand: Tan and grey, fine
CH	Sandy Clay: Grey and tan, fine sand - grey and red, moist
CL-CH	Clay: Grey w/silt laminations
CH	Clay: Purple and brown - soft and wet

WELL DESCRIPTION

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
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SOIL BORING LOG

BORING/WELL NO.:	**AD-11**
TOTAL DEPTH:	**20'**
TOP OF CASING ELEV.:	**342.18 ft. NGVD**
GROUND SURFACE ELEV.:	**339.61 ft. NGVD**

CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04824**
Longitude: 94.84177

▽ Water level during drilling
▼ Water level in completed well

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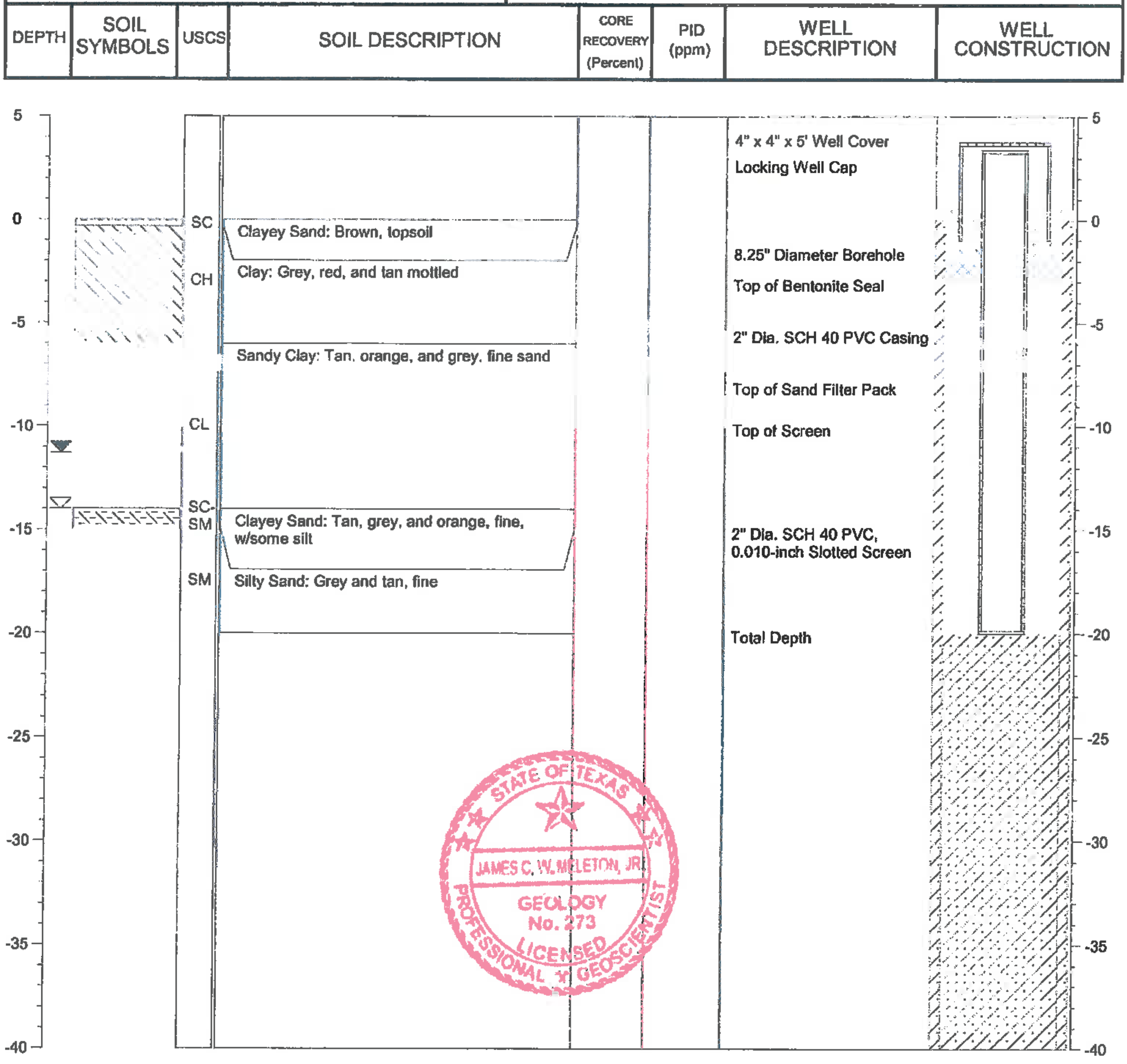

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SOIL BORING LOG

BORING/WELL NO.:	**AD-12**
TOTAL DEPTH:	**30'**
TOP OF CASING ELEV.:	**369.33 ft. NGVD**
GROUND SURFACE ELEV.:	**366.27 ft. NGVD**

CLIENT:	**AEP**
PROJECT:	**Ash Disposal Area**
SITE LOCATION:	**Welsh Power Plant**
PROJECT NO.:	**S-08-0109**
LOGGED BY:	**James Meleton, Jr.**

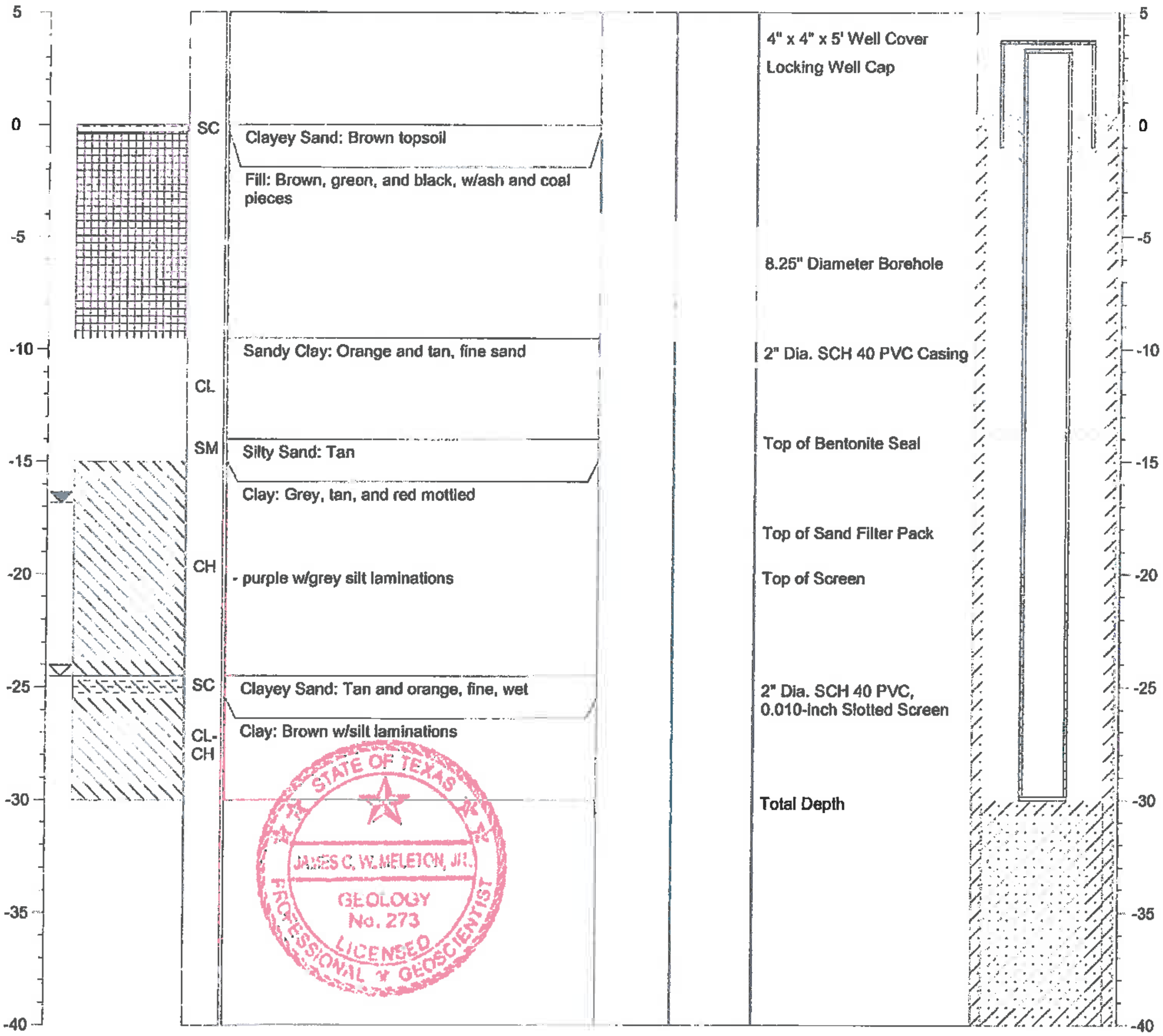
DRILLING CO.:	**WEST Drilling**
DRILLER:	**Tom McCullough**
METHOD OF DRILLING:	**Hollow-stem Auger**
SAMPLING METHODS:	**Split-spoon**
DATE DRILLED:	**9/24/09**

NOTES: **Latitude: 33.04901**
Longitude: 94.84977

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown topsoil
	Fill: Brown, green, and black, w/ash and coal pieces
CL	Sandy Clay: Orange and tan, fine sand
SM	Silty Sand: Tan
CH	Clay: Grey, tan, and red mottled - purple w/grey silt laminations
SC	Clayey Sand: Tan and orange, fine, wet
CL-CH	Clay: Brown w/silt laminations

WELL DESCRIPTION:
- 4" x 4" x 5' Well Cover
- Locking Well Cap
- 8.25" Diameter Borehole
- 2" Dia. SCH 40 PVC Casing
- Top of Bentonite Seal
- Top of Sand Filter Pack
- Top of Screen
- 2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
- Total Depth

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SOIL BORING LOG

BORING/WELL NO.:	**AD-13**
TOTAL DEPTH:	**20'**
TOP OF CASING ELEV.:	**347.00 ft. NGVD**
GROUND SURFACE ELEV.:	**344.12 ft. NGVD**

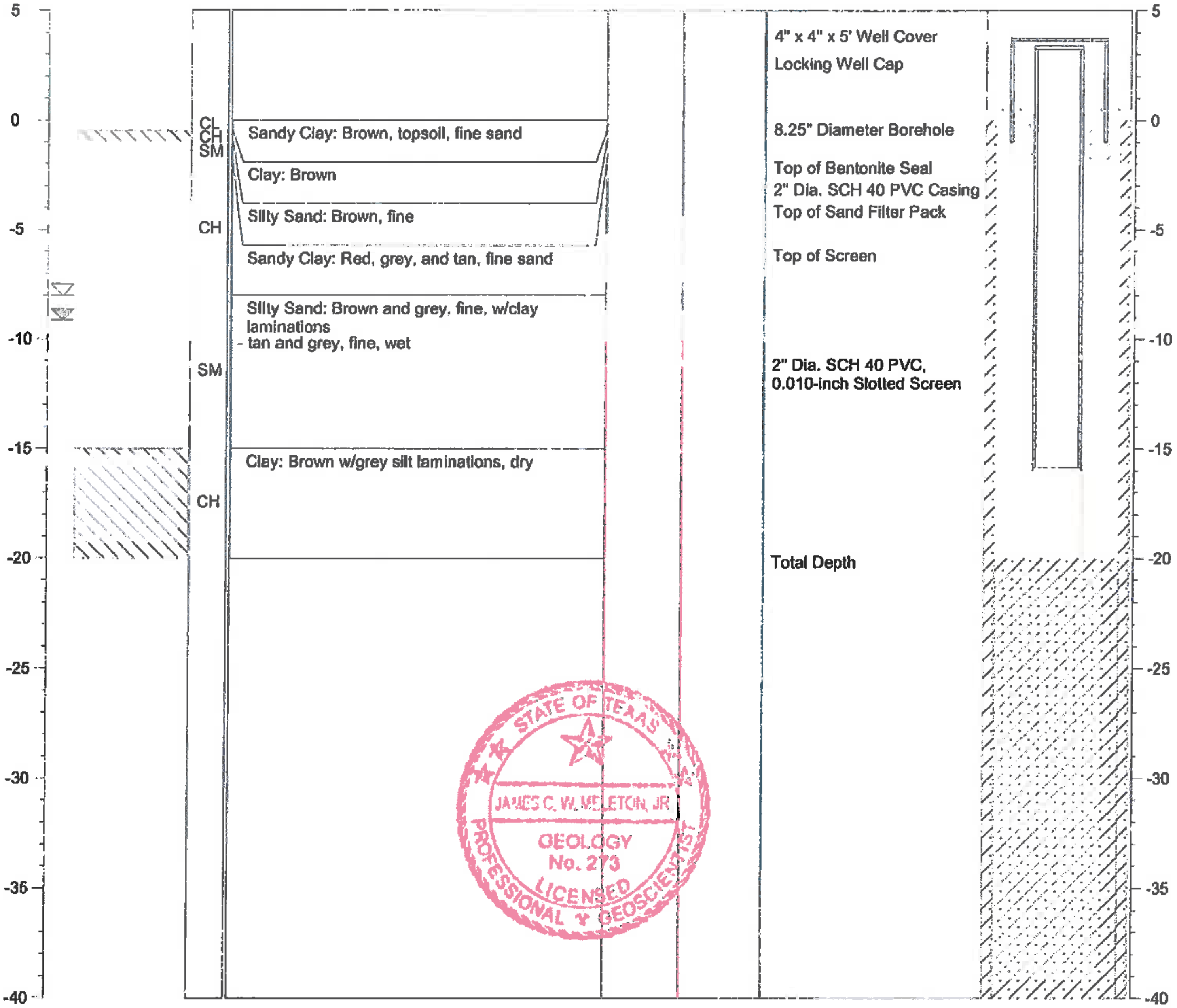
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04918**
Longitude: 94.84275

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
CL	Sandy Clay: Brown, topsoil, fine sand
CH	Clay: Brown
SM	Silty Sand: Brown, fine
CH	Sandy Clay: Red, grey, and tan, fine sand
SM	Silty Sand: Brown and grey, fine, w/clay laminations - tan and grey, fine, wet
CH	Clay: Brown w/grey silt laminations, dry

WELL DESCRIPTION:
4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
Top of Bentonite Seal
2" Dia. SCH 40 PVC Casing
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED
PROFESSIONAL GEOSCIENTIST

EAGLE
ENVIRONMENTAL SERVICES OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-14**
TOTAL DEPTH:	**18.5'**
TOP OF CASING ELEV.:	**345.43 ft. NGVD**
GROUND SURFACE ELEV.:	**342.32 ft. NGVD**

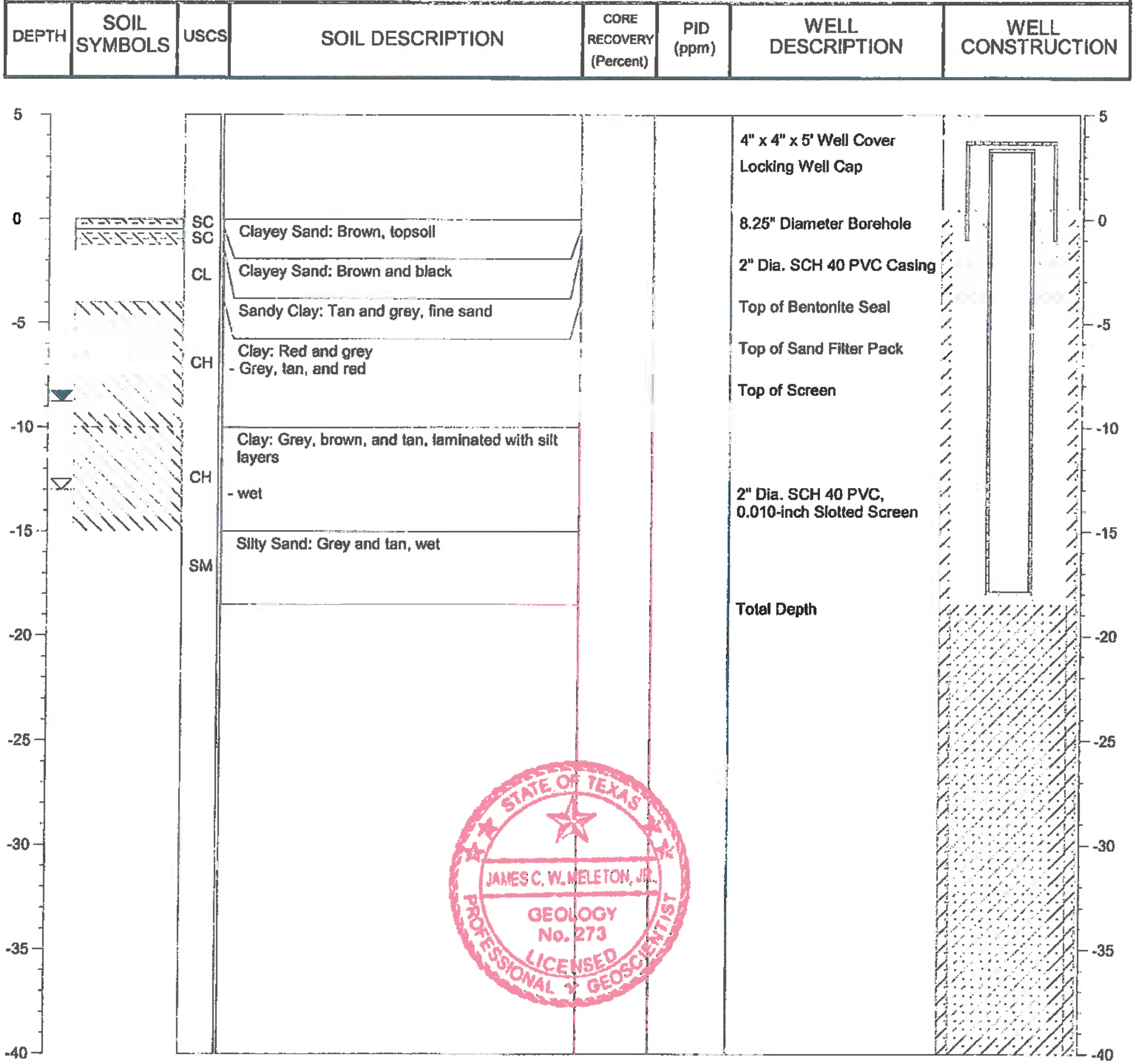
CLIENT:	**AEP**
PROJECT:	**Ash Disposal Area**
SITE LOCATION:	**Welsh Power Plant**
PROJECT NO.:	**S-08-0109**
LOGGED BY:	**James Meleton, Jr.**

DRILLING CO.:	**WEST Drilling**
DRILLER:	**Tom McCullough**
METHOD OF DRILLING:	**Hollow-stem Auger**
SAMPLING METHODS:	**Split-spoon**
DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04715**
Longitude: 94.84256

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
SC	Clayey Sand: Brown and black
CL	Sandy Clay: Tan and grey, fine sand
CH	Clay: Red and grey - Grey, tan, and red
CH	Clay: Grey, brown, and tan, laminated with silt layers - wet
SM	Silty Sand: Grey and tan, wet

WELL DESCRIPTION
4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
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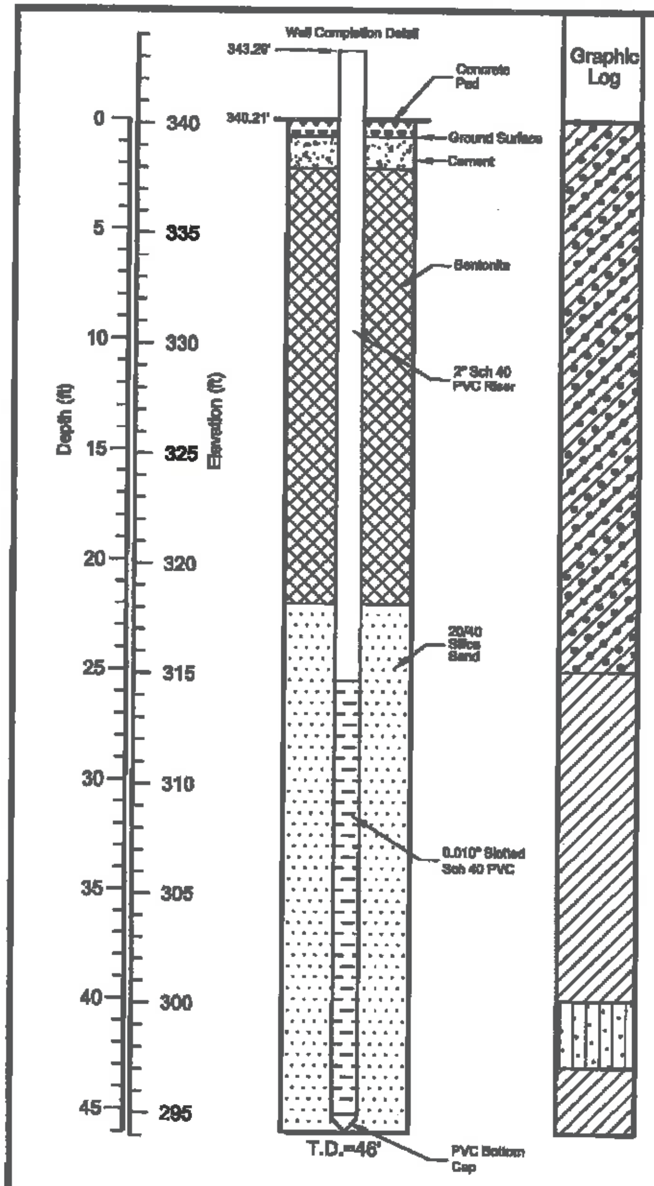


PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		SC	Clayey SAND: reddish brown	16	48	37	18	19
				- 2" lense of brown sand					
				- 3" lense of brown sand					
	Direct Push		CL	Sandy Lean CLAY: reddish brown, very moist					
				- less moisture	22	51	36	19	17
			SM	Silty SAND: light brown & light gray, wet.	27	24	28	NP	-
			CL	Lean CLAY: orangish brown & light gray, mottled, with sand	28	94	45	21	24

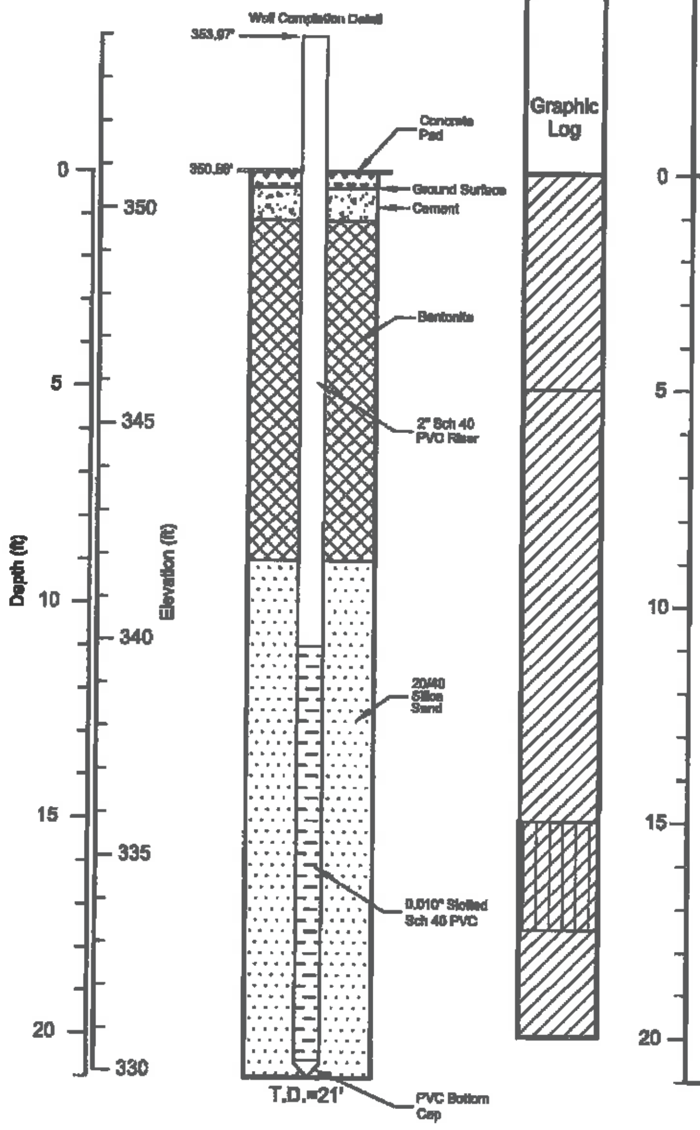
STEVEN R. WEMPLE
SOIL SCIENCE
LICENSE NUMBER 2176

1-22-16

west
DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/12/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-15
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/12/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: —	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg



PID Reading (ppm)	Sampling Device	Sample Interval	Description Interval (feet bgs)	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		CL	Lean CLAY w/ Sand: light brown & light gray - orangish brown, with silt	16	82	26	16	10
			CL	Lean CLAY w/ Sand: orangish-brown & light gray	22	88	31	19	12
			CL-ML	Silty CLAY: orange w/ brown, wet	30	69	27	20	7
			CL	Sandy, Lean CLAY: brown w/ orange, stiff	26	66	46	26	20

STEVEN R. WEMPLE
SOIL SCIENCE
LICENSE NUMBER 2176

1-22-16

West DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/10/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-16
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/10/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: –	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg

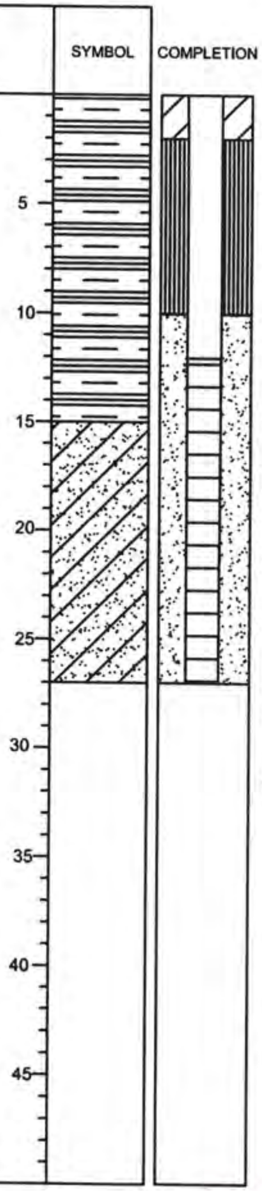
WELL LOG

DEPTH	SAMPLE	ANALYZED	TYPE	ORGANIC VAPOR (ppm)	SAMPLE DESCRIPTION
			SS		(0-15') SILTY CLAY (CL), BROWN TO ORANGE-BROWN, STIFF, DRY.
			SS		
			SS		
			SS		
			SS		
			SS		
			SS		
			SS		(15-18') SILTY CLAY AND SANDY CLAY, ORANGE-BROWN TO LIGHT GRAY, MOIST.
			SS		(18-27') SILTY CLAY AND SANDY CLAY, DARK BROWN TO GRAY, MOIST TO WET.
			SS		
			SS		
			SS		
			SS		

TOTAL DEPTH = 27' BGS

Kenneth J. Brandner
Geology
1787

Kenneth J. Brandner 4-12-17



AD-16R
WELL

AEP
CLIENT

BOTTOM ASH STORAGE POND
PROJECT

WELSH POWER PLANT
LOCATION

4/12/17
DATE

HSA
DRILLING METHOD

2" PVC, 2' AGL-12' BGL
CASING

2" PVC, 12'-27' BGS
SCREEN

0-2' BGS
CEMENT

2-10' BGS
BENTONITE

10-27' BGS
SAND PACK

350.55' / 353.49'
GROUND ELEV. / TOP OF CASING ELEV.

CT - CUTTINGS
SB - SPLIT BARREL(5')
SS - SPLIT SPOON(2')

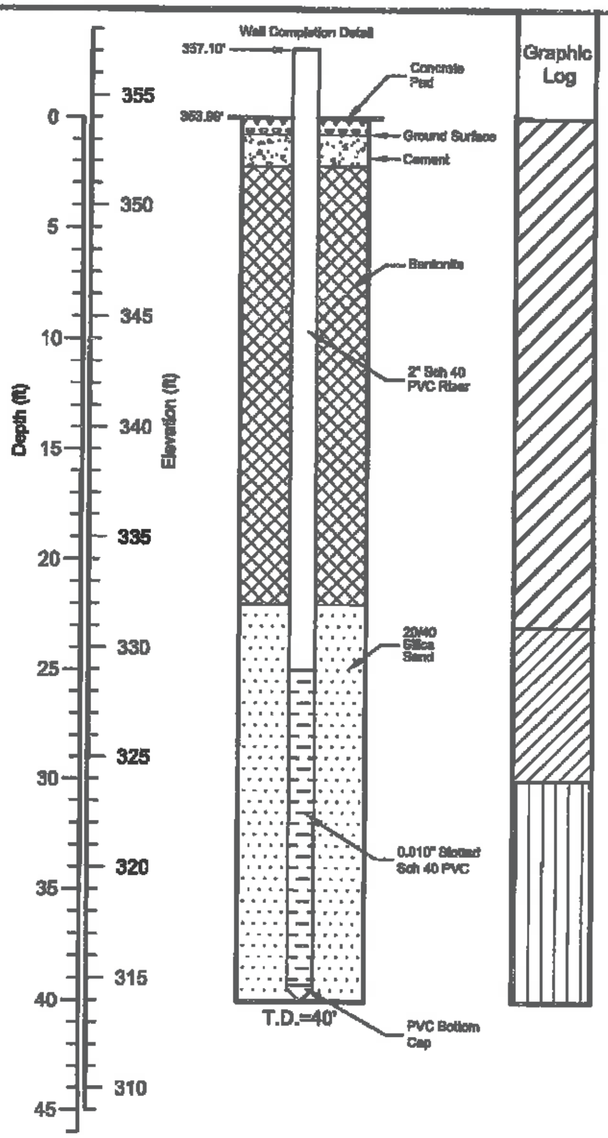
▽ HC LEVEL
▼ WATER LEVEL

▨ SAND
▨ SILT
▨ CLAY
▨ FILL/CONCRETE
▨ BENTONITE
▨ GRAVEL

START: FINISH:

PAGE 1 OF 1

ARCADIS Design & Consultancy for natural and built assets
711 N. CARANCAHUA, #1080
CORPUS CHRISTI, TEXAS 78401
TEL: (361) 883-1353 FAX: (361) 883-7565



Depth (ft)	PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
0		Direct Push		CH	Fat CLAY: reddish-brown					
5					- light gray to light brown, reddish brown w/ Sand and gravel lenses	24	97	83	30	53
10					- light brown					
15					- brown Sand lenses, wet					
20					- gray, w/ some Silt	18	90	53	25	28
25				CL	Lean CLAY with Sand: gray	22	81	43	22	21
30		Direct Push		ML	Sandy SILT: gray	23	63	26	NP	-
35										
40										

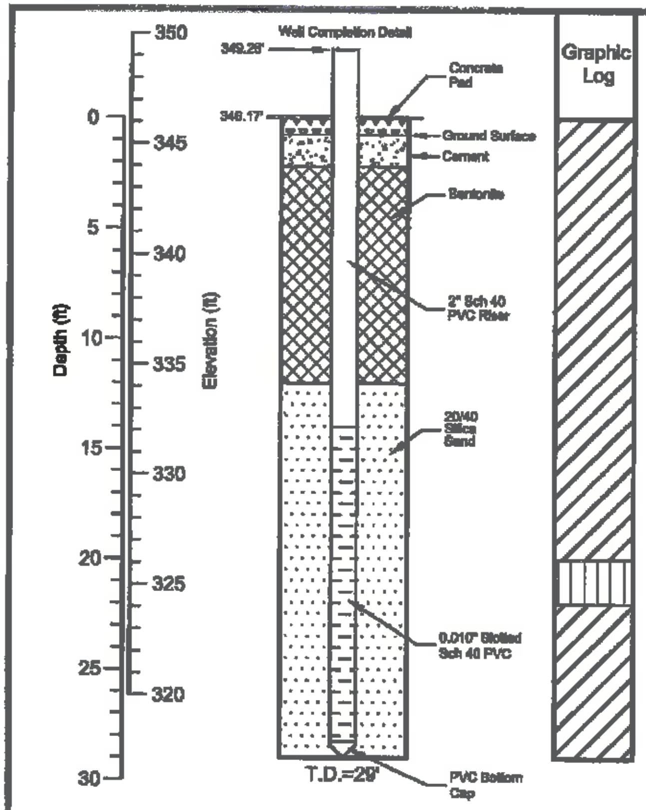
STEVEN R. WEMPLE
SOIL SCIENCE
LICENSE NUMBER 2176

1/22/16

west DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahatchie, Texas 75165

DATE: 12/10/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-17
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/11/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: –	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg



Depth (ft)	PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
0		Direct Push		CH	Fat CLAY: light brown & light gray, sandy					
5					- reddish brown and light gray, with Sand					
10						19	88	50	24	26
15					- gray with silt					
					- gray, stiff					
20				ML	SILT: gray, with Clay and Sand, wet	29	86	26	NP	-
25				CH	Fat CLAY: light gray, silty w/ Sand, very stiff	20	85	50	23	27
30										

STEVEN R. WEMPLE
2176

1-22-21

WEST DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/11/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-18
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/11/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: –	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg

Project: AEP Welsh Power Plant
Project Location: Cason, TX
Project Number: TXL0064

Log of Boring GB-1

Sheet 1 of 2

Date(s) Drilled **July 23, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **37 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **367 feet MSL**
Groundwater Level and Date Measured	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Bentonite Chips**	Location **On the Northern edge of proposed chemical pond along the screening berm.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
367	0					Other		Black COAL, a few fine roots and organics.						
			ST											Shelby tube pulled black COAL
			SS	10										SPT 4, 5, 5, 5. 24" recovered
362	5		SS	11	Soft to Firm	SC		Reddish Brown fine SAND, little clay, trace silt, Dry. Natural Ground.						SPT 4, 5, 6, 7. 24" recovered
			SS	11	Soft	SM		Reddish brown fine SAND with silt, trace clay. Vertical sand seams in sample, Dry.						SPT 3, 5, 6, 8. 24" recovered.
357	10		ST						23.6	[illegible]	48.9	5.4E-07		Shelby tube sample, 18" recovered.
			SS	12	Soft	SC		Reddish brown well graded fine SAND, trace silt and clay. Damp.						SPT 5, 6, 6, 9. 24" recovered
					Firm	CL		Greyish red CLAY, little sand, horizontal sand seams, Dry.						
			SS	13	Soft	SC		Brownish red fine SAND, little clay, Damp.						SPT 7, 6, 7, 9. 24" recovered.
					Firm	SC-CL		Four-inch CLAY seam, little fine sand.						
					Firm	CL		Reddish grey CLAY, little sand, oxidized iron ore. Dry						
352	15		SS	16	Soft	SM		Brownish red fine SAND, trace clay, thin clay seams. Moist.	17.74	14	40.1			SPT 8, 9, 9, 9. 24" recovered.
			ST						16.25	NP	28.9	3.6E-05		Shelby tube samples look like SC. 17" recovered.
347	20		SS	17	Soft	Other		Iron oxidized material						SPT 9, 8, 9, 11. 24 inches recovered.
					Soft	SC		Brownish red fine SAND, little clay. Moist.						
			SS	15										SPT 5, 7, 8, 50/2. 21" recovered
			SS	50	Soft	CL		Dark grey CLAY, little fine sand, Wet.						SPT 50/3".
					Very Hard	SP		Dark grey-black cemented SAND, little clay. Wet. Driller comments that cemented sand terminates at 25.5 feet.						
342	25													
			SS	27	Soft to Firm	SC		Dark grey fine SAND, little clay. Moist. Soft sand with lenses of firm clay.						SPT 11, 13, 14, 16. 24" recovered.
					Hard	CL		Dark grey CLAY, little sand, Dry.						
			SS	46	Soft	SC		Dark grey-black fine SAND, little clay, Wet. Encountered water but water rose to 19 feet after 15 min break.						SPT 11, 16, 30, 14. 24" recovered.
			SS	37										SPT 11, 15, 22, 25. 24" recovered.
337	30				Hard	CL								

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, TX
Project Number: TXL0064

Log of Boring GB-1

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
337	30	▨	SS	37	Hard	CL	▨	Dark grey CLAY, little fine sand, occansional horizontal sand seams. Wet. (cont.)						SPT 11, 15, 22, 25. 24" recovered.
		▨			Soft	ML	▥	Dark grey-black fine SAND, with clay, frequent hard clay lenses (1-3"), Wet.						SPT 6, 11, 18, 24. 24 recovered.
		▨	SS	29			▥		26.37	NP	57.5			
332	35				Hard	CL	▨	Black CLAY, trace to little fine sand, trace silt. Dry						SPT 9, 16, 18, 23. 24" recovered.
			SS	34			▨							
								Bottom of Boring at 37 feet bgs						
327	40													
322	45													
317	50													
312	55													
307	60													
302	65													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-02

Sheet 1 of 1

Date(s) Drilled **August 14, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **30 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **364.56 feet MSL**
Groundwater Level and Date Measured **21.53 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Well Completion**	Location **Western edge of proposed chemical pond near perimeter fence.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
364.6	0				Soft	Other		Coal						
					Soft	CL		Greyish brown CLAY, with little silt, little sand, damp.						
			SS	4										SPT 2, 2, 2. 12" recovered.
			SS	13										SPT 4, 7, 6, 12.
														Shelby Tube Sample
359.6	5		ST											
					Firm	CH		Brownish tan CLAY with silt, little sand, Damp. Occasional sand and iron ore.						SPT 8, 12, 17, 21
			SS	29					23.71	36	77.3			
														SPT 20, 30, 50/5. 17" recovered
			SS	80										
354.6	10				Soft	SC		Red-orange fine SAND, little clay, damp. Occasional iron ore.						SPT 15, 20, 24, 31. 18" recovered.
					Soft	CL		Brownish tan CLAY, little silt, little sand, Damp.						
			SS	44	Soft	SM		Red-orange fine SAND, little clay, Damp.						
														SPT 11, 12, 9, 32.
			SS	21					20.35	NP	33.5			
														SPT 6, 6, 12, 6.
349.6	15		SS	18										
					Soft	SM-SC		Light brown fine SAND, with little silt, little sand, Damp.						
														SPT 12, 25, 50/5.
					Firm	CL		Black CLAY, with fine sand, Wet.						
			SS	75	Soft	SM-SC		Dark red fine SAND, little clay, little silt, Wet.						
														SPT 9, 16, 12, 15.
					Soft-Firm	SC		Dark grey fine SAND, little clay, Wet. Occasional clay seams.						
			SS	28										
344.6	20													SPT 9, 17, 21, 27.
			SS	38	Firm	SC		Frequent clay lenses. 8/11/09 ▼	22.55	13	36.6			
														SPT 22, 35, 50/4".
			SS	65										
														SPT 10, 15, 18, 26.
339.6	25		SS	33										
					Soft	SC		Less clay lenses, Wet.						SPT 12, 27, 37, 50/5".
			SS	64										
														SPT 19, 24, 21, 50/5".
			SS	44										
					Hard	CL		Dark grey CLAY, [illegible] trace silt, Wet.						
334.6	30													

Figure

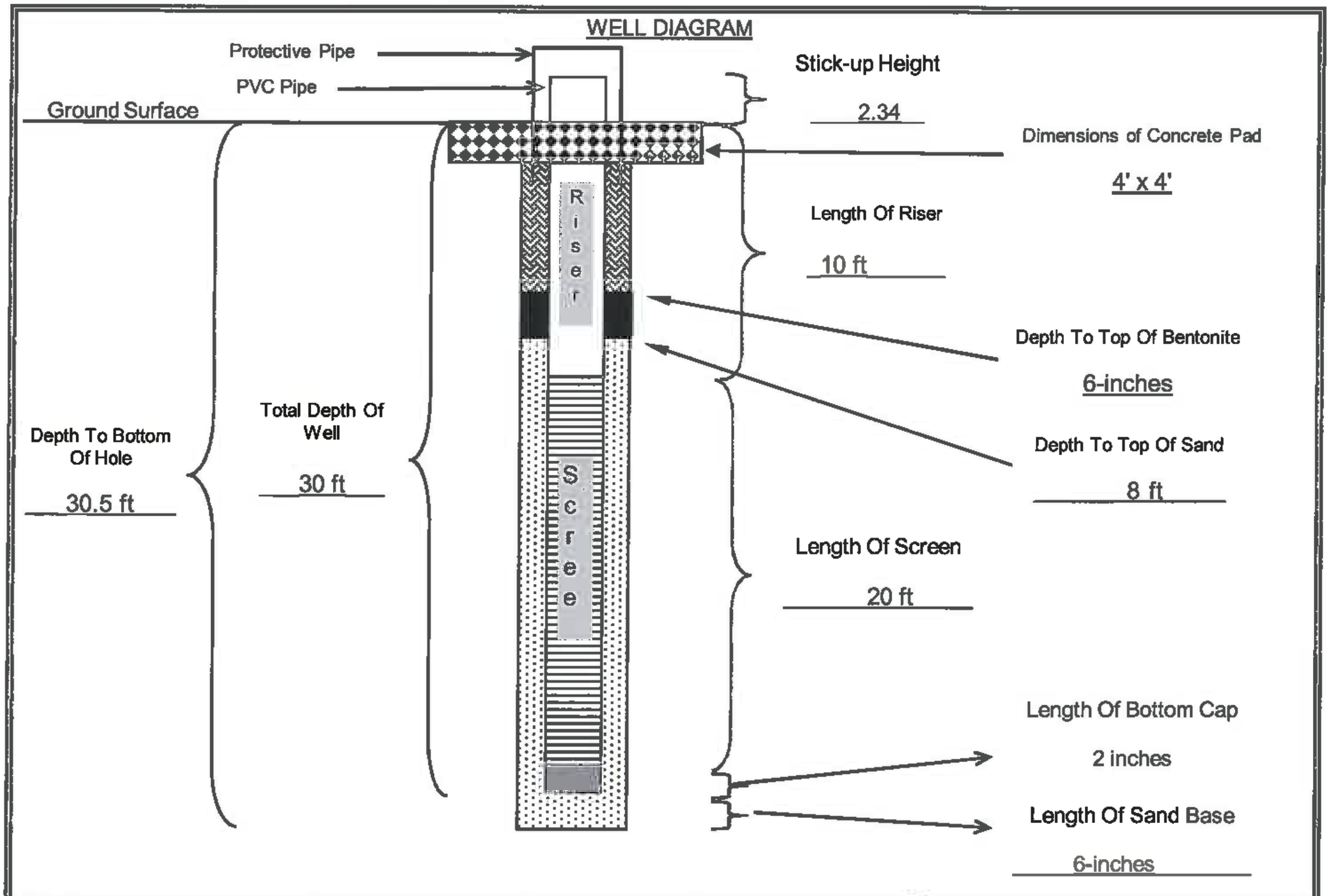
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		GB-02
JOB NO.:	TXL0064		
DATE/TIME:	8/7/2009	WELL NO.:	
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	364.56 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	354.56 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	334.06 (ft, msl)	CEMENT TYPE:	Not used-sealed with bentonite chips
NORTHING: 747.0223	EASTING: -2442.888	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	4 bags lbs
RISER DIAMETER:	2 (in) Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in) Length: 20 (ft)	AMOUNT SAND USED:	13 bags lbs
BOREHOLE DIAMETER:	8 (in)	STATIC WATER:	21.53 depth from TOC
DRILLING TECHNIQUE:	Hollow stem Size: (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.34

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2 inches

Length Of Sand Base: 6-inches

Depth To Bottom Of Hole: 30.5 ft

Total Depth Of Well: 30 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC	INSTALLED BY: Total Support Services	OBSERVED BY:	Kush Chohan
	DATE: August 7th, 2009	CHECKED BY:	DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-03

Sheet 1 of 2

Date(s) Drilled **August 7, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **31 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **359.91 feet MSL**
Groundwater Level and Date Measured **21.89 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Well Completion**	Location **Southwest corner of proposed chemical pond near screening pile.**	

Elevation, feet	Depth, feet	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	REMARKS AND OTHER TESTS
359.9	0			Soft	Other	Coal					
354.9	5			Soft	CH	Shelby Tube					Shelby tube sample.
		ST						43	96.1		
				Firm	CH	Light brown-grey CLAY, little silt, occasional sand seams (fine), Damp.					SPT 29, 22, 19, 21.
		SS	41				24.04	29	90.4		
				Soft	CH	Brownish dark grey CLAY, trace sand, trace silt, Wet.					SPT 6, 12, 15, 20.
349.9	10	SS	27								
											SPT 17, 29, 24, 25.
		SS	53	Soft	SC	Dark orange red SAND, little clay, trace silt, Wet. Occasional clay seam (dark grey).					
				Soft	SC	Clay lenses.					SPT 7, 15, 17, 40.
		SS	32								
344.9	15										SPT 9, 17, 30, 20.
		SS	47	Soft	SC	Clay lense					
				Soft	SC	Dark grey fine SAND with clay, occasional clay lense, Wet.					SPT 11, 50/4".
		SS	50	Firm	CL	Dark grey CLAY, little fine sand, Wet.					
				Soft	SC	Dark grey fine SAND, little clay, occasional clay seam, iron ore, Wet.					SPT 11, 27, 17, 21.
339.9	20	SS	44								
						8/11/09					
334.9	25										SPT 27, 40, 50/4".
		SS	90								
				Firm	SC	Dark grey clay lense					SPT 11, 15, 40, 50/3".
		SS	55								
											SPT 17, 50/5.5".
		SS	55								
329.9	30										

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-03

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
329.9	30	▨ SS	55	Hard	CL	▨	Dark gray CLAY, trace silt, trace fine sand.					▨	SPT 17, 50/5.5".
							Bottom of Boring at 31 feet bgs						
324.9	35												
319.9	40												
314.9	45												
309.9	50												
304.9	55												
299.9	60												
294.9	65												

Figure

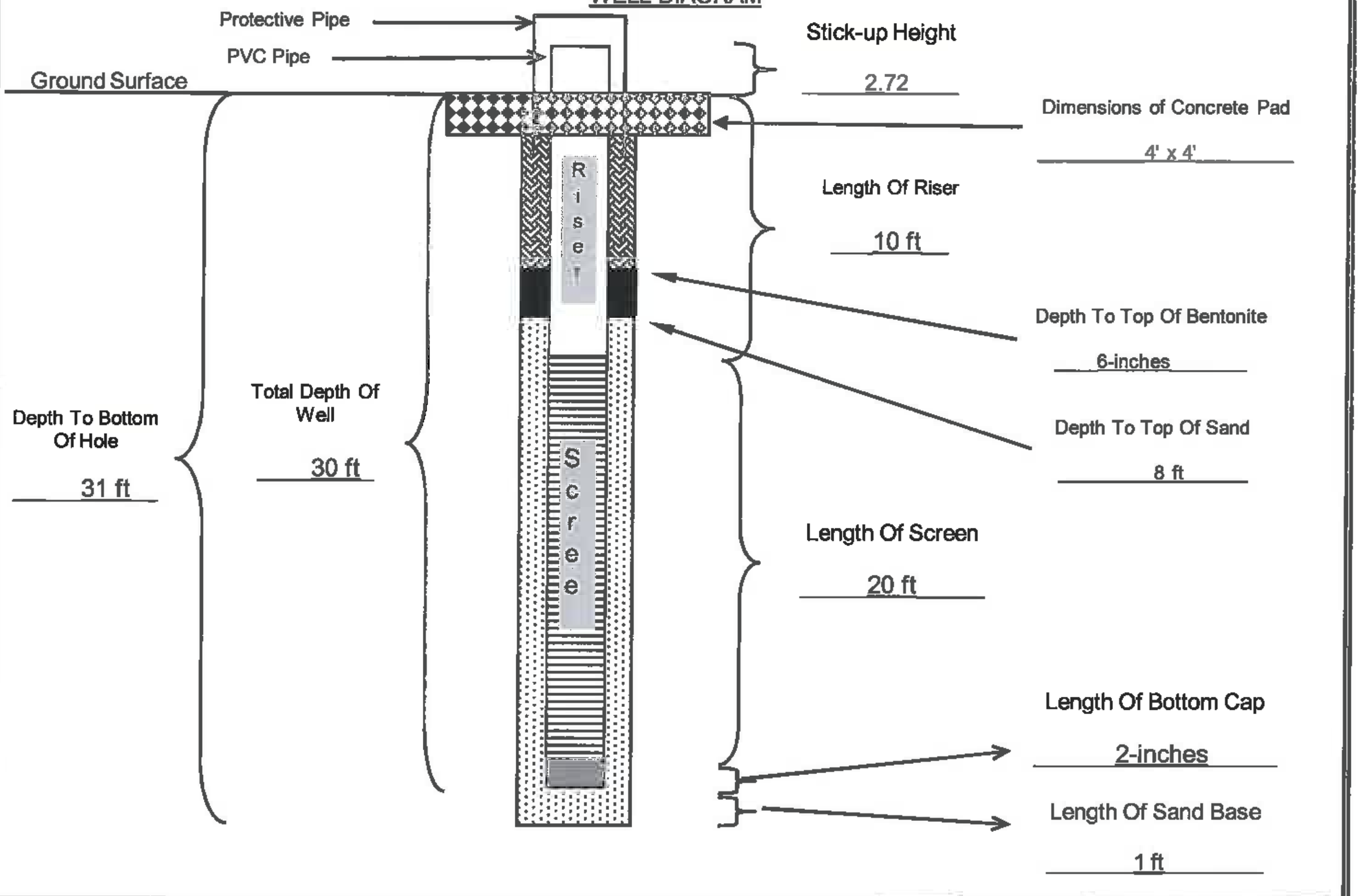
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		
JOB NO.:	TXL0064		
DATE/TIME:	8/7/2009	WELL NO.:	GB-03
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	359.57 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	349.57 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	328.57 (ft, msl)	CEMENT TYPE:	None used-sealed with bentonite chips
NORTHING:	460.5803 EASTING: -2507.6332	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	4 bags lbs
RISER DIAMETER:	2 (in) Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in) Length: 20 (ft)	AMOUNT SAND USED:	12 bags lbs
BOREHOLE DIAMETER:	8 (in)	STATIC WATER:	21.89 depth from TOC
DRILLING TECHNIQUE:	Hollow Stem Size: 8 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.72

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Depth To Bottom Of Hole: 31 ft

Total Depth Of Well: 30 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 1 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

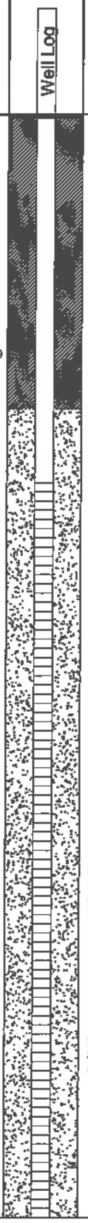
QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush S. Chohan
DATE:	7-Aug-09	CHECKED BY:	DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-04

Sheet 1 of 2

Date(s) Drilled **July 24, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **34 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **357.22 feet MSL**
Groundwater Level and Date Measured **20.54 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Well Completion**	Location **Southeast corner of proposed chemical evaportation pond. Located in a grassy field.**	



Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	REMARKS AND OTHER TESTS
357.2	0	▨			Soft	SM-SC	Reddish brown fine SAND, little silt, trace clay, damp.					SPT 1, 3, 6, 6. 24" recovered.
		▨	SS	9	Soft Firm	Other SC	COAL Brownish red SAND, little clay, trace silt. Damp.					
		▨			Firm	CL	Reddish pink CLAY, some fine sand, Dry.					SPT 4, 4, 4, 4. 24" recovered.
		▨	SS	8				24.49	47	90.2		
		▨					Oxidized SAND and clay with iron ore.					SPT 5, 6, 8, 4. 18" recovered.
352.2	5	▨	SS	14	Soft Soft	Other CH	Light reddish brown CLAY and sand mixture, Dry.					
		☒	ST		Soft	SC	Reddish brown SAND, little clay, Dry.	28.4	36	61.1	7.7E-09	12" Shelby tube. 9" recovered.
		▨	SS	17	Firm	CH	Light brownish tan CLAY, little sand, occasional sand seams, Dry.					SPT 3, 4, 13, 15. 27" recovered.
347.2	10											
342.2	15	▨	SS	10	Soft Firm	SC SC	Red/yellowish brown SAND, some clay, Wet. Occasional clay lenses.	6.95	14	47		SPT 3, 7, 3, 15. 24" recovered.
337.2	20	☒	ST				8/11/09					Shelby tube. 12" driven 0" pulled. Gravel material encountered.
		▨	SS	19	Soft to Firm	SM	Black to dark grey fine/med SAND, little clay, occasional clay lenses, Wet.					SPT 7, 10, 9, 13. 24" recovered.
332.2	25	▨	SS	74	Soft	SM	Well graded light grey fine/med SAND, trace silt, Wet.	22.29	NP	13.5		SPT 17, 24, 50/5.5". 19" recovered.
					Firm Firm	CL SM-SC	Dark grey clay lense, Wet. Well graded light grey fine/med SAND, trace silt, Wet.					
327.2	30											

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-04

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
327.2	30	☒	ST		Hard	ML		Dark grey CLAY, little sand, Wet.						12" Shelby tube. Bent shelby tube.
		☒	ST						21.3	NP	84.2	2.0E-08		12" Shelby tube.
		▨	SS	38	Hard	CL		Dark grey CLAY, trace sand, Wet.	25.44	18	92.5			SPT 15, 19, 19, 25. 24" recovered.
								Bottom of Boring at 34 feet bgs						
322.2	35													
317.2	40													
312.2	45													
307.2	50													
302.2	55													
297.2	60													
292.2	65													

Figure

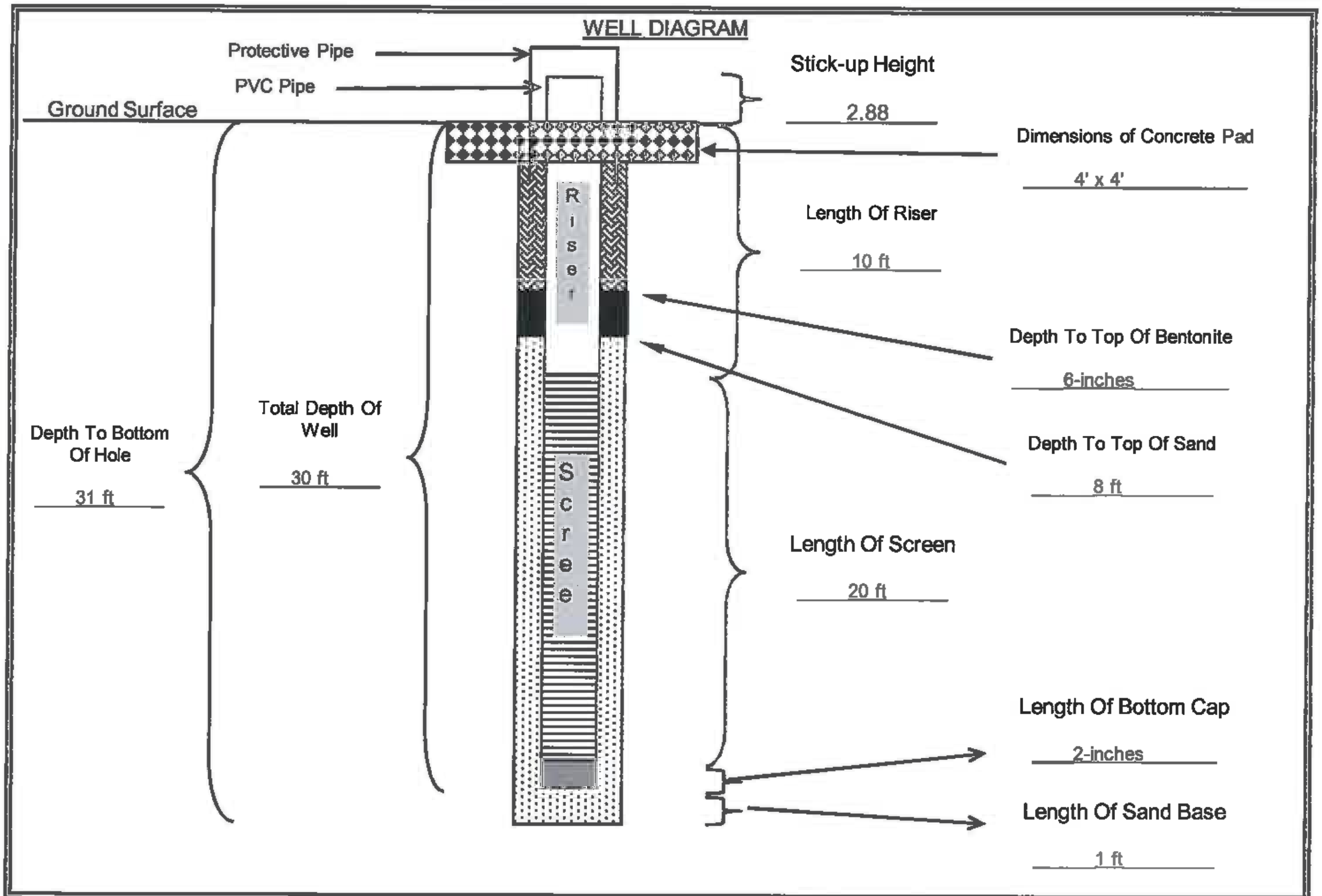
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: 24-Jul-09
WELL LOCATION:
WELL NO.: GB-04
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION:	357.22 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	347.22 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	326.22 (ft, msl)	CEMENT TYPE:	
NORTHING: -384.9666	EASTING: -2353.7375	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	3 bags lbs
RISER DIAMETER: 2 (in)	Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER: 2 (in)	Length: 20 (ft)	AMOUNT SAND USED:	7 bags lbs
BOREHOLE DIAMETER:	6.75 (in)	STATIC WATER:	20.54 depth from TOC
DRILLING TECHNIQUE: Hollow Stem	Size: 6.75 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.88

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Depth To Bottom Of Hole: 31 ft

Total Depth Of Well: 30 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 1 ft

▨ Cement/Bentonite Grout ⋯ Sand Pack ▦ Neat Concrete ■ Bentonite ▩ Bottom Cap

QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush S. Chohan
DATE:	24-Jul-09	CHECKED BY:	DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-05

Sheet 1 of 2

Date(s) Drilled	**July 24, 2009**	Logged By	**Kush S. Chohan**	Checked By	
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type		Total Depth of Borehole	**30.5 feet bgs**
Drill Rig Type	**Mobil B61**	Drilling Contractor	**Total Support Services**	Approximate Surface Elevation	**357.49 feet MSL**
Groundwater Level and Date Measured	**15.3 feet measured on 8-11-09**	Sampling Method(s)	**SPT, Tube**	Hammer Data	**140 lb, 30 in drop, Auto-hammer**
Borehole Backfill	**Well Completion**	Location	**Eastern edge of proposed chemical evaporation pond.**		

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.5	0				Soft	SW-SM		Dark fine SAND with brown organic material and roots.						SPT 2, 2, 5, 5. 24" recovered
			SS	7	Firm	CH		Dark red/grey CLAY, trace silt. Dry.	23.37	44	68.6			
														SPT 4, 4, 7, 9. 24" recovered.
			SS	11								7E-07		
														SPT 5, 6, 8, 13. 24 recovered
352.5	5		SS	14										
						CH		Trace of sand						
			ST		Soft	CH		Dark red fine SAND, trace clay, Damp.	16.5	41	73.8	3.2E-08		Shelby tube. Pushed 12 recovered 9".
														SPT 5, 7, 11, 11. 24" recovered.
			SS	18	Firm	CH		Light tan CLAY, trace sand, Dry.						
					Soft	SC		Dark red SAND, trace of CLAY, Damp.						
					Firm	CL		Light tan CLAY, trace fine sand, Dry.						
					Soft	SC		Dark red SAND, little clay, frequent clay seams, Damp						SPT 6, 7, 11, 14. 24" recovered.
347.5	10		SS	18										
						SC		Frequent clay seams						SPT 11, 22, 13, 14. 24" recovered.
			SS	35	Soft	SC		Red/orange fine SAND, trace clay, trace coarse sand, poorly sorted, Moist.						
														SPT 17, 27, 50/5". 17" recovered.
			SS	77	Firm	CL		Brownish grey CLAY, trace sand, Moist.						
					Soft	SC		Tanish grey fine SAND, some clay, Wet.						
342.5	15													
			ST					8-11-09	19.9	13	35.7	8.6E-07		Shelby tube. Pushed 12" recovered 9".
														SPT 11, 13, 10, 14. 24" recovered.
			SS	23					27.98	NP	32.3			
					Soft	SM		Dark grey coarse SAND/GRAVEL mix, some fine sand, trace clay, Wet.						
					Soft	SM-SC		Red fine SAND, trace clay, Moist. cemented. Moist.						SPT 7, 8, 11, 13. 24" recovered.
			SS	19										
					Firm	SC		Black fine SAND, occasional clay, Wet.						
337.5	20													
					Firm	CL		Dark grey CLAY, little sand, Wet.						SPT 8, 10, 12, 15. 24" recovered.
					Firm	SM		Black fine SAND, some medium sand, some clay, Wet.						
			SS	22					32.23	NP	35.5			
					Firm	CL		Dark grey CLAY, little sand, Wet.						
					Firm	SM		Black fine SAND, some medium sand, some clay, Wet.						
														SPT 6, 11, 17, 21. 24" recovered.
			SS	28	Firm	SM		Frequent clay seams						
					Firm	SM		Frequent clay seams.						
			ST											Shelby tube. 12" driven 0 recovered.
332.5	25													SPT 15, 19, 21, 27. 24" recovered.
					Hard	CL		Dark grey CLAY, trace of sand, Dry.						
			SS	40										
														SPT 10, 11, 11, 50/5". 23" recovered.
			SS	22										
					Very Hard	CL		Dark grey CLAY, frequent iron stone/ore. Rig chatter driller comments						
			ST						24.9	15	75.0	1.0E-07		Shelby tube. 12" driven 9" recovered.
327.5	30													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-05

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
327.5	30	☒	ST		Hard	CL	▨	Dark grey CLAY, trace of sand, Dry. (cont.)	24.9	15	75.0	1.0E-07		Shelby tube. 12" driven 9" recovered.
								Bottom of Boring at 30.5 feet bgs						
322.5	35													
317.5	40													
312.5	45													
307.5	50													
302.5	55													
297.5	60													
292.5	65													

Figure

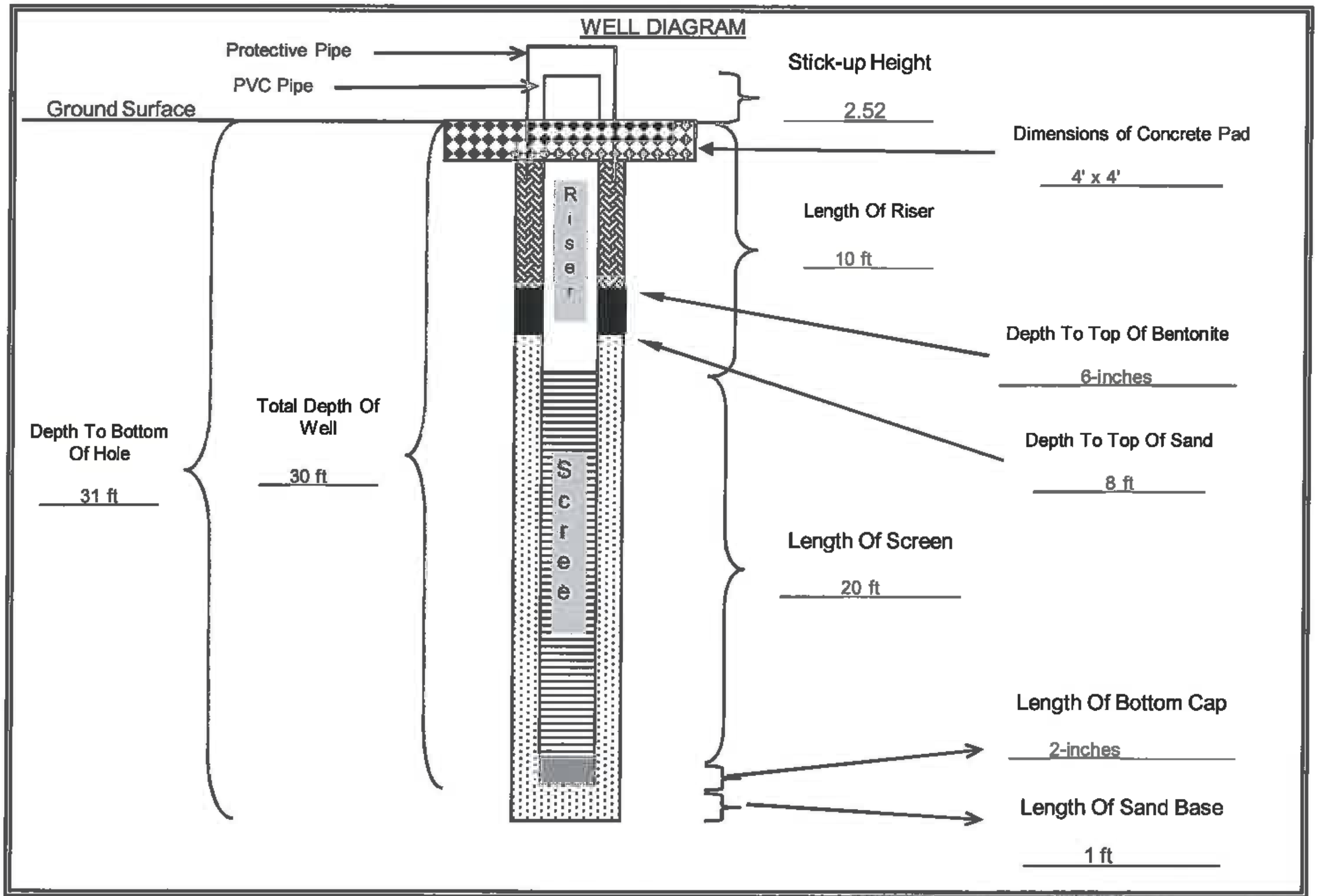
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		
JOB NO.:	TXL0064	WELL NO.:	GB-05
DATE/TIME:	August 6 2009		
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	357.49 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	347.49 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	326.49 (ft, msl)	CEMENT TYPE:	
NORTHING: 529.1865	EASTING: -2243.9973	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	3 bags lbs
RISER DIAMETER: 2 (in)	Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER: 2 (in)	Length: 20 (ft)	AMOUNT SAND USED:	7 bags lbs
BOREHOLE DIAMETER:	8 (in)	STATIC WATER:	17.33 depth from TOC
DRILLING TECHNIQUE: Hollow Stem	Size: 8 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.52

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 1 ft

Total Depth Of Well: 30 ft

Depth To Bottom Of Hole: 31 ft

▨ Cement/Bentonite Grout ░ Sand Pack ▦ Neat Concrete ■ Bentonite ▩ Bottom Cap

QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush Chohan
DATE:	6-Aug-09	CHECKED BY:	DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-06

Sheet 1 of 1

Date(s) Drilled	**7/23/2009**	Logged By	**Kush S. Chohan**	Checked By	
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type		Total Depth of Borehole	**30 feet bgs**
Drill Rig Type	**Mobil B61**	Drilling Contractor	**Total Support Services**	Approximate Surface Elevation	**357.41 feet MSL**
Groundwater Level and Date Measured	**15.3 feet measured on 8/11/09**	Sampling Method(s)	**SPT, Tube, Other**	Hammer Data	**140 lb, 30 in drop, auto hammer**
Borehole Backfill	**Well Completion**	Location	**Northeast corner of proposed chemical pond in the middle of open grass field.**		

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.4	0				Soft	SP		Greyish brown fine SAND with trace fines. Organic material (roots).						Hand Auger
			HA		Soft	SP-SM		Greyish red fine SAND, little silt. Poorly sorted, less organic material.						
					Soft	SM		Greyish red fine SAND, with little silt and clay. Dry.						
					Soft			Tanish grey fine SAND, trace silt and clay, frequent iron oxide, frequent discoloration.						SPT 4, 7, 7. 16" recovered
			SS	14	Firm	CL		Red light brown CLAY, little sand, trace silt, Dry.	12.74	34	67.9			
352.4	5													SPT 3, 5, 6, 8. 20" recovered
			SS	11	Soft	SC		Dark reddish brown fine SAND, little clay.						
					Soft	CL		Light grey CLAY, little sand, trace silt. Dry.						SPT 3, 5, 7, 7. 24" recovered
					Soft	SC		Reddish brown fine SAND, trace clay, trace silt. Occasional clay seams. Damp.						
			SS	12					17.65	NP	43.2			
					Soft	CL		Light grey CLAY, little fine sand						
			SS		Soft to Firm	SC		Brownish red fine SAND, little to some clay, some cementation, Damp.						24" driven, 15" recovered.
347.4	10													
			SS	19										SPT 8, 9, 10, 10. 24" recovered.
					Soft to Firm	CL		Brown CLAY, little fine sand, frequent brown sand-clay mixture with iron ore oxide.						
			ST						22.9	21	43.2	6.0e-07		Shelby Tube. 24" driven/16" recovered
342.4	15				Firm	CL		Dark redish brown CLAY, little fine sand, Damp. 8/11/09 ▼						SPT 15, 10, 22, 30. 24" recovered
			SS	40	Firm	SC		Dark reddish brown SAND, little to some clay, Moist.						
					Firm	CL		Black CLAY, little fine sand, Wet.						SPT 2, 8, 14, 10. 24" recovered
			SS	22	Firm	SW		Black fine SAND, trace clay, trace med sand, Wet.						
					Firm	CL		Black CLAY, trace fine sand, trace silt, Wet.						SPT 5, 8, 22, 50/4". 22 recovered.
						SC		Black fine SAND, little clay, Wet.						
337.4	20		SS	30	Firm	CL		Black CLAY, trace sand, trace silt. Wet.						
					Firm	SC		Black fine SAND, trace to little clay, Wet. Occansional black clay seams.						SPT 10, 11, 23, 33. 24" recovered
			SS	34	Firm	SP-SC		Black fine SAND, with little clay, trace med sand, Wet.						
						SW-SC		Grading to med SAND, Wet.						SPT 11, 16, 16, 24. 24" recovered.
			SS	36										
332.4	25													SPT 9, 11, 12, 22. 24" recovered.
			SS	23	Firm	SW-SC		Occasional CLAY lenses, Wet.						
					Firm	SC		Black fine SAND, little med sand and clay, Wet.						SPT 7, 15, 25, 50/3". 21 recovered.
			SS	40	Hard	CL		Dark grey CLAY, little sand, little silt, Dry.						
			ST							19	45.1			Shelby tube. 12" driven-8" recovered.
327.4	30							Bottom of Boring at 30 feet bgs						

Figure

WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

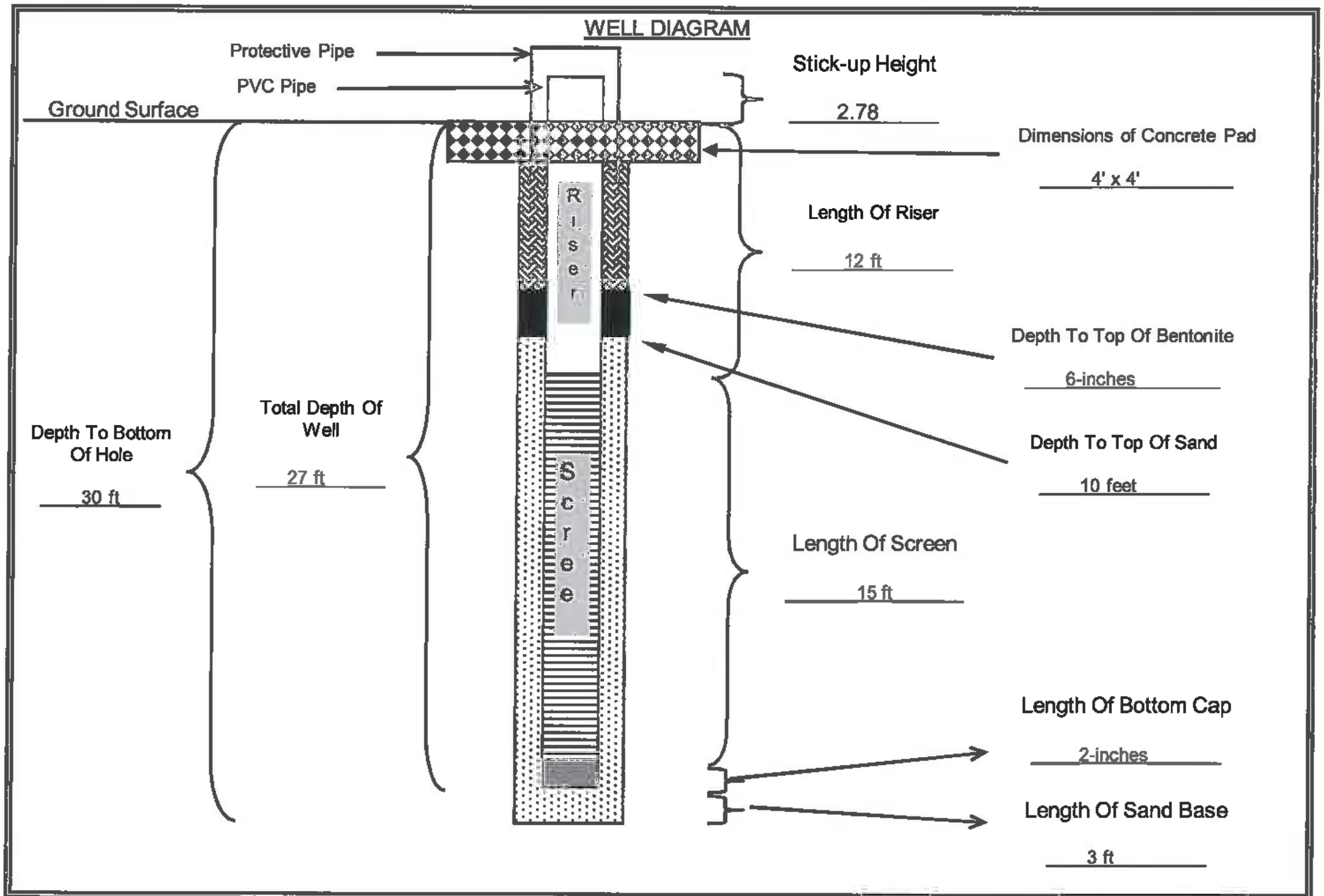
Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: 23-Jul-09
WELL LOCATION:
WELL NO.: **GB-06**
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION: 357.41 (ft, msl)
TOP OF SCREEN ELEVATION: 345.41 (ft, msl)
BOTTOM OF WELL ELEVATION: 327.41 (ft, msl)
NORTHING: 740.4893 EASTING: -2166.134
SCREEN MATERIAL: PVC
SCREEN MANUFACTURER:
RISER MATERIAL: PVC
RISER MANUFACTURER:
RISER DIAMETER: 2 (in) Length: 12 (ft)
SCREEN DIAMETER: 2 (in) Length: 15 (ft)
BOREHOLE DIAMETER: 6.75 (in)
DRILLING TECHNIQUE: Hollow Stem Size: 6.75 (in)

BENTONITE TYPE: Western Bentonite
MANUFACTURER: PDS
CEMENT TYPE:
CEMENT MANUFACTURER:
SAND PACK TYPE AND SIZE: Silica 20/40
SAND MANUFACTURER: Uninum
DRILLING CONTRACTOR: Total Support Services
AMOUNT BENTONITE USED: 2.5 bags lbs
AMOUNT CEMENT USED: bags lbs
AMOUNT SAND USED: 7 bags lbs
STATIC WATER: 15.3 depth from TOC
ENCOUNTERED WATER: depth from ground

WELL DIAGRAM



Stick-up Height: 2.78
Dimensions of Concrete Pad: 4' x 4'
Length Of Riser: 12 ft
Depth To Top Of Bentonite: 6-inches
Depth To Top Of Sand: 10 feet
Length Of Screen: 15 ft
Length Of Bottom Cap: 2-inches
Length Of Sand Base: 3 ft
Depth To Bottom Of Hole: 30 ft
Total Depth Of Well: 27 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC
INSTALLED BY: Total Support Services
DATE: 23-Jul-09
OBSERVED BY: Kush Chohan
CHECKED BY:
DATE:

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**GB-07/MW-7**
TOTAL DEPTH:	**34'**
TOP OF CASING ELEV.:	**362.75 ft. NGVD**
GROUND SURFACE ELEV.:	**360.20 ft. NGVD**

CLIENT:	**AEP**
PROJECT:	**Metal Cleaning Waste Pond**
SITE LOCATION:	**Welsh Power Plant**
PROJECT NO.:	**S-08-0120**
LOGGED BY:	**James Meleton, Jr.**

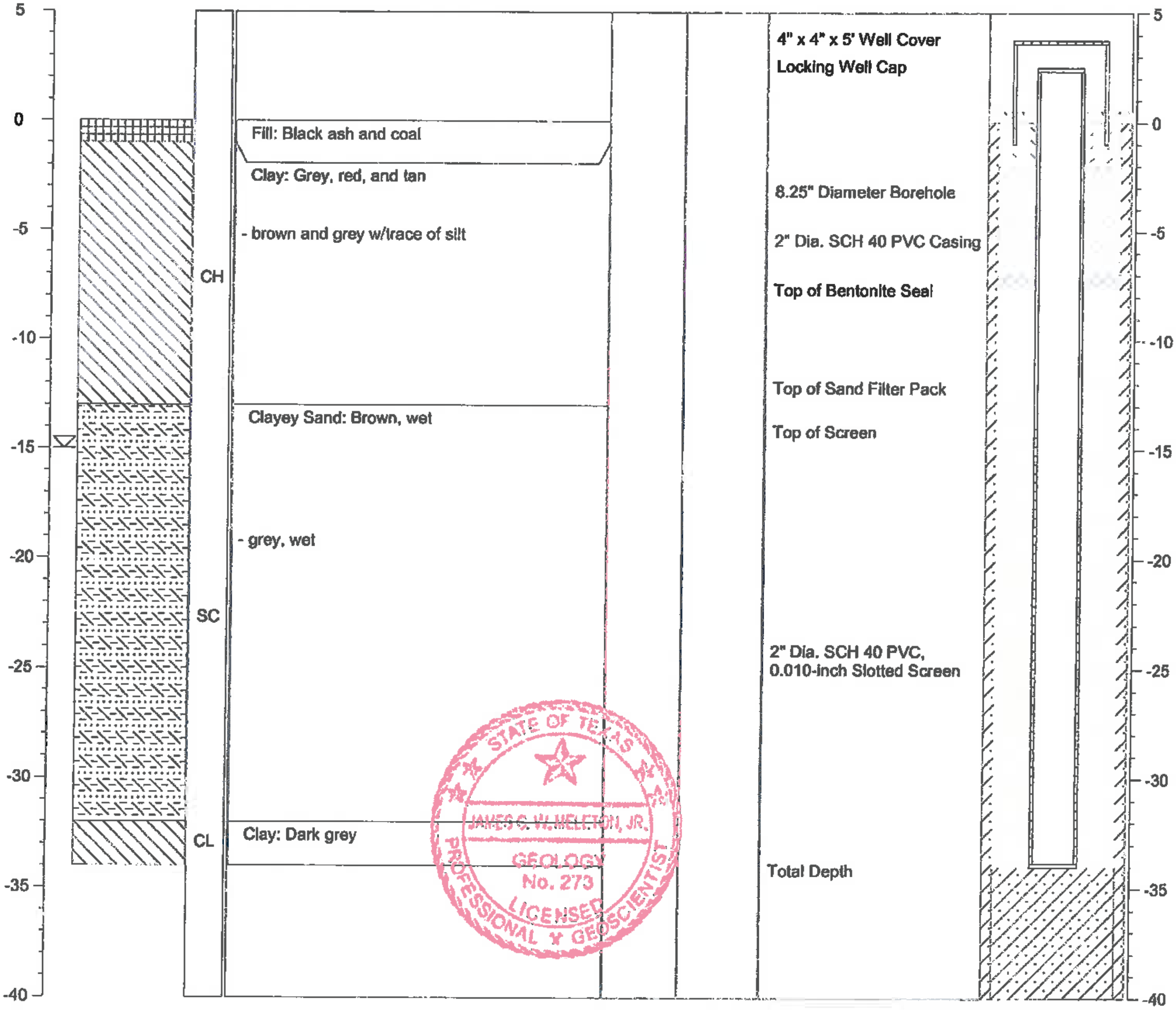
DRILLING CO.:	**WEST Drilling**
DRILLER:	**Tom McCullough**
METHOD OF DRILLING:	**Hollow-stem Auger**
SAMPLING METHODS:	**Split-spoon**
DATE DRILLED:	**12/1/09**

NOTES: **Latitude: 33.05455**
Longitude: 94.84674

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-1

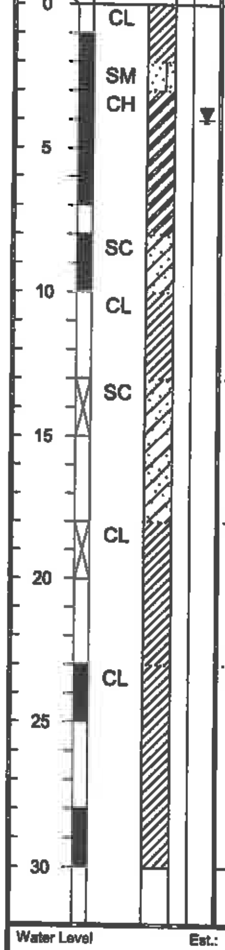
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

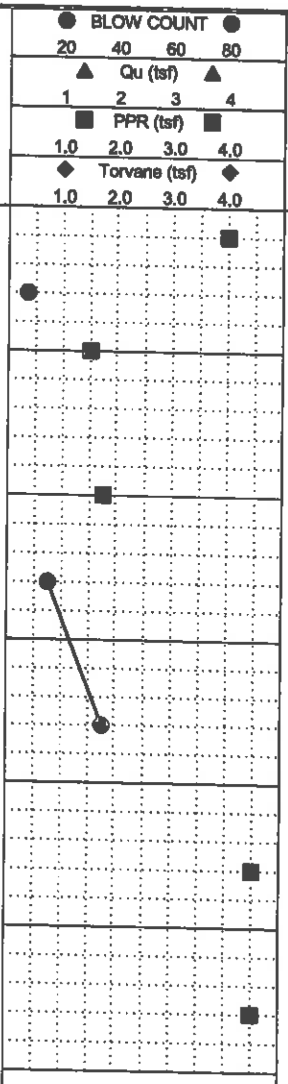
BORING TYPE: Flight Auger

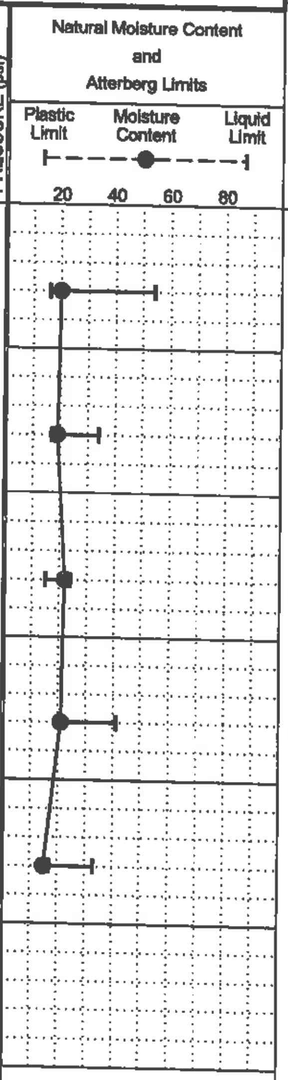
DATE 10/27/09

SURFACE ELEVATION 324.1



DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL		SANDY LEAN CLAY(CL) very stiff; brownish orange	P=4.0 SF										
	SM	▼	SILTY SAND(SM) tannish orange	N=7										
5	CH		SANDY FAT CLAY(CH) medium stiff; tannish orange						20	54	16	38	63	+40Sieve=10%, +4 Sieve=1%
			–stiff	P=1.5										
	SC		CLAYEY SAND(SC) medium dense; tannish orange; with clay seams	P=1.75					19	34	17	17	32	+40 Sieve=7%, +4 Sieve=3%
10	CL		SANDY LEAN CLAY(CL) stiff; orange											
15	SC		CLAYEY SAND(SC) medium dense; orange; saturated; with iron oxide cemented sandstone rock	N=15					22	24	15	9	19	+40Sieve=35%, +4 Sieve=22%
20	CL		LEAN CLAY WITH SAND(CL) hard; dark gray; with clay seams	N=35					21	41	21	20	75	+40 Sieve=2%, +4 Sieve=0%
25	CL		SANDY LEAN CLAY(CL) hard; dark brown	P=4.5+					15	33	17	16	52	+40 Sieve=1%, +4 Sieve=0%
			–grayish brown; laminated with silt	P=4.5+										
30			Bottom of Boring @ 30'											





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

Water Observations: Seepage @ 5' while drilling. Water level @ 4' and open to 30' upon completion.

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

Notes:
GPS Coordinates: N 33°03.090', W 94°50.417'

Piezometer B-2

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-2

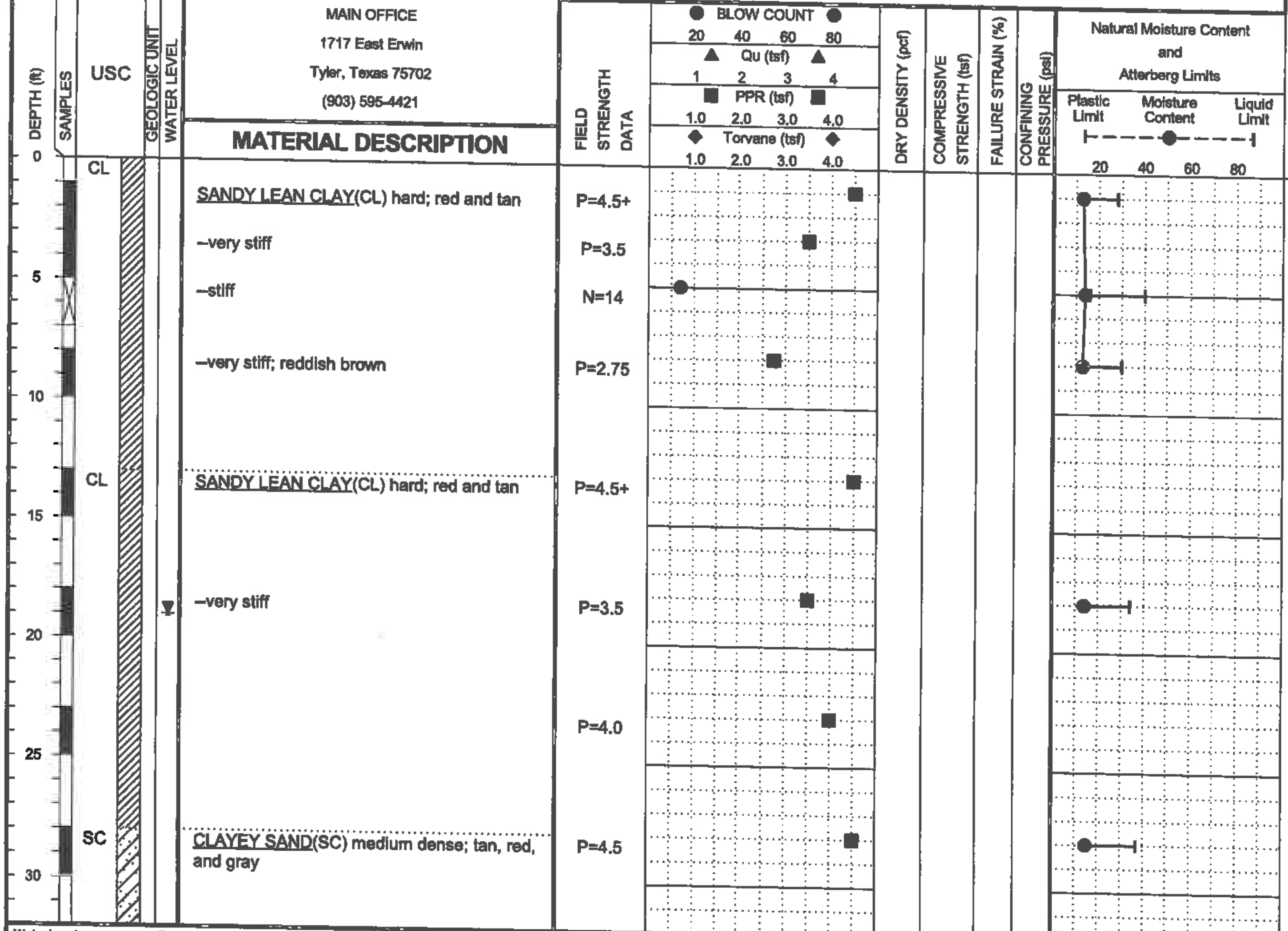
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/28/09

SURFACE ELEVATION 339.7



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	13	28	14	14	61	+40 Sieve=3%, +4 Sieve=0%
	–very stiff	P=3.5						
	–stiff	N=14	14	40	16	24	65	+40 Sieve=0%, +4 Sieve=0%
	–very stiff; reddish brown	P=2.75	13	30	14	16	58	+40 Sieve=0%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+						
	–very stiff	P=3.5	14	34	15	19	54	+40 Sieve=0%, +4 Sieve=0%
		P=4.0						
SC	CLAYEY SAND(SC) medium dense; tan, red, and gray	P=4.5	15	37	16	21	47	+40 Sieve=5%, +4 Sieve=3%

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

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

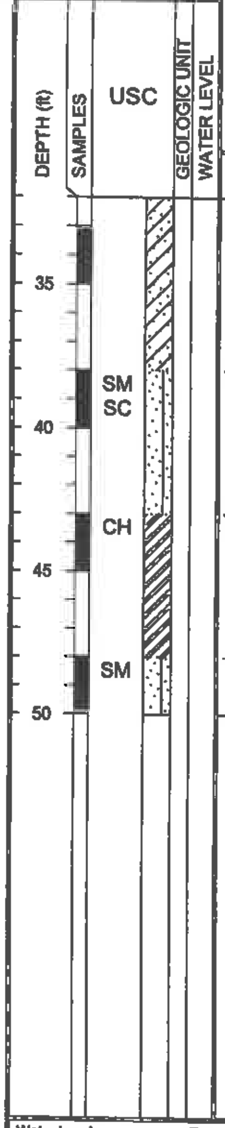
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

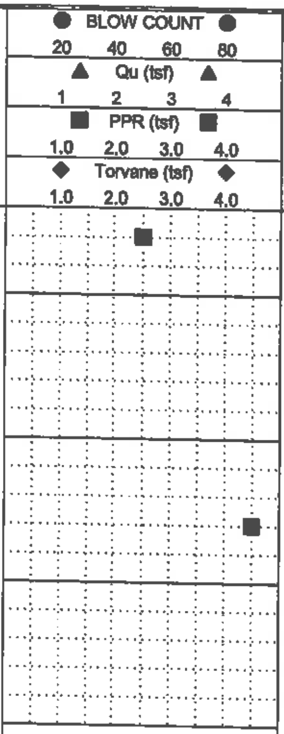
BORING TYPE: Flight Auger

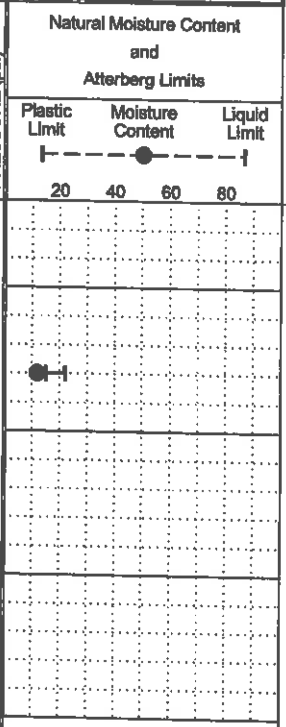
DATE 10/28/09

SURFACE ELEVATION 339.7



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	--red and tan	P=2.5										
SM SC	SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated	SF					12	22	15	7	48	+40 Sieve=0%, +4 Sieve=0%
CH	FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams	P=4.5+										
SM	SILTY SAND(SM) black and gray	SF										
	Bottom of Boring @ 50'											





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

Water Observations: Water level @ 19' and open to 24' upon completion.

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

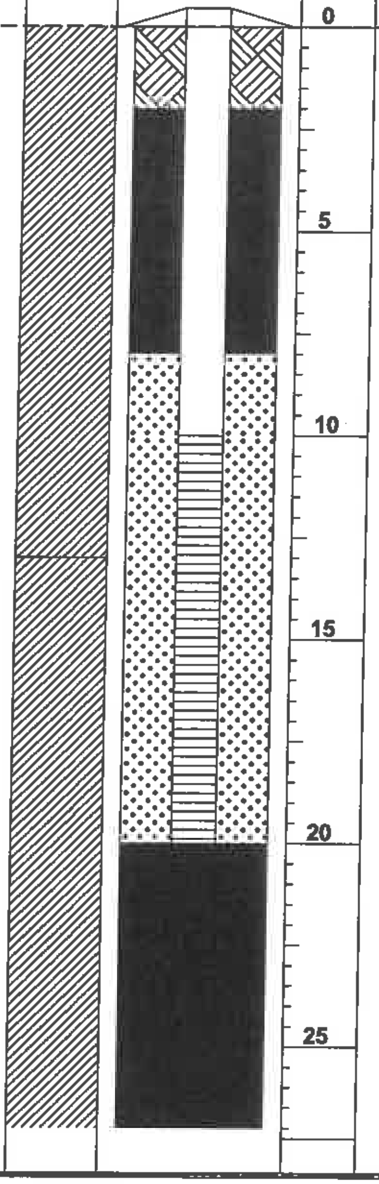
Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

Piezometer B-2

ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**
Well No. B-2
Location Pittsburg, Texas
Surface Elev.
Page 1 **of** 2

Depth Feet Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
						T.O.C. Elev.
0	Ground Surface				0	
	SANDY LEAN CLAY(CL) hard; red and tan					
	–very stiff					
5	--stiff				5	
	–very stiff; reddish brown					
10					10	
	SANDY LEAN CLAY(CL) hard; red and tan					
15					15	
	–very stiff					
20					20	
25					25	



Continued Next Page

Driller Doug Hinds
Logged By James Griffith
Drilling Started 10/28/09
Drilling Completed 10/28/09
Construction Completed
Development Completed
Type of Well

Drilling Method Soild Stem Auger
Borehole Diameter 6.5"
Well Casing 2.0" **Dia.** 0.0' **to** 10.0'
Casing Type PVC
Well Screen 2.0" **Dia.** 10.0' **to** 20.0'
Screen Type Slotted
Slot Size 0.010"
Grout Type Bentonite

Bentonite Seal 2-8' & 20-50'
Filter Pack Qty. 8-20'
Filter Pack Type 20/40 Sand
Static Water Level
Notes:

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

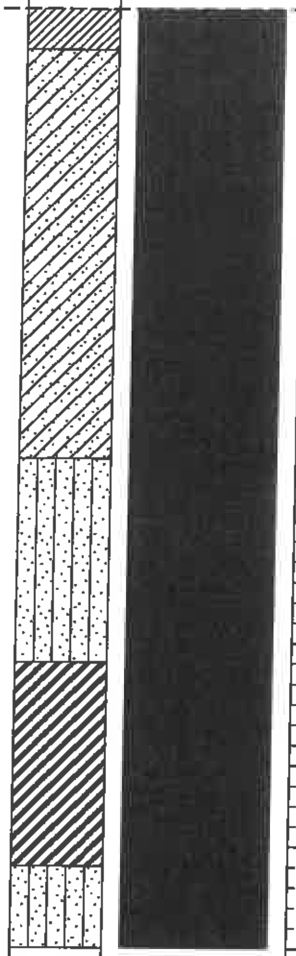
Well No. B-2

Location Pittsburg, Texas

Surface Elev.

Page 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
		Continued from previous page					
		CLAYEY SAND(SC) medium dense; tan, red, and gray					
30						30	
		--red and tan					
35						35	
		SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated					
40						40	
		FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams					
45						45	
		SILTY SAND(SM) black and gray					
50						50	
		Bottom of Boring @ 50'					
55							
60							



ETTL Engineers & Consultants Inc.

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS

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

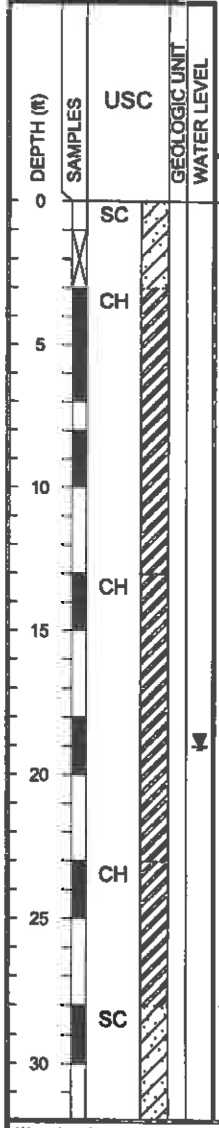
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

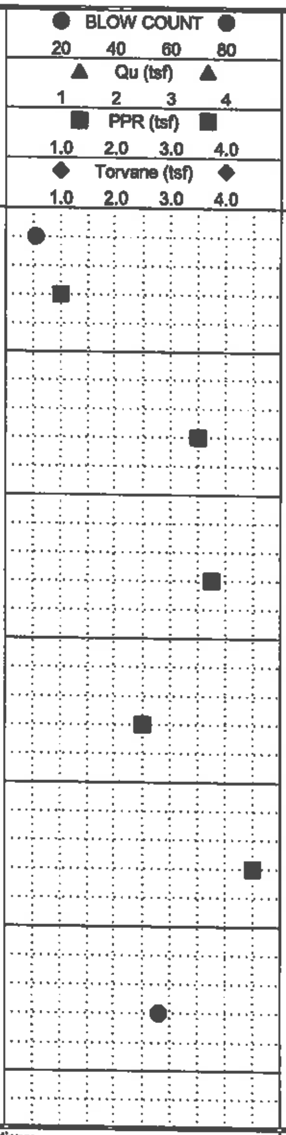
BORING TYPE: Flight Auger

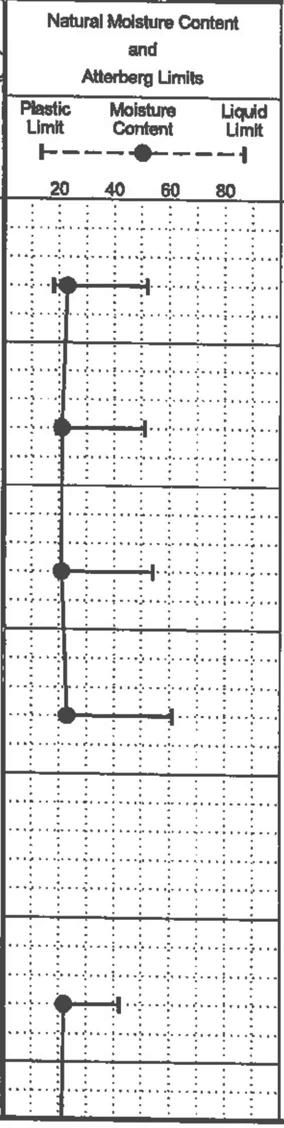
DATE 10/27/09

SURFACE ELEVATION 339.6



USC	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. #)
SC	CLAYEY SAND(SC) medium dense; gray and red	N=11										
CH	FAT CLAY(CH) stiff; red and tan; with sand seams	P=1.0					23	52	18	34	87	+40 Sieve=3%, +4 Sieve=0%
	–very stiff	P=3.5					21	51	19	32	86	+40 Sieve=3%, +4 Sieve=0%
CH	FAT CLAY WITH SAND(CH) very stiff; brown; with ferric joints	P=3.75					21	54	20	34	85	+40Sieve=10%, +4 Sieve=1%
	–red and tan; layered; with ferric seams	P=2.5					23	61	24	37	81	+40Sieve=11%, +4 Sieve=0%
CH	FAT CLAY(CH) hard; gray; with sand seams	P=4.5+										
SC	CLAYEY SAND(SC) very dense; gray; with sand seams	N=56					22	42	22	20	35	+40 Sieve=1%, +4 Sieve=0%





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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-3

PROJECT: Welsh Power Plant
Pittsburgh, Texas

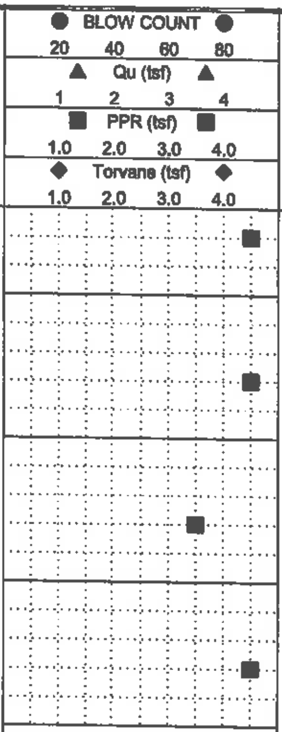
PROJECT NO.: G3242-09

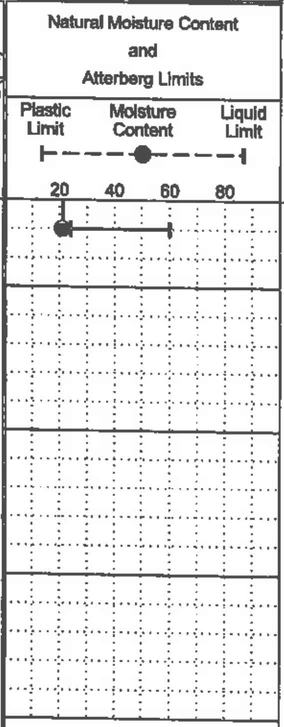
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	CH	FAT CLAY(CH) hard; brown; layered and with sand seams	P=4.5+					21	60	24	36	95	+40 Sieve=1%, +4 Sieve=0%
40		--gray and green	P=4.5+										
45	CL	SANDY LEAN CLAY(CL) very stiff; gray and dark green; layered; with sand seams	P=3.5										
50	CH	FAT CLAY(CH) hard; gray and dark green; layered; with silt seams	P=4.5+										
		Bottom of Boring @ 50'											





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' 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 33°02.998', W 94°50.514'

Piezometer B-4

LOG OF BORING B-4

ETTL
ENGINEERS &
CONSULTANTS

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

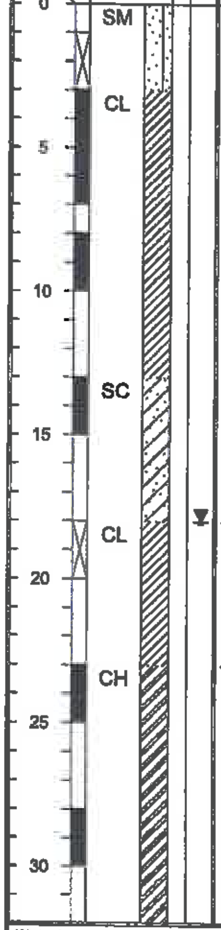
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

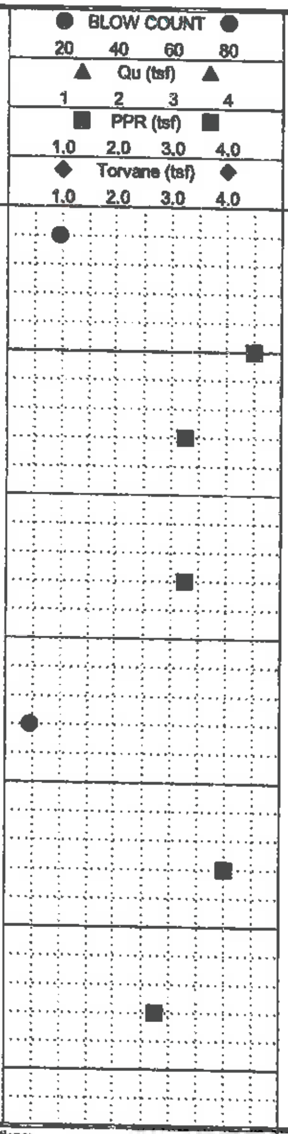
BORING TYPE: Flight Auger

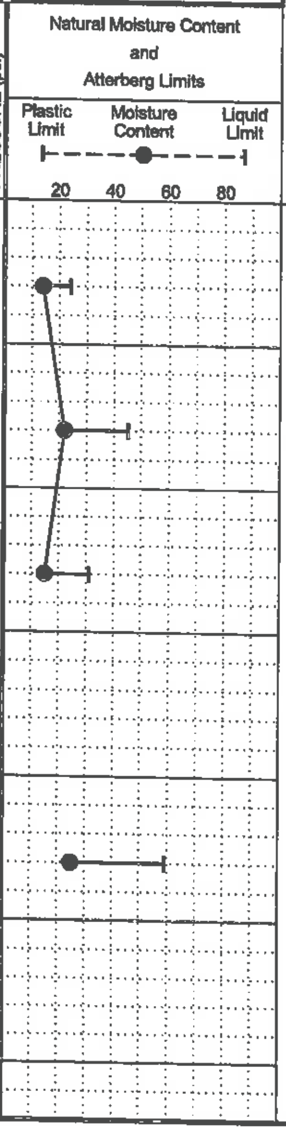
DATE 10/27/09

SURFACE ELEVATION 340.6



USC	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. #)
SM	SILTY SAND(SM) medium dense; tan; with gravel	N=19										
CL	SANDY LEAN CLAY(CL) dark brown	SF										
	--tannish orange						14	24	15	9	59	+40 Sieve=1%, +4 Sieve=0%
	--hard; orangish tan	P=4.5										
		P=3.25					22	45	21	24	94	+40 Sieve=2%, +4 Sieve=0%
	--very stiff; white											
SC	CLAYEY SAND(SC) medium dense; tan	P=3.25										
	--orangish gray; with sand seams						15	31	15	16	40	+40 Sieve=1%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) stiff; orangish tan	N=9										
CH	FAT CLAY(CH) very stiff; orangish tan; with ferric seams	P=4.0					25	59	24	35	88	+40 Sieve=4%, +4 Sieve=0%
	--tannish brown; with iron ore seams	P=2.75										





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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-4

PROJECT: Welsh Power Plant
Pittsburgh, Texas

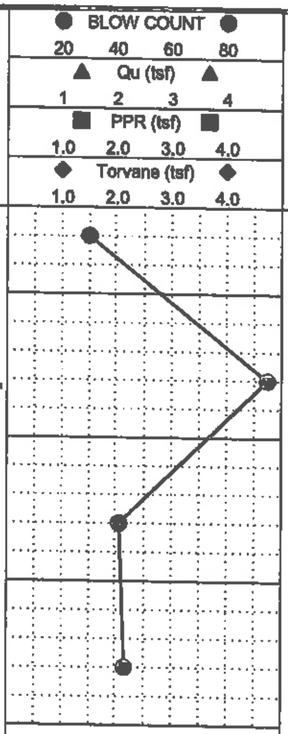
PROJECT NO.: G3242-09

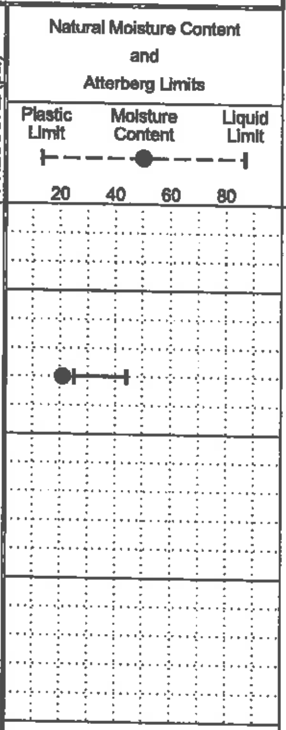
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6

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. #)
35	☒	CL	▨		–hard; light gray; layered and with silt seams	N=30										
40	☒		▨		LEAN CLAY(CL) hard; light gray; layered and with silt seams	N=50/5.75"					21	44	25	19	93	+40 Sieve=1%, +4 Sieve=0%
45	☒		▨		–light gray	N=41										
50	☒		▨		–layered and with sand seams; with lignite	N=43										
					Bottom of Boring @ 50'											





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

Water Observations: Water level @ 18' and open to 48' 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 33°03.011', W 94°50.462'

Piezometer B-4

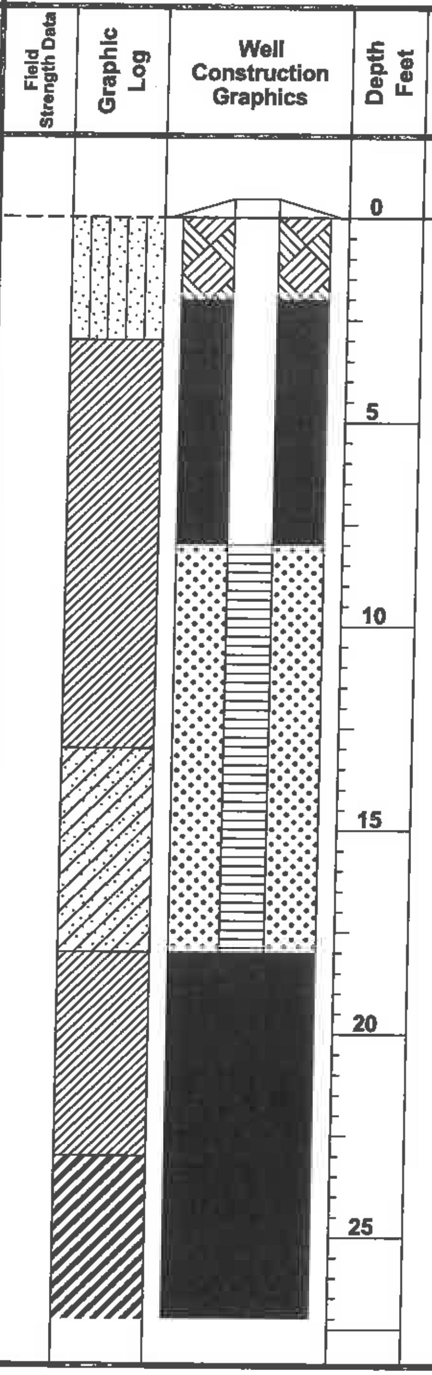
ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**

Well No. B-4
Location Pittsburg, Texas
Surface Elev.
Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description
0		Ground Surface
		SILTY SAND(SM) medium dense; tan; with gravel
		SANDY LEAN CLAY(CL) dark brown
		–tannish orange
5		–hard; orangish tan
10		–very stiff; white
		CLAYEY SAND(SC) medium dense; tan
15		–orangish gray; with sand seams
		SANDY LEAN CLAY(CL) stiff; orangish tan
20		
		FAT CLAY(CH) very stiff; orangish tan; with ferric seams
25		

Continued Next Page



Well Construction Details

T.O.C. Elev.

Driller Doug Hinds
Logged By James Griffith
Drilling Started 10/27/09
Drilling Completed 10/27/09
Construction Completed
Development Completed
Type of Well

Drilling Method Soild Stem Auger
Borehole Diameter 6.5"
Well Casing 2.0" **Dia.** 0.0' **to** 8.0'
Casing Type PVC
Well Screen 2.0" **Dia.** 8.0' **to** 18.0'
Screen Type Slotted
Slot Size 0.010"
Grout Type Bentonite

Bentonite Seal 2-8' & 18-50'
Filter Pack Qty. 6-18'
Filter Pack Type 20/40 Sand
Static Water Level

Notes:

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-4

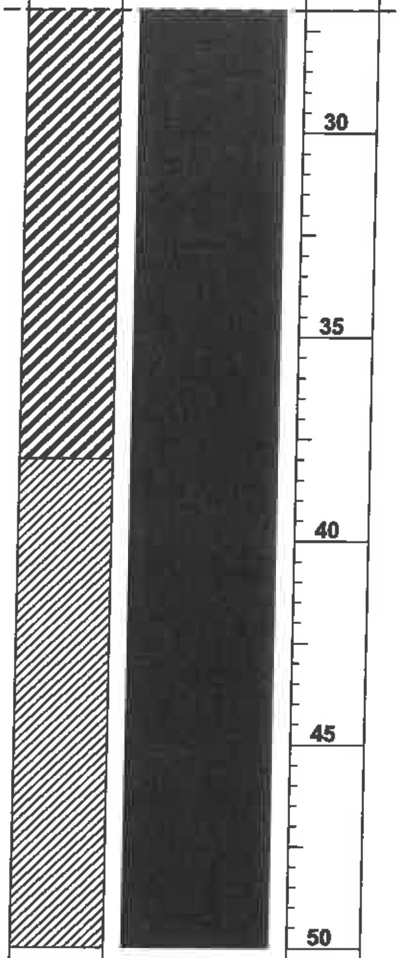
Location Pittsburg, Texas

Surface Elev.

Page 2 **of** 2

Depth Feet	Overburden/Lithologic Description
	Continued from previous page
	--tannish brown; with iron ore seams
30	
	--hard; light gray; layered and with silt seams
35	
	LEAN CLAY(CL) hard; light gray; layered and with silt seams
40	
	--light gray
45	
	--layered and with sand seams; with lignite
50	Bottom of Boring @ 50'
55	
60	

Field Strength Data | Graphic Log | Well Construction Graphics | Depth Feet | Well Construction Details



Piezometer B-5

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-5

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

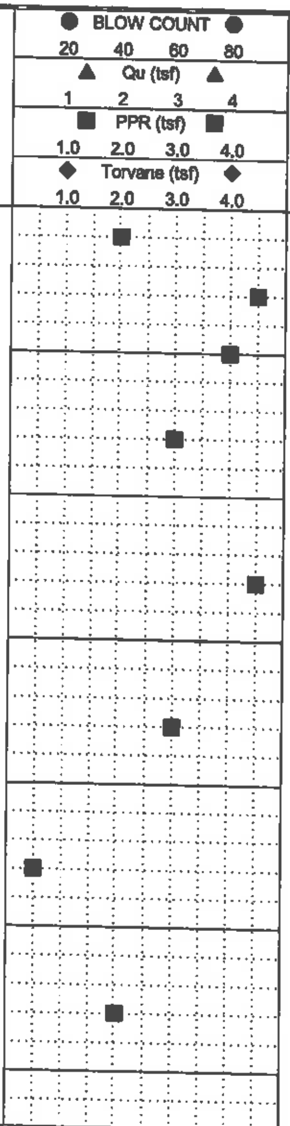
BORING TYPE: Flight Auger

DATE 10/27/09

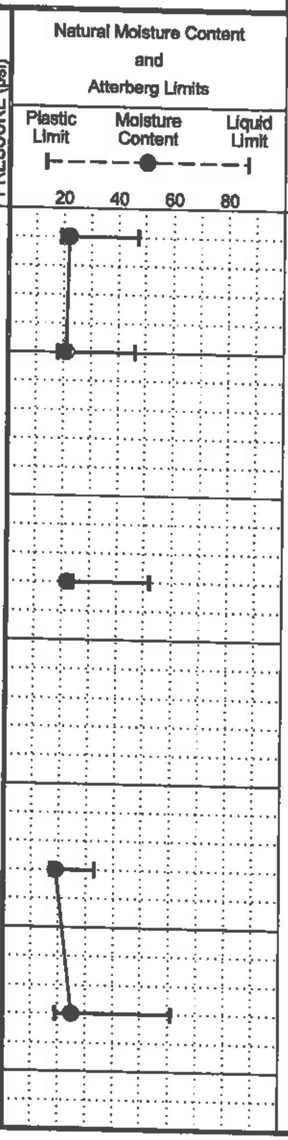
SURFACE ELEVATION 340.0

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) stiff; red and tan	P=2.0	22	47	19	28	81	+40 Sieve=9%, +4 Sieve=3%
CL	LEAN CLAY(CL) hard; red and tan	P=4.5+						
	–very stiff	P=4.0	21	46	18	28	94	+40 Sieve=3%, +4 Sieve=0%
CH	FAT CLAY(CL) very stiff; brown and tan	P=3.0						
CH	FAT CLAY WITH SAND(CH) hard; red and tan	P=4.5+	22	52	24	28	88	+40 Sieve=3%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams	P=3.0						
SC	CLAYEY SAND(SC) very loose; tan, red, and gray	P=0.5	19	33	17	16	44	+40 Sieve=1%, +4 Sieve=0%
CH	FAT CLAY WITH SAND(CH) stiff; red and gray	P=2.0	25	61	19	42	83	+40 Sieve=5%, +4 Sieve=3%

Depth (ft): 0, 5, 10, 15, 20, 25, 30



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

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CONSULTANTS

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

LOG OF BORING B-5

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	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)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	SC	SILTY CLAYEY SAND(SC) gray and red; saturated	SF											
40	CH	FAT CLAY(CH) hard; red and gray; with sand seams	P=4.5+	■					25	51	31	20	87	+40 Sieve=6%, +4 Sieve=0%
45		–gray, tan, and red; with sand seams	P=4.5+	■										
50	SM SC	SILTY SAND(SM-SC) red and gray	SF											
		Bottom of Boring @ 50'												

Natural Moisture Content and Atterberg Limits: Plastic Limit ⊢ – – – ● – – – ⊣ Liquid Limit, Moisture Content (20 40 60 80)

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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

Piezometer B-5

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-5

Location Pittsburg, Texas

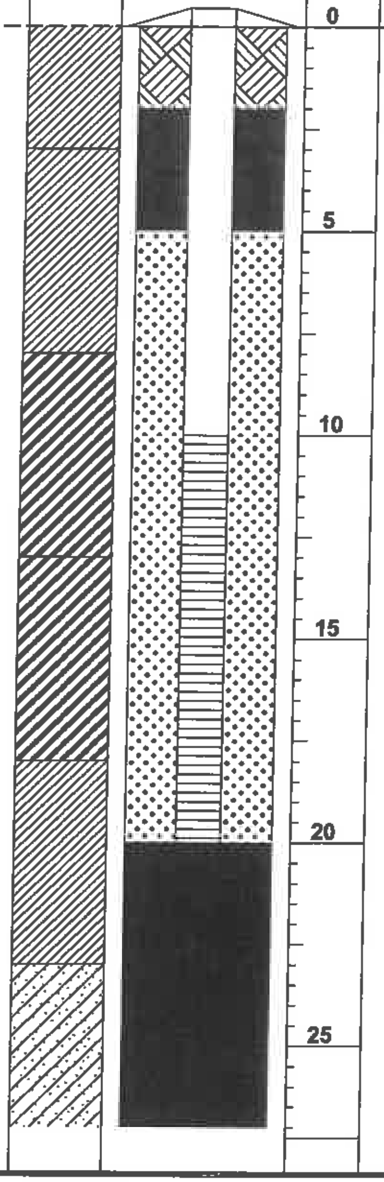
Surface Elev.

Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description
0		Ground Surface
		LEAN CLAY WITH SAND(CL) stiff; red and tan
		LEAN CLAY(CL) hard; red and tan
5		--very stiff
		FAT CLAY(CL) very stiff; brown and tan
10		
		FAT CLAY WITH SAND(CH) hard; red and tan
15		
		SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams
20		
		CLAYEY SAND(SC) very loose; tan, red, and gray
25		

Field Strength Data | **Graphic Log** | **Well Construction Graphics** | **Depth Feet** | **Well Construction Details**

T.O.C. Elev.



Continued Next Page

Driller Doug Hinds	**Drilling Method** Soild Stem Auger	**Bentonite Seal** 2-5' & 20-50'
Logged By James Griffith	**Borehole Diameter** 6.5"	**Filter Pack Qty.** 5-20'
Drilling Started 10/27/09	**Well Casing** 2.0" **Dia.** 0.0' **to** 10.0'	**Filter Pack Type** 20/40 Sand
Drilling Completed 10/27/09	**Casing Type** PVC	**Static Water Level**
Construction Completed	**Well Screen** 2.0" **Dia.** 10.0' **to** 20.0'	
Development Completed	**Screen Type** Slotted	**Notes:**
Type of Well	**Slot Size** 0.010"	
	Grout Type Bentonite	

ETTL Engineers & Consultants Inc.

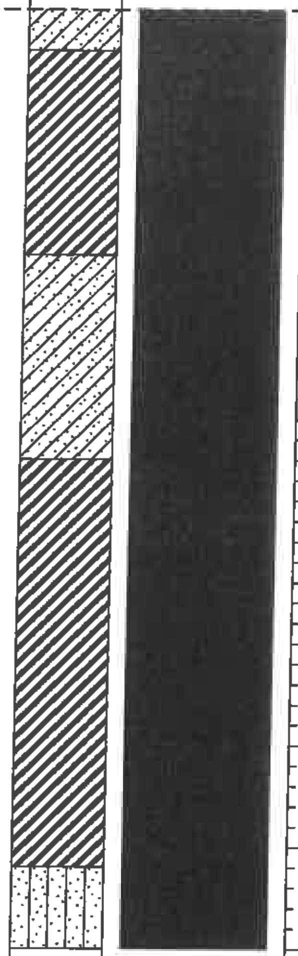
ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**

Well No. B-5
Location Pittsburg, Texas
Surface Elev.
Page 2 **of** 2

Depth Feet Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details

Continued from previous page



FAT CLAY WITH SAND(CH) stiff; red and gray

30

SILTY CLAYEY SAND(SC) gray and red; saturated

35

FAT CLAY(CH) hard; red and gray; with sand seams

40

–gray, tan, and red; with sand seams

45

SILTY SAND(SM-SC) red and gray

50

Bottom of Boring @ 50'

55

60

Piezometer B-6

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

LOG OF BORING B-6

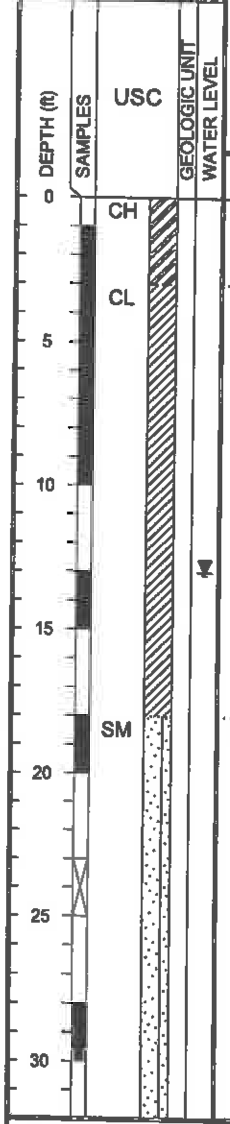
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

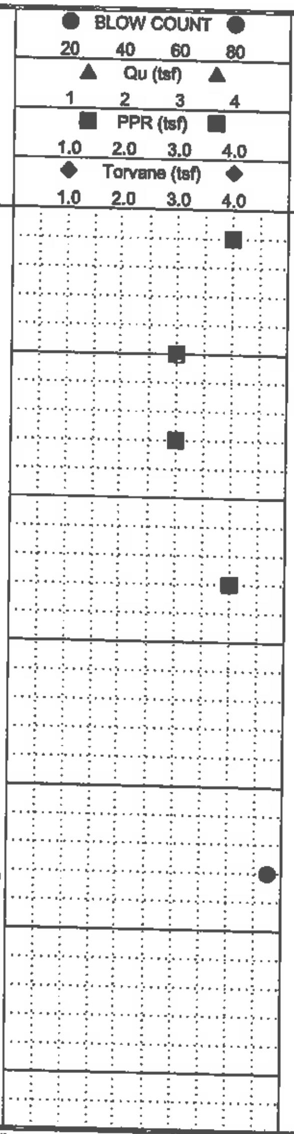
BORING TYPE: Flight Auger

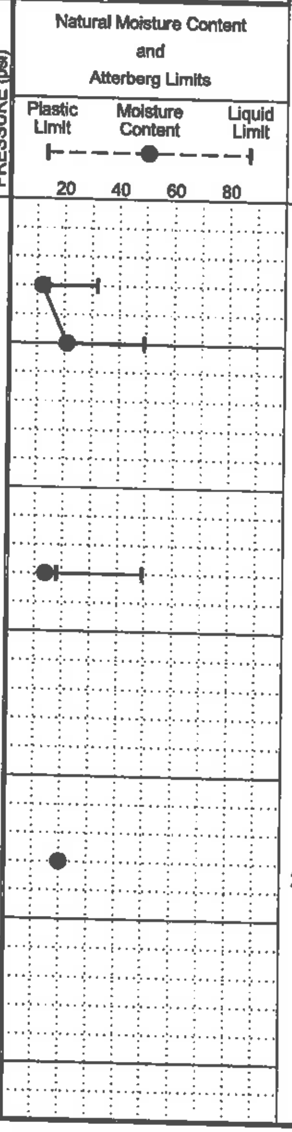
DATE 10/27/09

SURFACE ELEVATION 340.1



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY(CH) very stiff; red and gray; with ferric seams	P=4.0										
CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+					12	32	14	18	60	+40 Sieve=0%, +4 Sieve=0%
	—very stiff; red, gray, and brown; with gravel —with sand seams	P=3.0					21	49	20	29	93	+40 Sieve=2%, +4 Sieve=0%
		P=3.0										
		P=4.0					14	49	18	31	65	+40 Sieve=0%, +4 Sieve=0%
SM	SILTY SAND(SM) gray; saturated	P=3.0										
	—very dense; gray and red	N=50/5.25"					20				18	+40 Sieve=0%, +4 Sieve=0%
		SF										





Water Level Est.: ▽ Measured: ▼ Parched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

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LOG OF BORING B-6

PROJECT: Welsh Power Plant
Pittsburgh, Texas

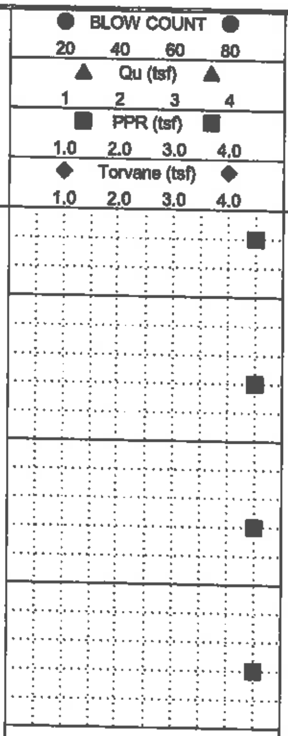
PROJECT NO.: G3242-09

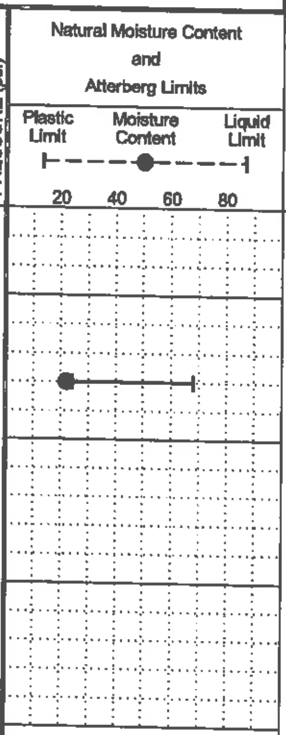
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	CH	FAT CLAY(CH) hard; brown; with sand seams	P=4.5+										
40			P=4.5+					22	68	24	44	95	+40 Sieve=0%, +4 Sieve=0%
45		--dark green	P=4.5+										
50	CL	LEAN CLAY(CL) hard; dark green; laminated with lignite	P=4.5+										
		Bottom of Boring @ 50'											





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

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

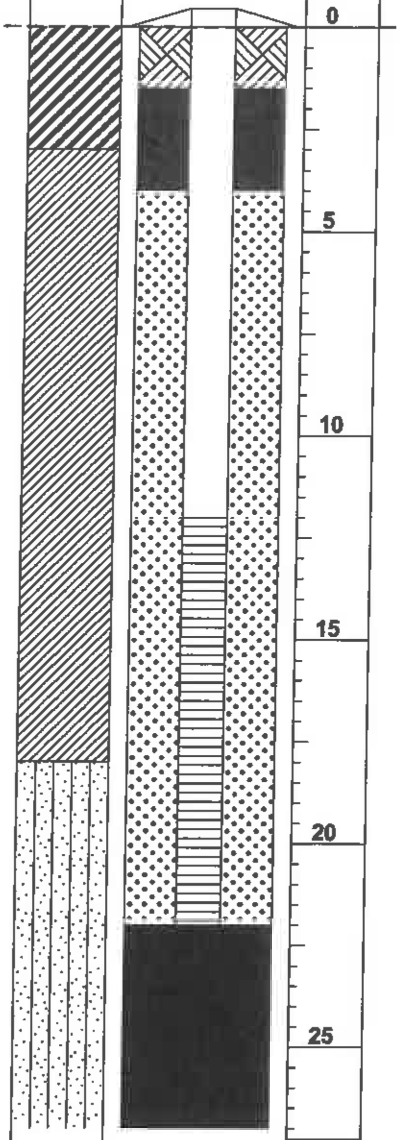
Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

Piezometer B-6

ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**
Well No. B-6
Location Pittsburg, Texas
Surface Elev.
Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
							T.O.C. Elev.
0		Ground Surface				0	
		FAT CLAY(CH) very stiff; red and gray; with ferric seams					
		SANDY LEAN CLAY(CL) hard; red and tan					
5						5	
		–very stiff; red, gray, and brown; with gravel					
		–with sand seams					
10						10	
15						15	
		SILTY SAND(SM) gray; saturated					
20						20	
		–very dense; gray and red					
25						25	



Continued Next Page

Driller Doug Hinds
Logged By James Griffith
Drilling Started 10/28/09
Drilling Completed 10/28/09
Construction Completed
Development Completed
Type of Well

Drilling Method Soild Stem Auger
Borehole Diameter 6.5"
Well Casing 2.0" **Dia.** 0.0' **to** 12.0'
Casing Type PVC
Well Screen 2.0" **Dia.** 12.0' **to** 22.0'
Screen Type Slotted
Slot Size 0.010"
Grout Type Bentonite

Bentonite Seal 1.5-4' & 22-50'
Filter Pack Qty. 4-22'
Filter Pack Type 20/40 Sand
Static Water Level
Notes:

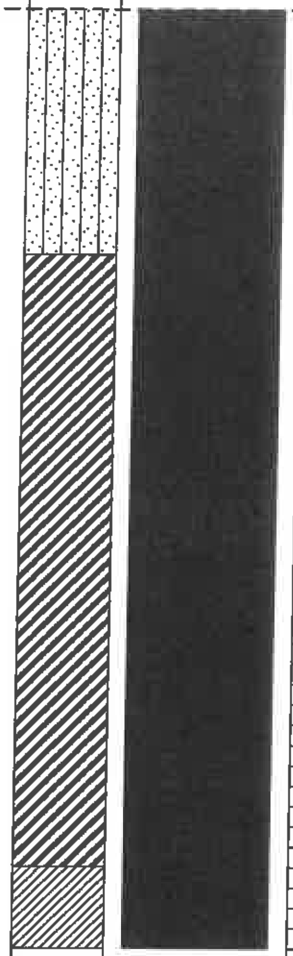
ETTL Engineers & Consultants Inc.

ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**

Well No. B-6
Location Pittsburg, Texas
Surface Elev.
Page 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Depth Feet	Well Construction Details
		Continued from previous page			
30				30	
		FAT CLAY(CH) hard; brown; with sand seams			
35				35	
40				40	
		--dark green			
45				45	
		LEAN CLAY(CL) hard; dark green; laminated with lignite			
50				50	
		Bottom of Boring @ 50'			
55					
60					



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

LOG OF BORING B-7

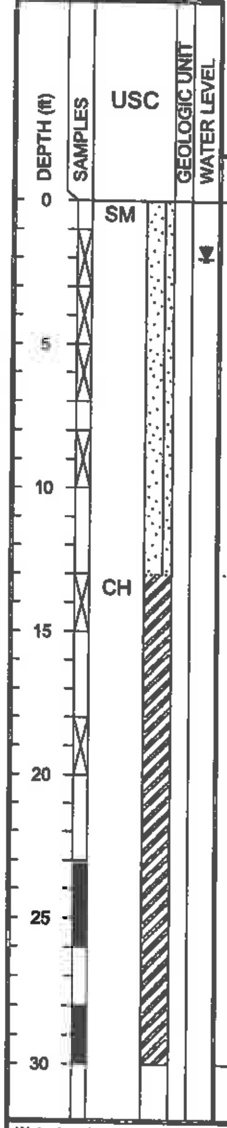
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

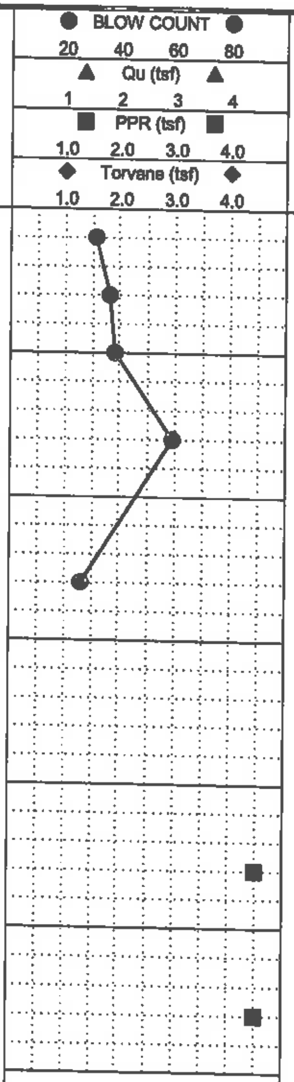
BORING TYPE: Flight Auger

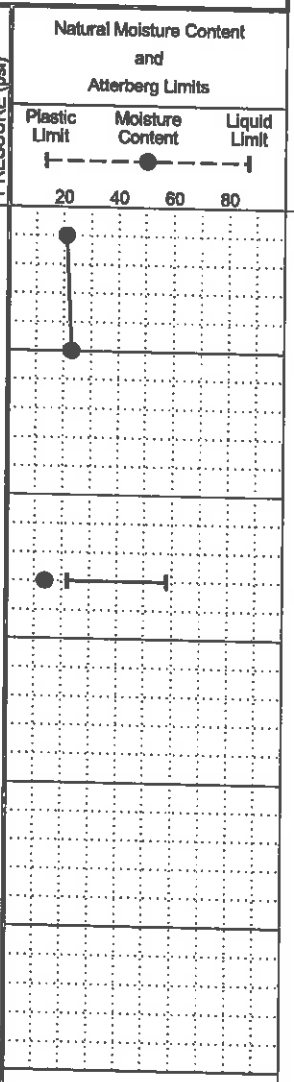
DATE 10/27/09

SURFACE ELEVATION 340.4



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) dense; tan	N=31					21				21	+40 Sieve=0%, +4 Sieve=0%
		N=36										
	--gray; saturated	N=38					23				15	+40 Sieve=0%, +4 Sieve=0%
	--very dense	N=59										
CH	FAT CLAY(CH) very stiff; dark gray; with silt and ferric seams	N=26					14	58	22	36	98	+40 Sieve=0%, +4 Sieve=0%
	--hard; gray and black; with trace of lignite	P=4.5+										
	--gray											
		P=4.5+										
	Bottom of Boring @ 30'											





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

Water Observations: Seepage @ 4' while drilling. Water level @ 2' and open to 7' upon completion.

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

Notes:
GPS Coordinates: N 33°02.898', W 94°50.519'

Landfill Boring B-2

LOG OF BORING B-2

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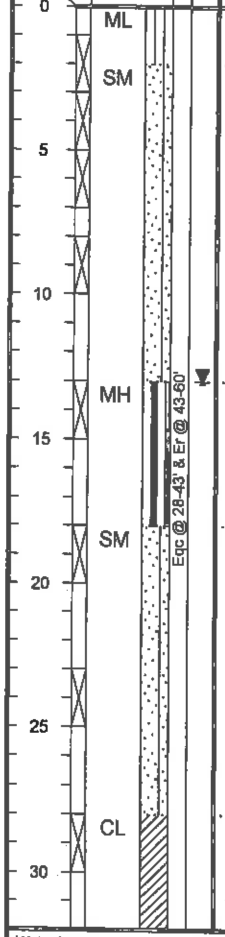
ENGINEERS & CONSULTANTS

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

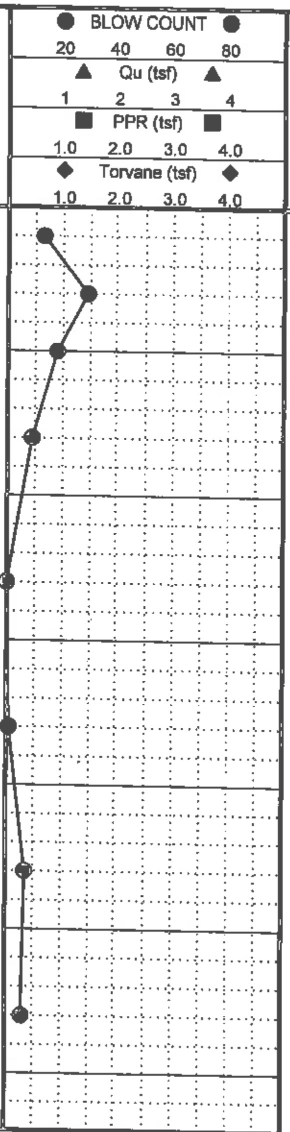
PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

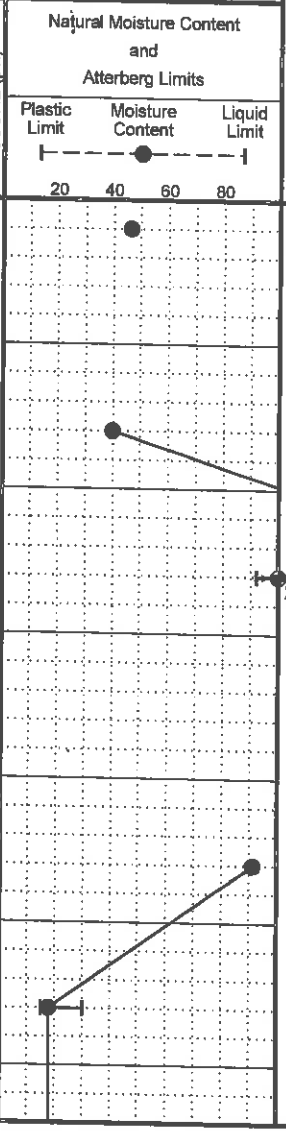
DATE 10/8/14
SURFACE ELEVATION 373.8



MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
ML	ASH (SILT WITH GRAVEL(ML)) medium dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=13					46				59	+40 Sieve=27% +4 Sieve=16%
SM		N=29										
	ASH (SILTY SAND(SM)) medium dense; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces	N=18										
	--loose; moist	N=9					40				40	+40 Sieve=19% +4 Sieve=2%
MH	ASH (ELASTIC SILT(MH)) very loose; black; with fine-grained sand and lightly cemented gravel pieces; saturated	N=0					200	134	92	42	100	+40 Sieve=0% +4 Sieve=0%
SM	ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=1										
	--loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					91				61	+40 Sieve=11% +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) medium stiff; dark brown and black; with fine-grained sand and cemented gravel pieces; saturated	N=6					18	30	15	15	63	+40 Sieve=1% +4 Sieve=0%





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

Water Observations: Water level @ 13'.

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

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-2 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

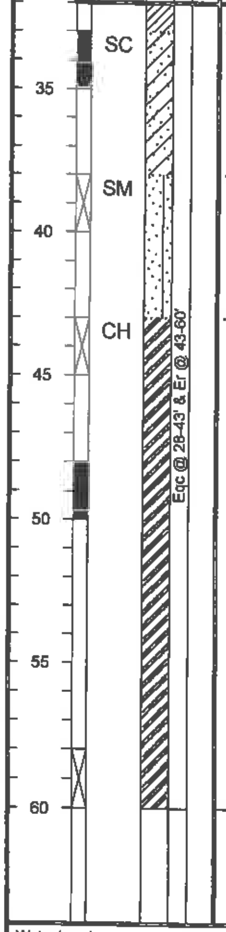
PROJECT NO.: G4207-146

DRILL RIG: B-61 HDX

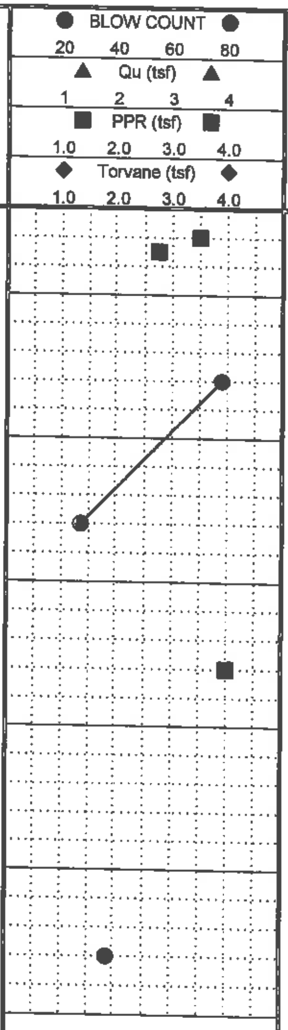
BORING TYPE: Rotary Wash/Flight Auger

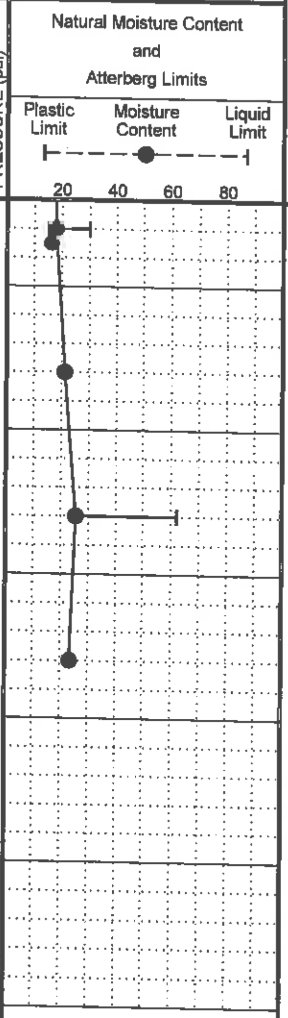
DATE 10/8/14

SURFACE ELEVATION 373.8



MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CLAYEY SAND(SC) dense; light brown, light gray and reddish brown; moist; with fine-grained sand; mottled	P=3.5 P=2.75	110	1.39	4.3	21	18 16	30	15	15	39	+40 Sieve=0% +4 Sieve=0%
SILTY SAND(SM) very dense; light brown, yellowish brown and light gray; moist; mottled; with fine-grained sand	N=78					21				24	+40 Sieve=0% +4 Sieve=0%
FAT CLAY(CH) very stiff; dark brown and light brown; moist; with sand seams; laminated	N=27					25	62	26	36	96	+40 Sieve=2% +4 Sieve=0%
--dark brown with light gray; moist; with silt seams	P=4.0	98				24					
--hard; dark brown; moist	N=37										
Bottom of Boring @ 60'											





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

Water Observations: Water level @ 13'.

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

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

Landfill boring B-10

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-10

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

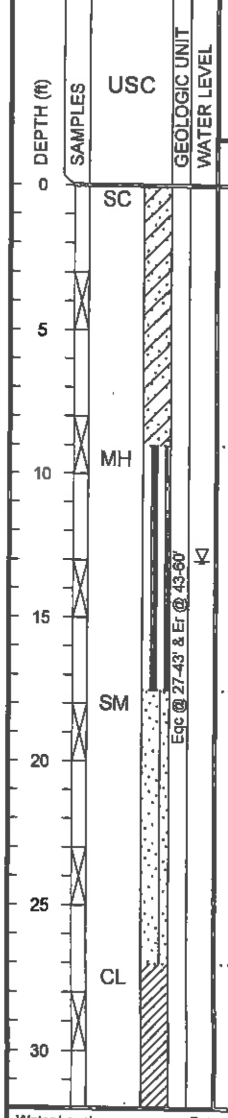
PROJECT NO.: G4207-146

DRILL RIG: B-61 HDX

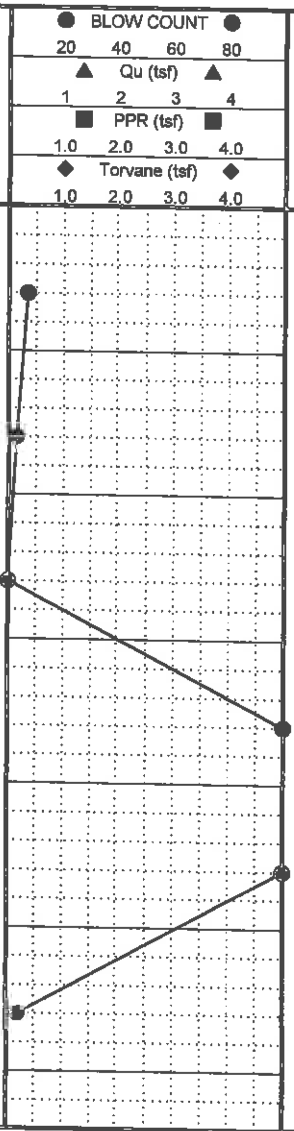
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

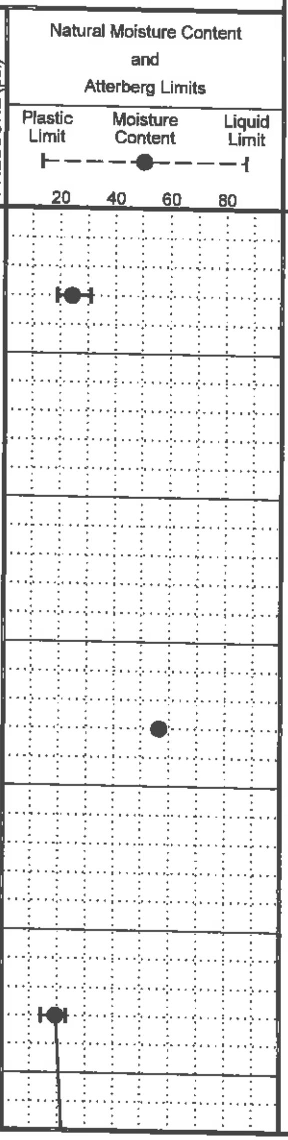
SURFACE ELEVATION 373.2



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	ASH (CLAYEY SAND(SC)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7	24	31	19	12	41	+40 Sieve=21% +4 Sieve=11%
MH	ASH (ELASTIC SILT(MH)) very loose; black; moist	N=3						
	--wet	N=0						
SM	ASH (SILTY SAND WITH GRAVEL(SM)) very dense; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist; cemented layer from 17.5' to 21'	N=50/1"	56				14	+40 Sieve=71% +4 Sieve=28%
	--cemented layer from 23' to 27'	N=50/4"						
CL	SANDY LEAN CLAY(CL) medium stiff; grayish brown and yellowish brown; saturated; mottled	N=4	19	23	14	9	57	+40 Sieve=1% +4 Sieve=0%



DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)



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

Water Observations: Seepage @ 13' while drilling.

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

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
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LOG OF BORING B-10 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

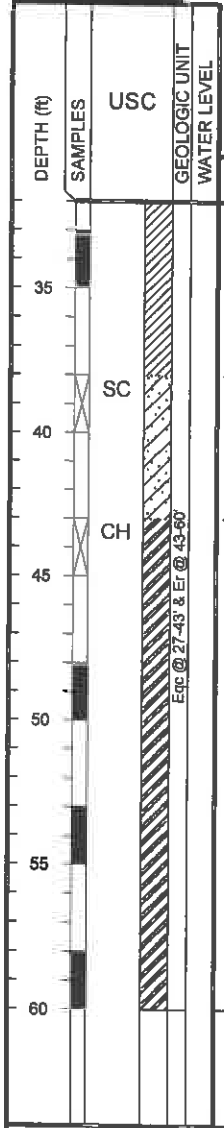
PROJECT NO.: G4207-146

DRILL RIG: B-61 HDX

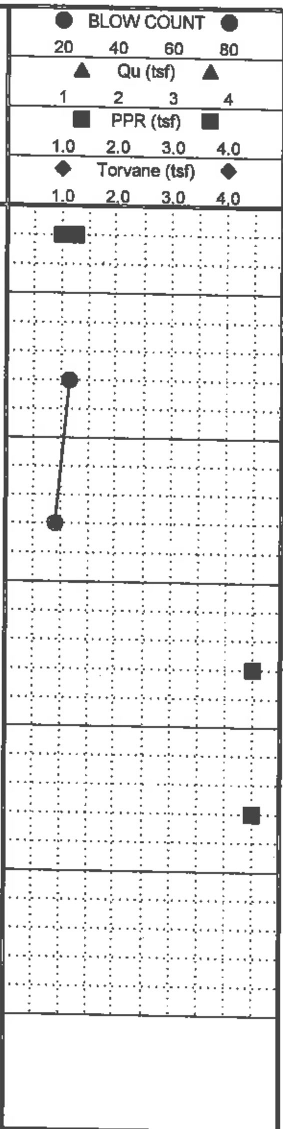
BORING TYPE: Rotary Wash/Flight Auger

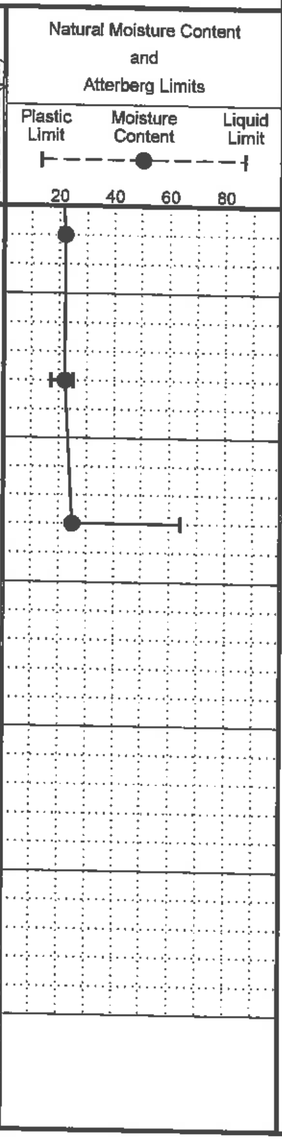
DATE 10/8/14

SURFACE ELEVATION 373.2



MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	P=1.25 P=1.0	107	2.10	6.1	21	22					
CLAYEY SAND(SC) medium dense; reddish brown and grayish brown; moist; mottled	N=23					22	25	17	8	27	+40 Sieve=3% +4 Sieve=0%
FAT CLAY(CH) very stiff; dark brown with light gray; with silt seams; moist	N=18					25	64	24	40	90	+40 Sieve=7% +4 Sieve=0%
--hard	P=4.5+										
	P=4.5+										
Bottom of Boring @ 60'											





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

Water Observations: Seepage @ 13' while drilling.

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

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

Landfill Boring B-12

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-12

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

PROJECT NO.: G4207-146

BORING TYPE: Flight Auger

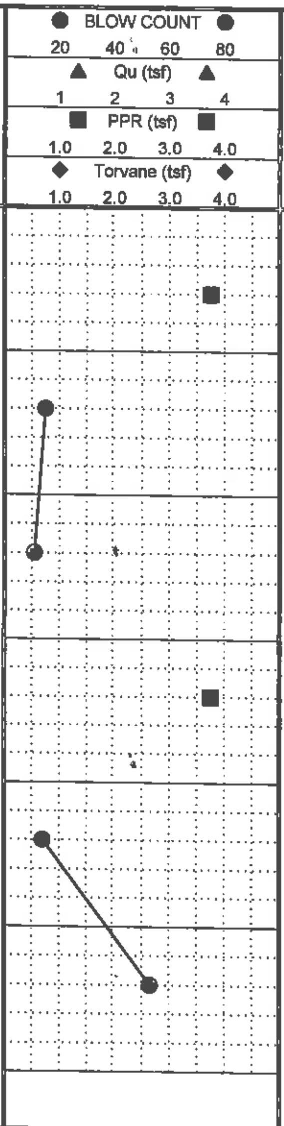
DATE 10/15/14

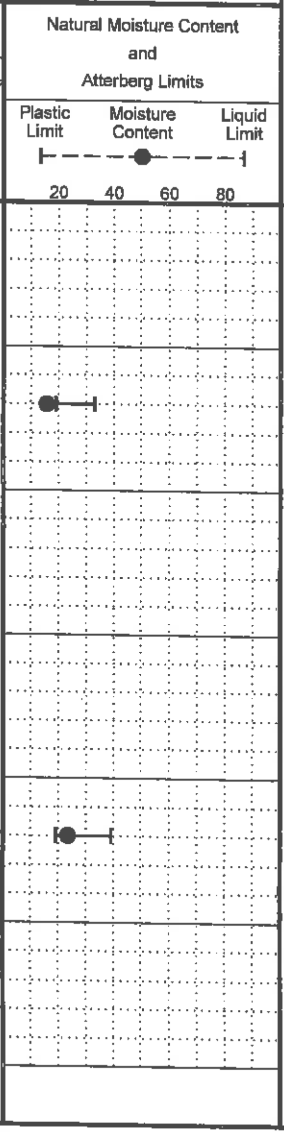
SURFACE ELEVATION 361.7

Geologic unit: Eqc

MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) stiff; light gray and reddish brown; moist; mottled	P=3.75						
CL	SANDY LEAN CLAY(CL) stiff; light brown, light gray and reddish brown; moist; mottled	N=15	16	33	19	14	58	+40 Sieve=1% +4 Sieve=0%
	--grayish brown and brown; moist	N=11						
CH	FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; moist; mottled; with ferric seams	P=3.75						
CL	LEAN CLAY(CL) stiff; light gray and brownish gray; moist; layered with silt	N=14	24	39	19	20	93	+40 Sieve=1% +4 Sieve=0%
ML	SILT WITH SAND(ML) very dense; light brown and yellowish brown; moist; with clay seams	N=53						
	Bottom of Boring @ 30'							





Depth (ft): 0, 5, 10, 15, 20, 25, 30

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

Water Observations: Water level @ 27' 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:

GPS Coordinates: N33.04713°, W94.84486°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-13

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-13

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

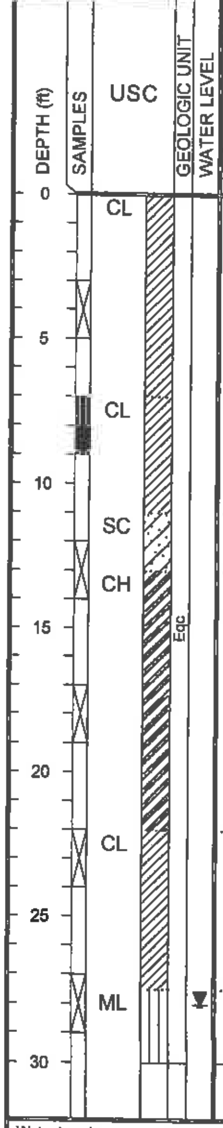
PROJECT NO.: G4207-146

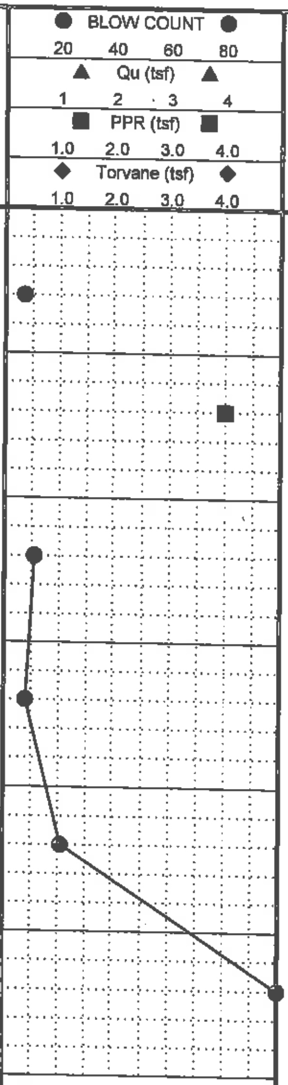
BORING TYPE: Flight Auger

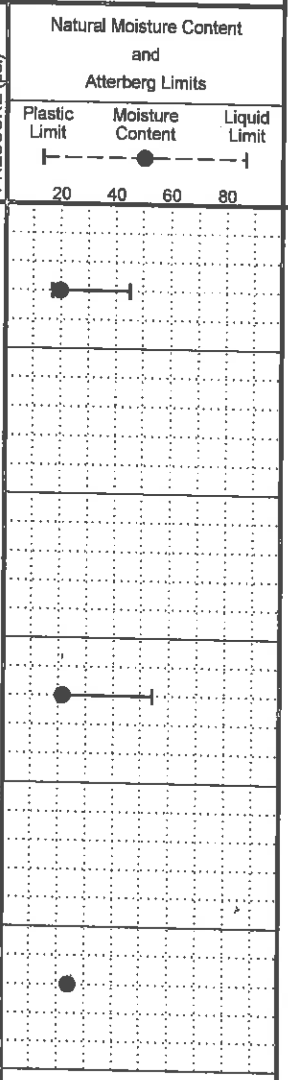
DATE 10/15/14

SURFACE ELEVATION 361.4

MATERIAL DESCRIPTION







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) medium stiff; reddish brown with light gray; moist	N=7					20	45	17	28	76	+40 Sieve=1% +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; light brown, gray and reddish brown; moist; mottled	P=4.0										
SC	CLAYEY SAND(SC) medium dense; grayish brown; moist	N=11										
CH	FAT CLAY WITH SAND(CH) medium stiff; reddish brown and light gray; moist; mottled	N=8					22	54	20	34	79	+40 Sieve=1% +4 Sieve=0%
CL	LEAN CLAY(CL) very stiff; light gray and grayish brown; moist; layered with silt	N=21										
ML	SILT WITH SAND(ML) very dense; light gray and yellowish brown; wet; with clay seams	N=50/5"					24				80	+40 Sieve=0% +4 Sieve=0%

Bottom of Boring @ 30'

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 28' 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:

GPS Coordinates: N33.047160°, W94.84384°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-14

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-14

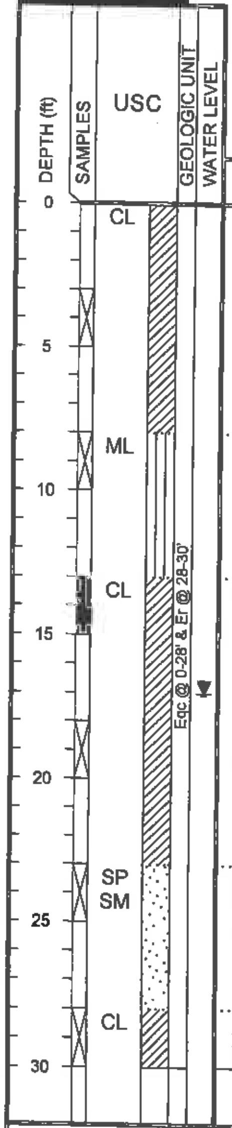
PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
PROJECT NO.: G4207-146
DRILL RIG:
BORING TYPE: Flight Auger

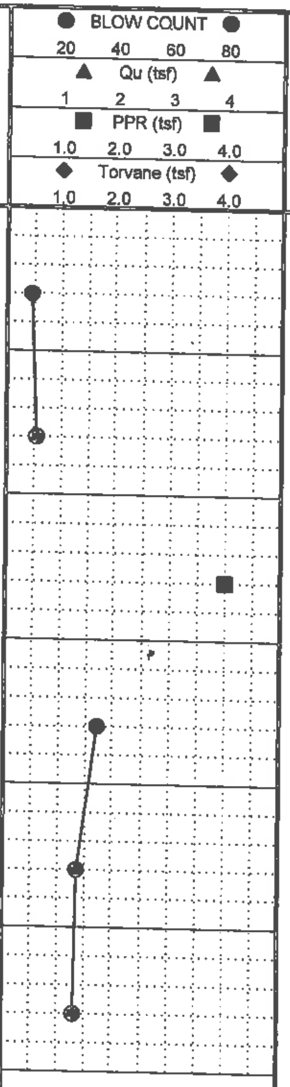
DATE 10/14/14
SURFACE ELEVATION 347.2

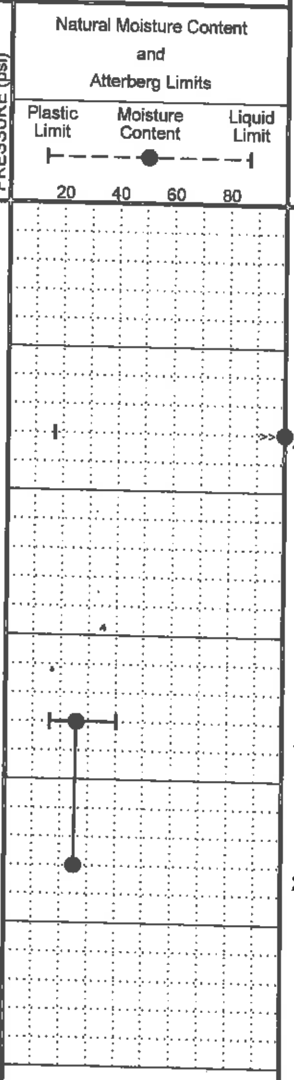
MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) medium stiff; yellowish brown with reddish brown; dry; with clay seams	N=9										
ML	SANDY SILT(ML) medium dense; grayish brown; moist; with clay seams	N=11					108	17	17	NP	68	+40 Sieve=1% +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) very stiff; light gray and gray; moist	P=4.0										
	--light gray and grayish brown; moist; layered with silt	N=34					26	40	16	24	67	+40 Sieve=1% +4 Sieve=0%
SP SM	POORLY GRADED SAND WITH SILT(SP-SM) medium dense; yellowish brown, light gray and reddish brown; wet	N=27					25				10	+40 Sieve=0% +4 Sieve=0%
CL	LEAN CLAY(CL) very stiff; dark brown; moist; with silt partings	N=26										
	Bottom of Boring @ 30'											

GEOLOGIC UNIT: Eqc @ 0-28' & Er @ 28-30'







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

Water Observations: Water level @ 17' and caved to 23' upon completion.

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

Notes:

GPS Coordinates: N33.04774°, W94.84290°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-15

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-15

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

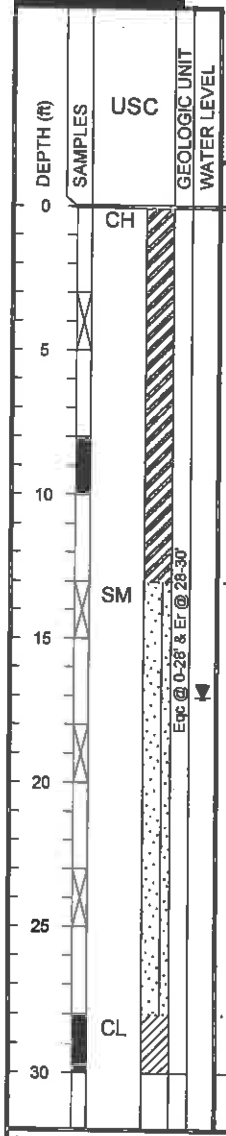
PROJECT NO.: G4207-146

DRILL RIG:

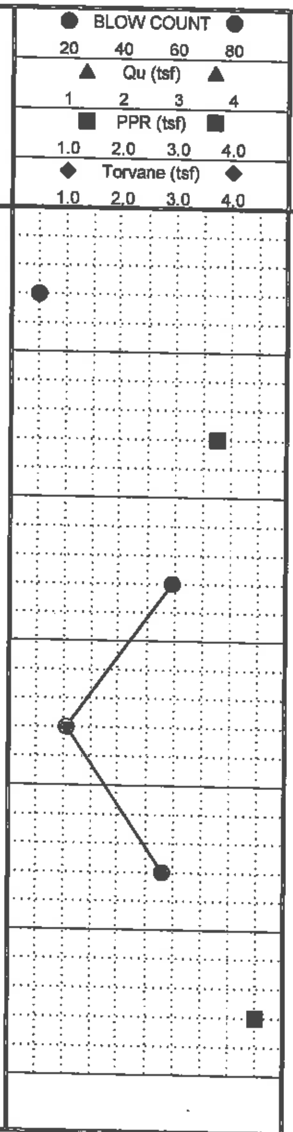
BORING TYPE: Flight Auger

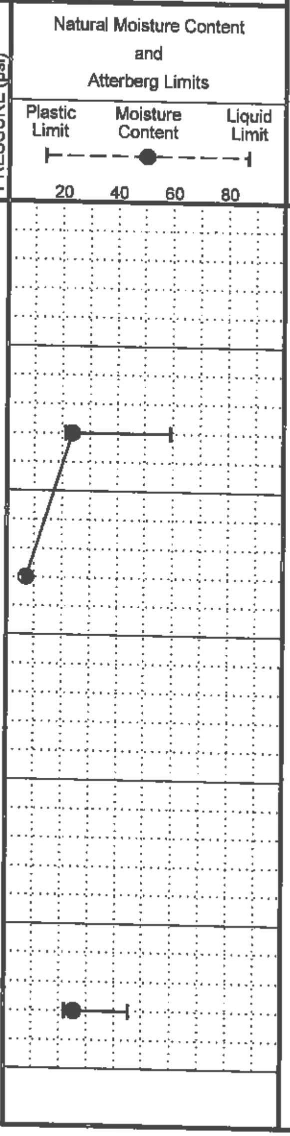
DATE 10/14/14

SURFACE ELEVATION 348.2



MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
FAT CLAY(CH) stiff; reddish brown and light gray; moist; mottled	N=10										
--very stiff; light gray, grayish brown and reddish brown; moist; layered	P=3.75					24	59	21	38	85	+40 Sieve=0% +4 Sieve=0%
SILTY SAND(SM) very dense; light brown; dry	N=59					7				12	+40 Sieve=0% +4 Sieve=0%
--medium dense; wet	N=21										
--very dense	N=56										
LEAN CLAY(CL) hard; dark brown; moist; with silt partings	P=4.5					25	45	22	23	92	+40 Sieve=0% +4 Sieve=0%
Bottom of Boring @ 30'											





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

Water Observations: Water level @ 17' and caved to 19' upon completion.

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

Notes:

GPS Coordinates: N33.04857°, W94.84286°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 1

Date: 8/20/2015

Direction Photo Taken:

North

Description:
Staging area west of landfill.

P8200493

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 2

Date: 8/20/2015

Direction Photo Taken:

South Southeast

Description:

Potential wetland on the top (west) end of the Primary Ash Pond.

P8200495

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 3

Date: 8/20/2015

Direction Photo Taken:

West Northwest

Description:

Ditch between road and railway west of landfill, this ditch would be non-jurisdictional.

P8200497

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 4

Date: 8/20/2015

Direction Photo Taken:

Northeast

Description:

Ground Water Monitoring Well AD-12 near northwest end of landfill.

P8200501

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. **5**	**Date:** 8/20/2015

Direction Photo Taken:

East Northeast

Description:

View of plant from top of landfill. Primary ash pond is within the wooded area on left.

P8200506

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. **6**	**Date:** 8/20/2015

Direction Photo Taken:

East Northeast

Description:

Drainage canal that drains from primary ash pond to clear water pond.

P8200510

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No.
7

Date:
8/20/2015

Direction Photo Taken:

West Northwest

Description:

Vegetated strip between landfill and road. This would be isolated due to lack of connectivity.

P8200521

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No.
8

Date:
8/20/2015

Direction Photo Taken:

North

Description:

Dike between landfill and primary ash pond. Facility in the background.

P8200522

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 9

Date: 8/20/2015

Direction Photo Taken:

West

Description:

Vegetated strip between landfill and road. This area would be isolated due to lack of connectivity.

P8200527

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 10

Date: 8/20/2015

Direction Photo Taken:

North Northeast

Description:

Road east of landfill running toward facility and clear water pond.

P8200530

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 11

Date: 8/20/2015

Direction Photo Taken:

South

Description:

Top of landfill.

P8200534

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 12

Date: 8/20/2015

Direction Photo Taken:

Southeast

Description:

View of lined bottom ash storage pond.

P8200538

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 13

Date: 8/20/2015

Direction Photo Taken:

Southeast

Description:

Lined bottom ash storage pond.

P8200545

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 14

Date: 8/20/2015

Direction Photo Taken:

South

Description:

Southside of lined bottom ash storage pond.

P8200547

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT

Location: PITTSBURG, TITUS COUNTY, TEXAS

Project No. OK001625.0001

Photo No. 15

Date: 8/20/2015

Direction Photo Taken:

West

Description:

East side of lined bottom ash storage pond.

P8200560

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT

Location: PITTSBURG, TITUS COUNTY, TEXAS

Project No. OK001625.0001

Photo No. 16

Date: 8/20/2015

Direction Photo Taken:

North

Description:

Upland with pine and ground water monitoring well AD-2 south of lined bottom ash storage pond.

P8200563

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – J. ROBERT WELSH POWER PLANT	PITTSBURG, TITUS COUNTY, TEXAS	OK001625.0001

Photo No.	Date:
17	8/20/2015

Direction Photo Taken:

Description:

Outflow of water from plant into the northeast portion of the Primary Ash Pond.

P8200577

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – J. ROBERT WELSH POWER PLANT	PITTSBURG, TITUS COUNTY, TEXAS	OK001625.0001

Photo No.	Date:
18	8/20/2015

Direction Photo Taken:

South Southwest

Description:

Northeast portion of primary ash pond, view facing south-southwest.

P8200578

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Infrastructure · Water · Environment · Buildings

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American Electric Power Service Corporation

Bottom Ash Storage Pond - CCR Groundwater Monitoring Well Network Evaluation

J. Robert Welsh Power Plant
1187 County Road 4865
Titus County
Pittsburg, Texas

February 5, 2018

Bottom Ash Storage Pond - CCR Groundwater Monitoring Well Network Evaluation

J. Robert Welsh Power Plant
1187County Road 4865
Titus County
Pittsburg, 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.:
OH015976.0011

Date:
February 5, 2018

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

Kenneth Brandner

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

Matthew J. Lamb /KJB

Matthew J. Lamb
Project Manager

John Holm /DPL

John Holm, P.E.
Professional Engineer

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 Bottom Ash Storage Pond (CCR Unit) at the AEP Generating Plant (Plant) located at 1187 County Road 4865 in Pittsburg, Titus 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.

Three regulated CCR units associated with the Plant were identified for review, which include the primary bottom ash pond, landfill, and Bottom Ash Storage Pond (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the Bottom Ash Storage Pond (Site).

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Bottom Ash Storage Pond CCR unit, as well as publicly-available geologic and hydrogeologic data. This 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 J. Robert Welsh Generating Plant (Welsh Plant) Bottom Ash Storage Pond.

2.1 Facility Location Description

The AEP Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The Bottom Ash Storage Pond CCR unit is located at the south end of the Plant and approximately 1,000 feet west of the Welsh Reservoir (**Figures 1** and **2**).

2.2 Description of Bottom Ash Storage Pond CCR Unit

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

2.2.1 Embankment Configuration

The Bottom Ash Storage Pond was placed into operation in 2000, and is located in the southern portion of the Plant. The Bottom Ash Storage Pond embankments are approximately 20 feet in height and are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical). The elevation at the base of the embankment is approximately 340 feet amsl, and the elevation at the top of the embankment around the perimeter of the Bottom Ash Storage Pond is approximately 360 feet amsl (Southwestern Electric Power Company, 2000).

2.2.2 Area/Volume

The Bottom Ash Storage Pond is 22 acres in size. Per the *Hydraulic Analysis of Welsh Power Plant Ash Ponds Report,* dated December 2010 (Freese and Nichols, 2010), the principal spillway for the Bottom Ash Storage Pond is located near the southeast corner of the pond and consists primarily of an 18 inch drain at elevation 350.5 feet amsl and also of a 40-foot-long broad-crested weir with a crest elevation of 355 feet amsl. The emergency spillway is an 8-foot-wide weir with a rock rip-rap discharge chute located along the southern embankment at an elevation of 358 feet amsl. The storage capacity of the Bottom Ash Storage Pond at elevation 358 feet amsl is 86.50 acre-ft (Freese and Nichols, 2010).

2.2.3 Construction and Operational History

The AEP J. Robert Welsh Plant began operations in approximately 1977 with three coal-fired generating units (Units 1, 2, and 3). Throughout the life of the generating plant, CCR materials (fly ash, bottom ash, economizer ash) have been generated. All of these byproducts were stored in the primary bottom ash pond and in the adjacent landfill that was constructed in the late 1970's. In 2000, the 22-acre Bottom Ash Storage Pond was installed south of the landfill. The Bottom Ash Storage Pond was constructed with a 60-mil high-density polyethylene (HDPE) liner, and receives bottom ash and economizer ash dredged and sluiced from the primary bottom ash pond (**Figure 2**).

The Bottom Ash Storage Pond 60-mil HDPE liner is located at the base of the Bottom Ash Storage Pond at an elevation of 340 feet amsl. The liner also extends along the base of the Bottom Ash Storage Pond sidewalls and is keyed into the top of the Bottom Ash Storage Pond earthen embankment at an elevation of 360 feet amsl (Southwestern Electric Power Company, 2000).

The southeast corner of the Bottom Ash Storage Pond contains an approximate ¼-acre clear water pond with a base elevation of 347 feet amsl (**Figure 3**). The clear water pond receives clear water primarily through an 18 inch drain and then through an overflow structure from the main part of the Bottom Ash Storage Pond through the 40-foot-long broad-crested weir discussed above in Section 2.2.2. Water in the ¼-acre clear water pond at the southeast corner of the Bottom Ash Storage Pond discharges through a 30-inch-diameter pipe into the primary bottom ash pond system.

2.2.4 Surface Water Control

Surface water flow within the Bottom Ash Storage Pond is primarily controlled by an 18 inch drain and then by a weir located on the southeast side of the pond below the embankments. The pond elevation is maintained so that surface water flows through the drain pipe at invert elevation 350.5 amsl or weir which has a crest elevation of 355 feet amsl. Clear water flows through the weir into the ¼-acre clear water pond at the southeast corner of the Bottom Ash Storage Pond, then discharges through a 30-inch-diameter pipe into the primary bottom ash pond (**Figure 3**).

The emergency spillway for the Bottom Ash Storage Pond is located along the southern embankment, and is 8 feet wide with a crest elevation of 358 feet amsl. The perimeter embankments of the Bottom Ash Storage Pond are located at an elevation of

360 feet amsl. Therefore the perimeter embankments have approximately five feet of freeboard above the clear water discharge weir, and approximately two feet of freeboard above the emergency spillway.

2.3 Previous Investigations

The initial soils investigation for the site was provided in a 1973 report prepared by McClelland Engineers, Inc. entitled "*Soils Investigation, Welsh Power Plant, Cason, Texas*". This investigation included advancement of soil borings in the primary bottom ash pond area, and geotechnical soil testing to characterize the area encompassed by the primary bottom ash pond.

In 2000, Maxim Technologies prepared a report entitled "*Subsurface Exploration for Ash Storage Area, Phase II, Welsh Power Plant, Cason, Texas*". This report evaluated the geotechnical properties of the soils below the Bottom Ash Storage Pond.

In 2000, an HDPE liner installation report was prepared by Alliance Incorporated. This report provided details regarding installation of the 60-mil HDPE liner on the bottom of the Bottom Ash Storage Pond.

In 2001, five monitoring wells (AD-1 through AD-5) were installed in the area of the primary bottom ash pond and Bottom Ash Storage Pond to obtain hydrologic data for the uppermost water-bearing unit. Twelve additional monitoring wells (AD-4a, AD-4b, AD-4c, AD-6 through AD-14) were installed in the area of the primary bottom ash pond, Bottom Ash Storage Pond, and landfill by Eagle Environmental Services in 2009 to obtain more detailed hydrologic data for the uppermost water-bearing unit.

In 2010, Freese and Nichols performed a *Hydraulic Analysis of the Welsh Power Plant Ash Ponds* (Freese and Nichols, 2010). The report concluded the spillways for the primary bottom ash pond, clear water pond, and Bottom Ash Storage Pond are hydraulically adequate for the full range of storm events from the 10-year to the 100-year storm events.

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant by installation of monitoring wells AD-15 through AD-18 (Auckland Consulting, 2016). In April 2017, ARCADIS installed monitoring well AD-16R as a replacement for monitoring well AD-16, which was nearly dry following drilling. Monitoring well completion diagrams are provided in **Appendix A.**

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 Site is located on the outcrop of the Eocene-age Recklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966).

These features are further illustrated on five lines of cross section that were prepared through the Bottom Ash Storage Pond 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

The climate of Titus County, Texas is moist subhumid. The normal January temperature is 45˚Fahrenheit (F), and the normal July temperature is 82.9˚F. The mean annual growing season is 228 days (Broom, 1965). Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches according to weatherdb.com.

2.4.2 Regional and Local Geologic Setting

The Site is located on the outcrop of the Eocene-age Recklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966). The Recklaw Formation attains a thickness of approximately 110 feet in Titus County, and is underlain by the Eocene-age Carrizo Sand which consists of fine to coarse sand, silt, and clay (Broom, 1965). In the topographically low areas underling the Welsh Reservoir to the east of the Bottom Ash Storage Pond, Quarternary alluvial sediments associated with Swauano Creek are present (Flawn, 1966).

Detailed regional geologic characterization can be found in several published reports including Texas Water Commission Bulletin 6517 "*Ground-Water Resources of Camp, Franklin, Morris and Titus Counties, Texas*" (Broom, 1965), and The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Texarkana Sheet*" (Flawn, 1966).

Detailed regional and site geologic characterization can be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Welsh Power Station, Existing Ash Storage Ponds Embankment Investigation, Pittsburg, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

The Site is generally less than one-half mile from Swauano Creek, which was dammed near the southern end of the Site during plant development to form the Welsh Reservoir. Groundwater flow direction at the Site is generally from west to east, following surface topography towards the Welsh Reservoir. The Welsh Reservoir is likely a gaining surface water feature, and groundwater elevations on site are higher than the normal stage elevation of the Welsh Reservoir (approximately 320 feet amsl).

The Bottom Ash Storage Pond normal operating level is near the clear water overflow weir which has a crest elevation of 355 feet amsl. **Figure 9** and **Figure 10** are potentiometric surface maps for the uppermost aquifer at the Site based on March 2016 and February 2017 water level data, respectively. 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 area of the Bottom Ash Storage Pond is east-southeasterly toward the Welsh Reservoir at an average hydraulic gradient of approximately 0.01 foot per foot.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed one water well within a ½-mile radius of the Site (Banks, 2013). The water well is located on-site to the southwest (sidegradient) of the primary bottom ash pond, and was installed for Southwestern Electric Company in 1974 with screens from 515 to 535 feet below ground surface, and plugged at a later date.

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 upgradient and down gradient of the Site. The upgradient 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 and monitoring wells installed at the Site show the uppermost aquifer in the area of the Bottom Ash Storage Pond is a very fine to fine grained silty sand and sandy silt stratum with an average thickness of approximately 12 feet that is located between an elevation of approximately 320 and 332 feet amsl (**Appendix A**). The base of the Bottom Ash Storage Pond is at an elevation of 340 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the Bottom Ash Storage Pond is approximately 8 feet. This separation distance is further illustrated on cross section C-C’ (**Figure 6)** and cross section D-D’ (**Figure 7)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (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 12 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 2017. The most recent comprehensive groundwater data set from February 2017 is depicted on **Figure 10**. The groundwater flow is generally easterly towards the Welsh Reservoir.

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 on-Site hydrostratigraphic unit in the area of the Bottom Ash Storage Pond is the very fine to fine grained silty sand and sandy silt stratum that is located between an elevation of approximately 320 and 332 feet amsl. This unit is not used locally for groundwater supply or industrial water use, but meets the TCEQ definition of a useable aquifer.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 20, 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 20, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-1 through AD-4, AD-4a, AD-4b, and AD-4c were previously installed at the Site to monitor the uppermost aquifer (very fine to fine grained silty sand and sandy silt stratum) associated with the Bottom Ash Storage Pond. As discussed above in Section 3.1.1, the aquifer below the Bottom Ash Storage Pond is approximately 12 feet thick and is located between an elevation of approximately 320 and 332 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Sections A-A' (**Figure 4**) and C-C' (**Figure 6**), existing monitoring wells AD-5 and AD-1 are screened at the top of the uppermost aquifer up gradient (northwest) of the Bottom Ash Storage Pond, and existing monitoring wells AD-4a, AD-4b, and AD4c are screened in the uppermost aquifer down gradient (east) of the Bottom Ash Storage Pond. Existing monitoring wells AD-1 and AD-5 will be utilized as the upgradient monitoring wells for the Bottom Ash Storage Pond. Monitoring well AD-17, installed northwest (upgradient) of the Bottom Ash Storage Pond during December 2015, will also be utilized as an upgradient monitoring well for the Bottom Ash Storage Pond.

Existing monitoring well AD-3, located east of the Bottom Ash Storage Pond, will be utilized as a down gradient monitoring well for the Bottom Ash Storage Pond. Existing monitoring wells AD-4, AD-4a, AD-4b, and AD-4c are located in close proximity to each other, and as shown on **Figure 9**, monitoring well AD-4c is the furthest down gradient of these four monitoring wells. Therefore monitoring well AD-4c will be utilized as a down gradient monitoring well for the Bottom Ash Storage Pond.

As shown on **Figures 9** and **10**, existing monitoring well AD-14 is located east of the northeast corner of the Bottom Ash Storage Pond. However, due to the close proximity of the landfill CCR unit directly north of the Bottom Ash Storage Pond, groundwater at monitoring well AD-14 could be affected by the landfill. Therefore monitoring well AD-14 will not be utilized as part of the groundwater monitoring system for the Bottom Ash Storage Pond. This data gap was addressed by installation of new monitoring well AD-16 during December 2015 east (down gradient) of the Bottom Ash Storage Pond as shown on **Figure 9** and **Figure 10**. However, monitoring well AD-16 was nearly dry following drilling. Therefore monitoring well AD-16 was replaced with monitoring well AD-16R during April 2017. With the addition of monitoring wells AD-16R and AD-17, there are no gaps remaining in the groundwater monitoring network for the Bottom Ash Storage Pond.

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 Bottom Ash Storage Pond (upgradient 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 Bottom Ash Storage Pond.

4.1 Recommended Monitoring Well Network Distribution

Three upgradient well locations (existing monitoring wells AD-1, AD-5, and AD-17) and three down gradient well locations (existing monitoring wells AD-3, AD-4c, and AD-16R) are recommended to establish a groundwater quality monitoring well network for the Bottom Ash Storage Pond. In addition, existing monitoring wells AD-2, AD-4, AD-4a, AD-4b, and AD-16 may be utilized as piezometers to obtain additional groundwater flow direction and gradient data for the Bottom Ash Storage Pond.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Bottom Ash Storage Pond is summarized on **Table 3** and illustrated on **Figure 11.**

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 332 feet amsl as shown on Geologic Cross Sections C-C’ (**Figure 6**) 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 Bottom Ash Storage Pond was addressed by installation of monitoring wells AD-16R and AD-17. Monitoring wells AD-16R and AD-17 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**.

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

Signature

KENNETH J. BRANDNER
69586

69586
Registration No.

TX
Registration State

2-5-18
Date

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Tables

Table 1
Water Level Data
AEP J. Robert Welsh Power Plant - CCR Storage Areas
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Top of Casing Elevation	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen		Bottom of Screen		6/7/2011	12/6/2011	5/2/2012	11/1/2012	5/14/2013	11/19/2013	5/12/2014	11/16/2014	5/12/2015	3/4/2016	5/26/2016	7/27/2016	10/19/2016	12/12/2016	1/17/2017	2/23/2017
									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	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																												
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	357.57	25.0	1/11/01	Sch. 40 PVC	2	15.0	340.57	25.0	330.57	338.46	334.92	337.88	337.18	337.43	336.73	338.03	337.64	340.82	342.83	344.89	342.89	341.23	340.58	341.18	339.74
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	346.16	25.0	4/26/01	Sch. 40 PVC	2	15.0	329.16	25.0	319.16	330.16	329.07	330.00	329.26	329.83	329.70	330.09	329.69	332.56	332.32	---	---	---	---	---	---
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	333.10	17.0	4/26/01	Sch. 40 PVC	2	7.0	324.10	17.0	314.10	323.81	323.19	323.99	323.29	323.77	323.98	324.12	323.28	325.58	325.12	324.59	323.70	323.47	323.78	325.04	324.92
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	342.61	30.0	4/26/01	Sch. 40 PVC	2	19.0	321.61	29.0	311.61	324.81	324.84	324.62	324.40	324.74	325.52	325.44	325.13	327.00	326.90	---	---	---	---	---	---
AD-4a (a)	33.04527	94.84258	340.19	342.85	30.0	9/22/09	Sch. 40 PVC	2	20.0	320.19	30.0	310.19	325.01	324.19	325.24	322.90	324.86	324.68	325.64	325.34	327.19	327.12	---	---	---	---	---	---
AD-4b (a)	33.04531	94.84230	329.55	333.23	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.55	15.0	314.55	324.35	324.32	324.50	324.30	324.30	325.21	325.22	324.90	326.58	326.67	---	---	---	---	---	---
AD-4c (a)	33.04507	94.84244	329.15	333.28	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.15	15.0	314.15	324.18	324.50	324.64	324.37	324.11	325.06	325.01	324.71	326.50	326.19	325.89	324.01	323.76	325.07	326.39	324.89
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	351.00	30.0	1/11/01	Sch. 40 PVC	2	20.0	329.00	30.0	319.00	336.34	336.58	336.82	336.99	336.78	336.47	336.80	336.01	339.07	338.04	337.62	337.24	337.74	337.01	338.34	336.17
AD-6 (a)	33.05235	94.84757	343.31	346.33	33.0	9/23/09	Sch. 40 PVC	2	23.0	320.31	33.0	310.31	333.04	333.02	332.83	333.02	333.11	332.81	333.11	332.81	333.38	334.00	---	---	---	---	---	---
AD-7 (a)	33.05257	94.84219	347.86	350.82	38.0	9/24/09	Sch. 40 PVC	2	28.0	319.86	38.0	309.86	334.32	334.12	334.19	334.20	334.13	334.58	333.77	333.98	334.09	333.61	---	---	---	---	---	---
AD-8 (a)	33.05187	94.84026	337.53	340.01	29.0	9/21/09	Sch. 40 PVC	2	16.0	321.53	26.0	311.53	325.41	324.09	325.69	325.15	325.79	325.75	325.98	325.77	326.05	325.70	325.68	325.05	325.29	325.92	326.76	324.27
AD-9 (a)	33.04995	94.84196	340.32	343.09	35.0	9/21/09	Sch. 40 PVC	2	20.0	320.32	35.0	305.32	328.46	328.53	328.63	328.44	328.74	329.38	NM	330.18	329.98	329.74	329.28	329.53	328.92	329.31	330.50	328.05
AD-10 (a)	33.04881	94.84047	340.23	343.01	35.0	9/22/09	Sch. 40 PVC	2	20.0	320.23	35.0	305.23	323.44	322.55	323.27	323.35	323.51	323.76	323.57	323.88	323.95	323.55	---	---	---	---	---	---
AD-11 (a)	33.04824	94.84177	339.61	342.18	20.0	9/22/09	Sch. 40 PVC	2	10.0	329.61	20.0	319.61	327.99	328.37	327.82	327.93	327.94	328.13	328.20	327.97	328.96	328.13	328.39	328.14	327.87	328.20	328.90	328.25
AD-12 (a)	33.04901	94.84977	366.27	369.33	30.0	9/24/09	Sch. 40 PVC	2	20.0	346.27	30.0	336.27	348.30	348.29	349.86	349.56	349.99	349.65	349.89	350.01	350.65	350.39	---	---	---	---	---	---
AD-13 (a)	33.04918	94.84275	344.12	347.00	20.0	9/22/09	Sch. 40 PVC	2	6.0	338.12	16.0	328.12	332.36	332.24	333.09	332.26	332.68	333.25	333.35	332.01	337.58	334.76	334.54	332.93	332.39	332.84	334.54	331.83
AD-14 (a)	33.04715	94.84256	342.32	345.43	19.0	9/22/09	Sch. 40 PVC	2	8.0	334.32	18.0	324.32	330.40	329.80	331.67	330.34	330.94	331.69	332.12	330.17	336.63	334.83	334.51	331.71	330.94	330.79	332.63	330.87
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	343.29	46.0	12/12/15	Sch. 40 PVC	2	25.5	314.71	45.5	294.71	---	---	---	---	---	---	---	---	---	322.14	321.93	321.28	321.42	321.71	321.64	322.81
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	353.97	21.0	12/10/15	Sch. 40 PVC	2	11.0	339.86	21.0	329.86	---	---	---	---	---	---	---	---	---	337.09	335.84	332.14	331.52	331.43	330.96	330.71
AD-16R(e)	33° 02' 49"	94° 50' 28.9"	350.55	353.49	27.0	4/12/17	Sch. 40 PVC	2	12.0	338.55	27.0	323.55	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	357.10	40.0	12/10/15	Sch. 40 PVC	2	24.0	329.99	39.0	314.99	---	---	---	---	---	---	---	---	---	334.64	334.26	334.30	334.45	334.64	334.05	333.94
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	349.28	29.0	12/11/15	Sch. 40 PVC	2	14.0	332.17	29.0	317.17	---	---	---	---	---	---	---	---	---	343.66	343.26	340.81	339.92	339.38	338.97	340.38
Piezometers																												
B-2 (b)	33° 03.078'	94° 50.449'	339.7	339.7	50.0	10/28/09	Sch. 40 PVC	2	10.0	329.70	20.0	319.70	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-4 (b)	33° 03.011'	94° 50.462'	340.6	340.6	50.0	10/27/09	Sch. 40 PVC	2	8.0	332.60	18.0	322.60	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-5 (b)	33° 02.964'	94° 50.428'	340.0	340.0	50.0	10/27/09	Sch. 40 PVC	2	10.0	330.00	20.0	320.00	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-6 (b)	33° 02.912'	94° 50.462'	340.1	340.1	50.0	10/28/09	Sch. 40 PVC	2	12.0	328.10	22.0	318.10	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

NM - Not measured.
(a) Source: Eagle Environmental Services Well Logs (2009).
(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).
(c) Source: Southwest Electric Power, State of Texas Well Report (2001).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.
(e) Monitoring well installed by ARCADIS on April 12, 2017 as a replacement for monitoring well AD-16.
Groundwater Elevation Source: AEP, Shallow Groundwater Data Summary through February 2017.

Table 2
Well Construction Details
AEP J. Robert Welsh Power Plant - CCR Units
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen		Bottom of Screen	
								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															
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	25.0	1/11/2001	PVC	2	13	343	25	331	15.0	340.57	25.0	330.57
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	25.0	4/26/2001	PVC	2	12	332	25	319	15.0	329.16	25.0	319.16
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	17.0	4/26/2001	PVC	2	5	326	17	314	7.0	324.10	17.0	314.10
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	30.0	4/26/2001	PVC	2	16	325	30	311	19.0	321.61	29.0	311.61
AD-4a (a)	33.04527	94.84258	340.19	30.0	9/22/2009	PVC	2	17	323	30	310	20.0	320.19	30.0	310.19
AD-4b (a)	33.04531	94.84230	329.55	15.0	9/23/2009	PVC	2	4	326	15	315	5.0	324.55	15.0	314.55
AD-4c (a)	33.04507	94.84244	329.15	15.0	9/23/2009	PVC	2	4	325	15	314	5.0	324.15	15.0	314.15
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	30.0	1/11/2001	PVC	2	16	333	30	319	20.0	329.00	30.0	319.00
AD-6 (a)	33.05235	94.84757	343.31	33.0	9/23/2009	PVC	2	21	322	33	310	23.0	320.31	33.0	310.31
AD-7 (a)	33.05257	94.84219	347.86	38.0	9/24/2009	PVC	2	26	322	38	310	28.0	319.86	38.0	309.86
AD-8 (a)	33.05187	94.84026	337.53	29.0	9/21/2009	PVC	2	14	324	29	309	16.0	321.53	26.0	311.53
AD-9 (a)	33.04995	94.84196	340.32	35.0	9/21/2009	PVC	2	18	322	35	305	20.0	320.32	35.0	305.32
AD-10 (a)	33.04881	94.84047	340.23	35.0	9/22/2009	PVC	2	18	322	35	305	20.0	320.23	35.0	305.23
AD-11 (a)	33.04824	94.84177	339.61	20.0	9/22/2009	PVC	2	8	332	20	320	10.0	329.61	20.0	319.61
AD-12 (a)	33.04901	94.84977	366.27	30.0	9/24/2009	PVC	2	18	348	30	336	20.0	346.27	30.0	336.27
AD-13 (a)	33.04918	94.84275	344.12	20.0	9/22/2009	PVC	2	4	340	20	324	6.0	338.12	16.0	328.12
AD-14 (a)	33.04715	94.84256	342.32	19.0	9/22/2009	PVC	2	6	336	18	324	8.0	334.32	18.0	324.32
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	46.0	12/12/15	PVC	2	22	318	45.5	295	25.5	314.71	45.5	294.71
AD-16R	33° 02' 49"	94° 50' 29"	350.55	27.0	4/12/17	PVC	2	10	341	27	324	12.0	338.55	27.0	323.55
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	40.0	12/10/15	PVC	2	22	332	39	315	24.0	329.99	39.0	314.99
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	29.0	12/11/15	PVC	2	12	334	29	317	14.0	332.17	29.0	317.17
Piezometers															
B-2 (b)	33° 03.078'	94° 50.449'	339.7	50.0	10/28/2009	PVC	2	8	332	20	320	10.0	329.70	20.0	319.70
B-4 (b)	33° 03.011'	94° 50.462'	340.6	50.0	10/27/2009	PVC	2	8	333	18	323	8.0	332.60	18.0	322.60
B-5 (b)	33° 02.964'	94° 50.428'	340.0	50.0	10/27/2009	PVC	2	5	335	20	320	10.0	330.00	20.0	320.00
B-6 (b)	33° 02.912'	94° 50.462'	340.1	50.0	10/28/2009	PVC	2	4	336	22	318	12.0	328.10	22.0	318.10
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	21.0	12/10/15	PVC	2	9	342	21	330	11.0	339.86	21.0	329.86

General Notes:
Elevation in feet above mean sea level.

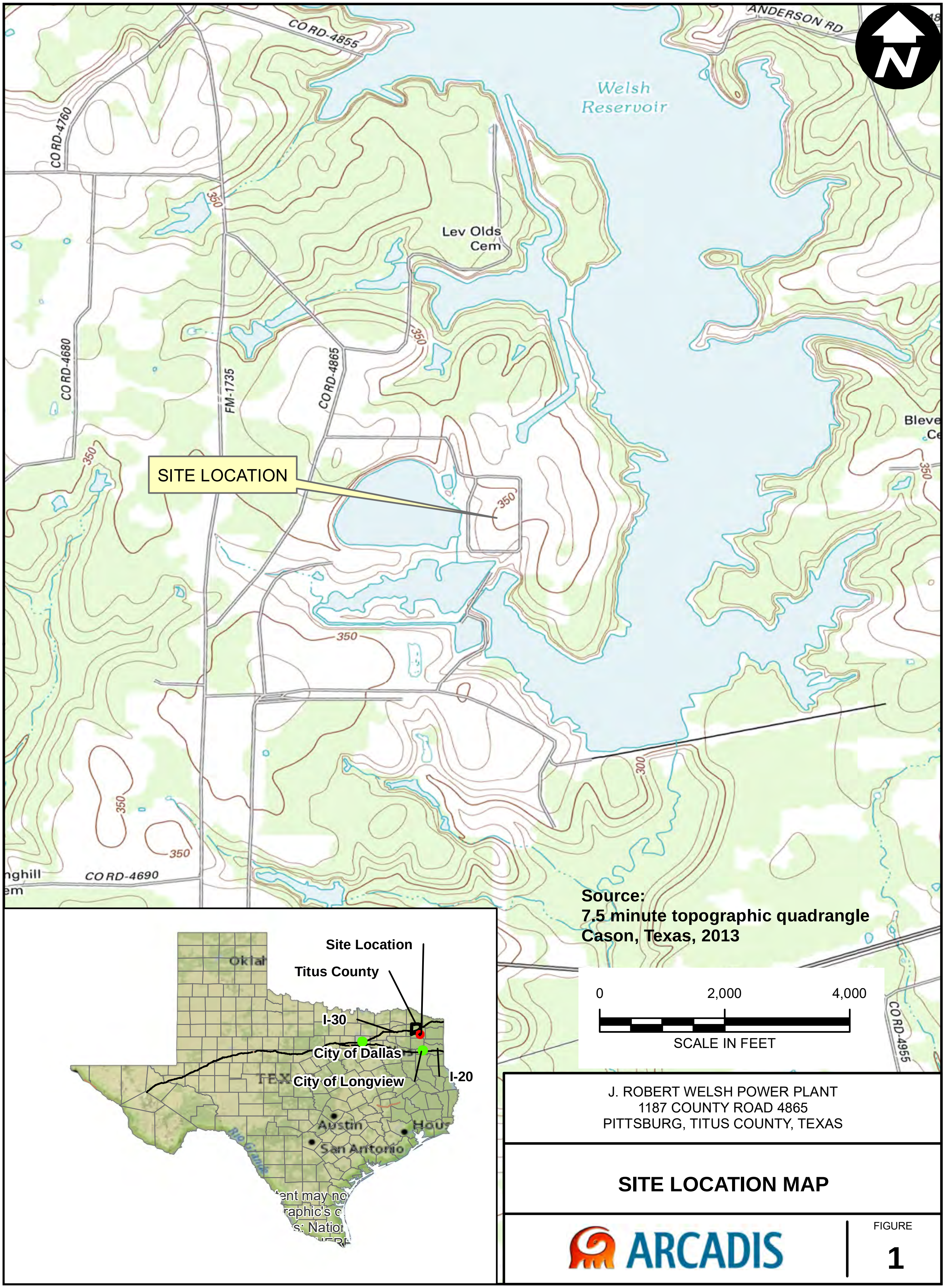
Footnotes:
(a) Source: Eagle Environmental Services Well Logs (2009).
(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).
(c) Source: Southwest Electric Power, State of Texas Well Report (2001).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.
Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP J. Robert Welsh Power Plant - Bottom Ash Storage Pond
Pittsburg, Titus County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Elevation (ft amsl)	Screen Bottom Elevation (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-1	Existing	Uppermost Water-Bearing Unit	West of Bottom Ash Storage Pond	Upgradient	340.6	330.6	10	Existing well installed in 2001; well will be utilitzed to establish backgroud water quality
AD-5	Existing	Uppermost Water-Bearing Unit	NW of Bottom Ash Storage Pond	Upgradient	329.0	319.0	10	Existing well installed in 2001; well will be utilitzed to establish backgroud water quality
AD-17	Existing	Uppermost Water-Bearing Unit	NW of Bottom Ash Storage Pond	Upgradient	330.0	315.0	15	New monitoring well installed during December 2015 in uppermost shallow aquifer northwest of Bottom Ash Storage Pond - upgradient; well will be utilized to establish background water quality
Downgradient								
AD-3	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	324.1	314.1	10	Existing well installed in 2001; uppermost shallow aquifer adjacent to the bottom ash storage pond - downgradient
AD-4c	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	324.2	314.2	10	Existing well installed in 2009; uppermost shallow aquifer adjacent to the bottom ash storage pond - downgradient
AD-16R	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	338.6	323.6	15	New monitoring well installed during April 2017 in uppermost shallow aquifer adjacent to the bottom ash storage pond - downgradient
Piezometers								
AD-2	Existing	Uppermost Water-Bearing Unit	South of Bottom Ash Storage Pond	Side gradient	329.2	319.2	10	Existing well installed in 2001; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-4	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	321.6	311.6	10	Existing well installed in 2001; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-4a	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	320.2	310.2	10	Existing well installed in 2009; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-4b	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	324.6	314.6	10	Existing well installed in 2009; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-16	Existing	Uppermost Water-Bearing Unit	East of Bottom Ash Storage Pond	Down gradient	339.9	329.9	10	New piezometer installed during December 2015 in uppermost shallow aquifer adjacent to the bottom ash storage pond - downgradient

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

Figures



Source:
7.5 minute topographic quadrangle
Cason, Texas, 2013

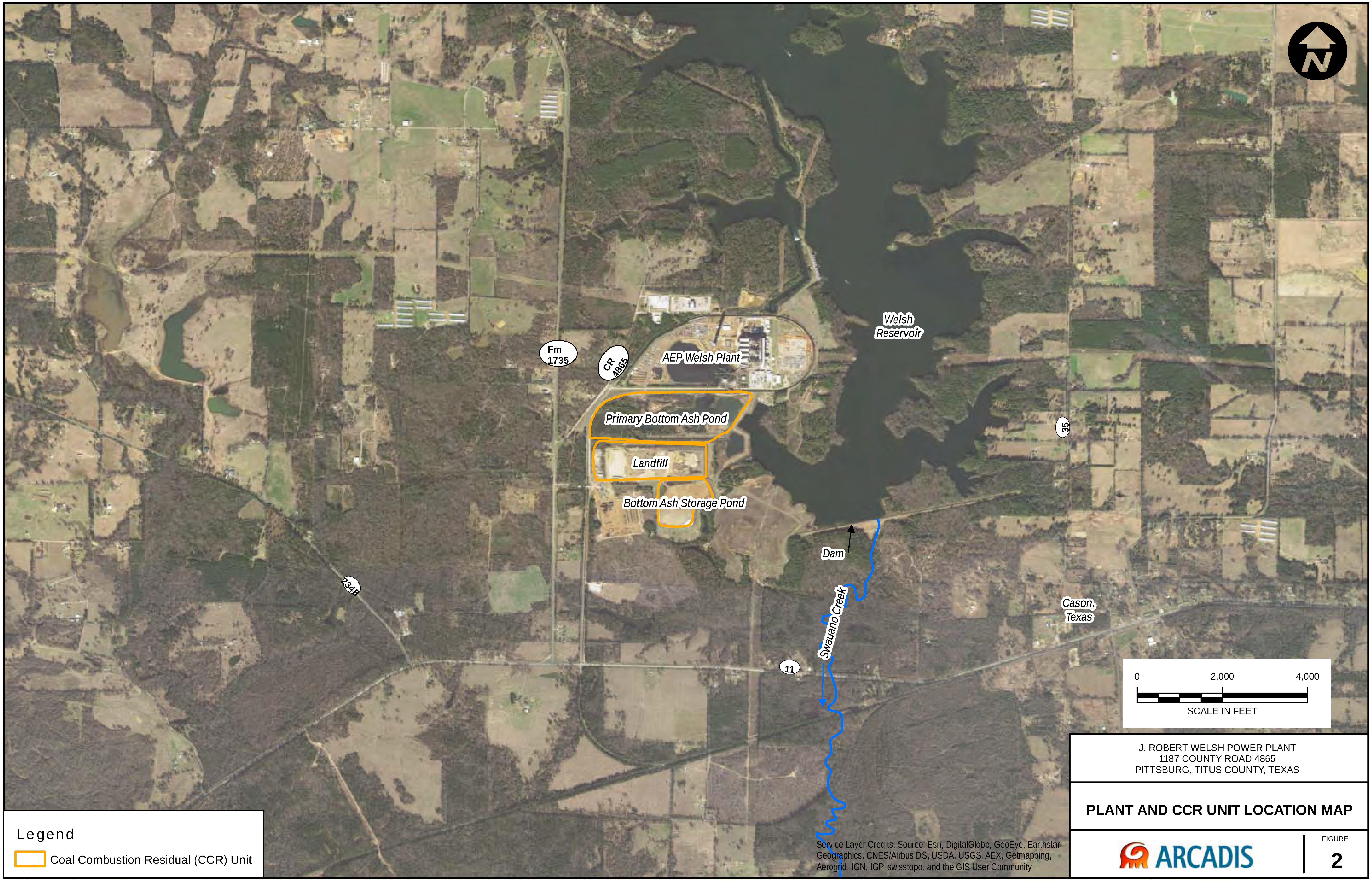
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 1 - site map.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

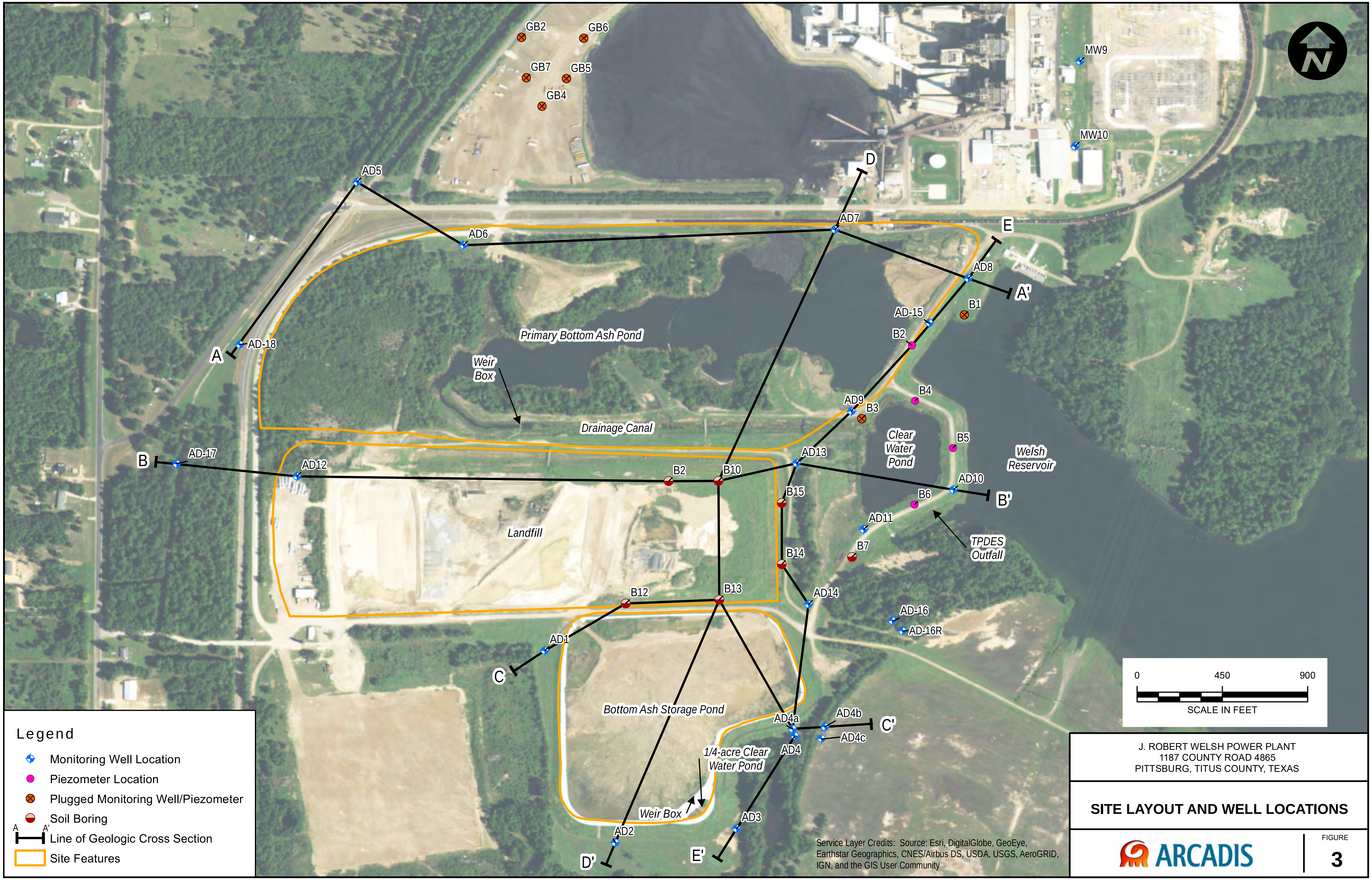
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 2 - CCR location.mxd



Legend

⊕ Monitoring Well Location

● Piezometer Location

⊗ Plugged Monitoring Well/Piezometer

◒ Soil Boring

A ⊢⊣ A' Line of Geologic Cross Section

▭ Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

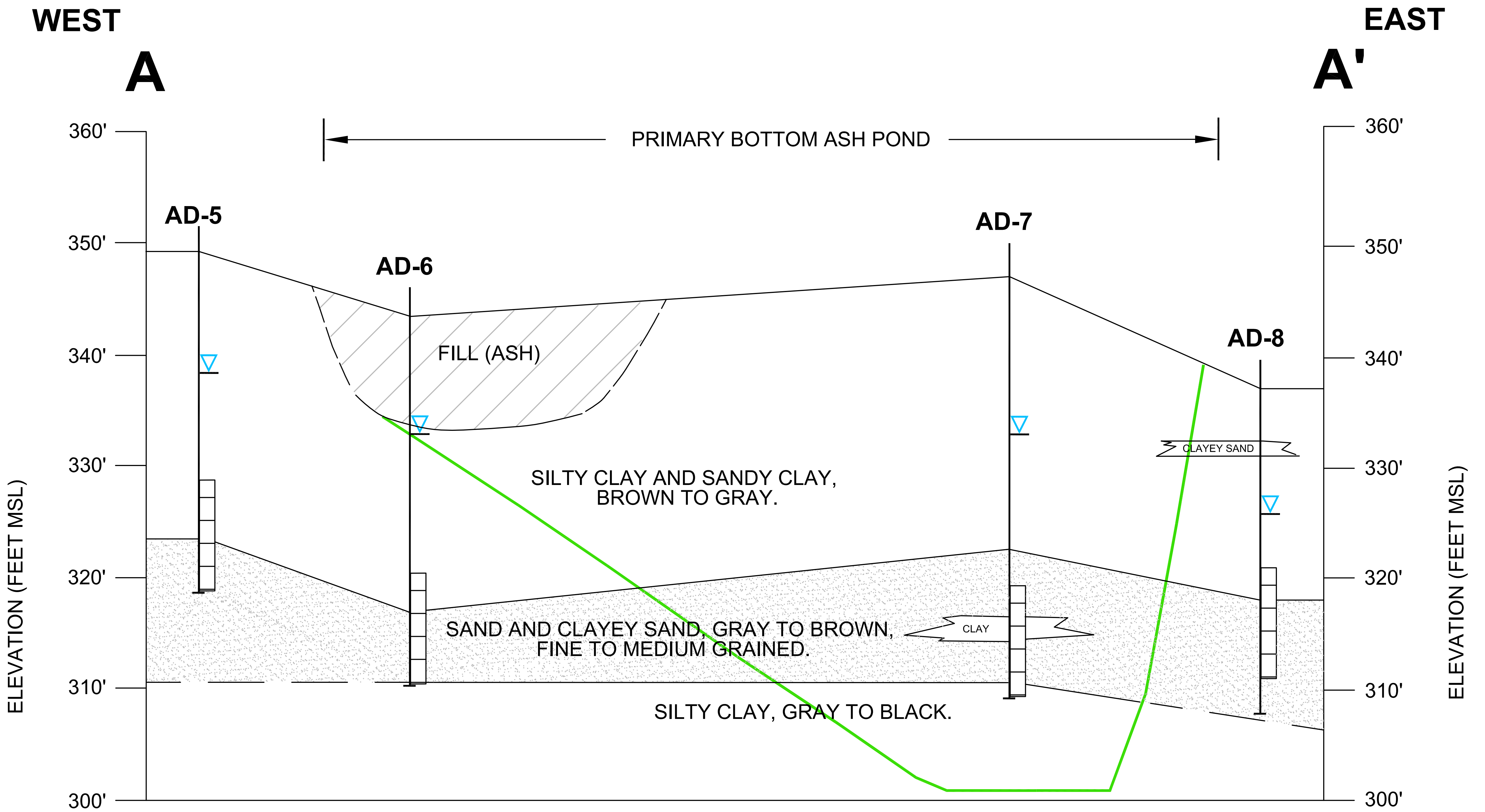
SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 3 - site layout.mxd

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond WELL Network Evaluation\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 8/26/2015 9:53 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 6/23/2016 10:35 AM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
🟩	PROJECTED BASE OF ASH POND (SEE NOTE)

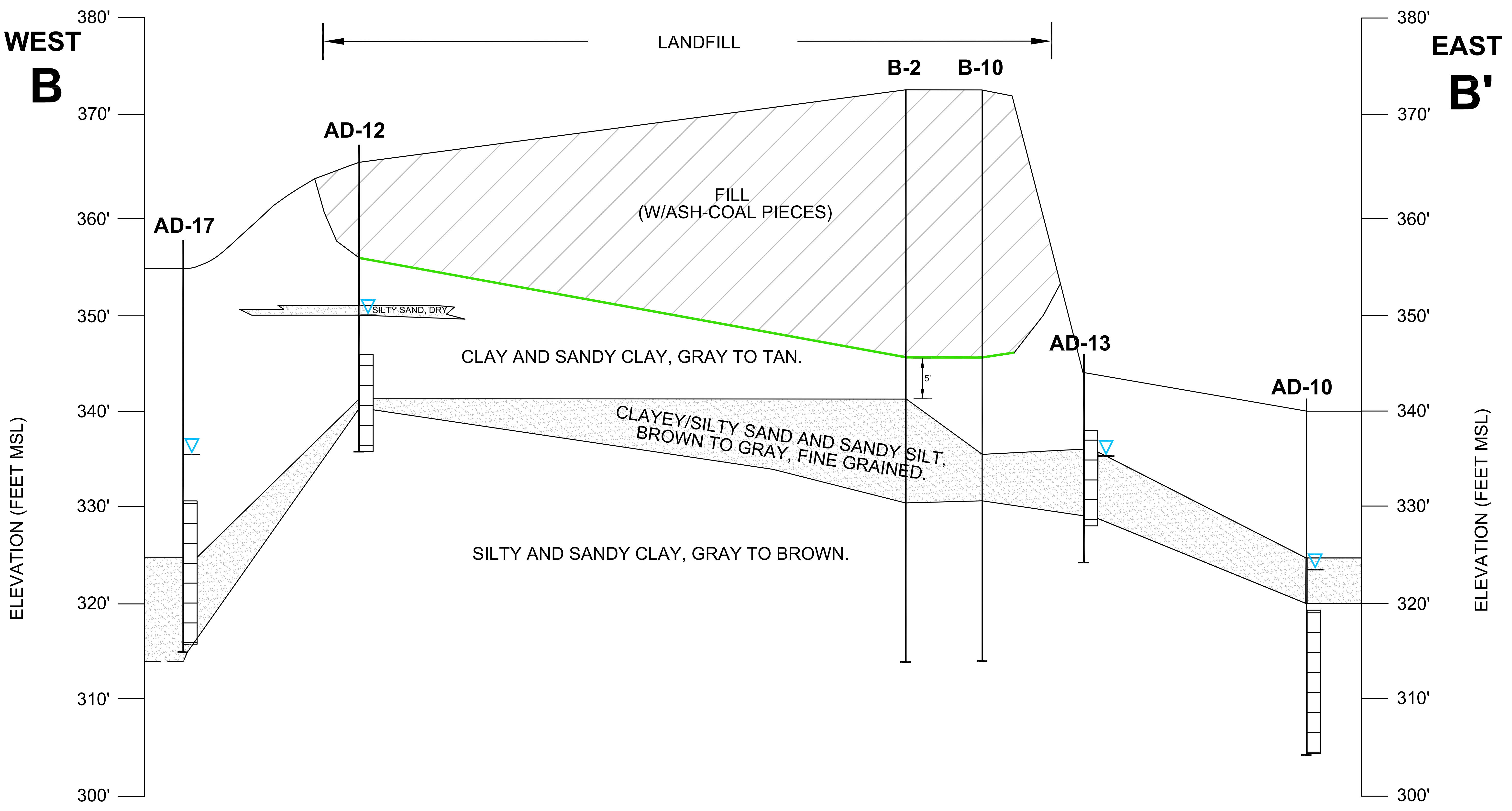
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 3/11/2016 10:41 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 3/11/2016 12:33 PM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

NOTE: BASE OF LANDFILL ELEVATION TAKEN FROM "WELSH POWER PLANT- UNIT 1 FLY ASH STORAGE AREA PHASE I" DRAWING ID WEPX-88, DATED 12/3/76.

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
—	BASE OF LANDFILL (SEE NOTE)

J. ROBERT WELSH POWER PLANT
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PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 3/11/2016 10:54 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ----
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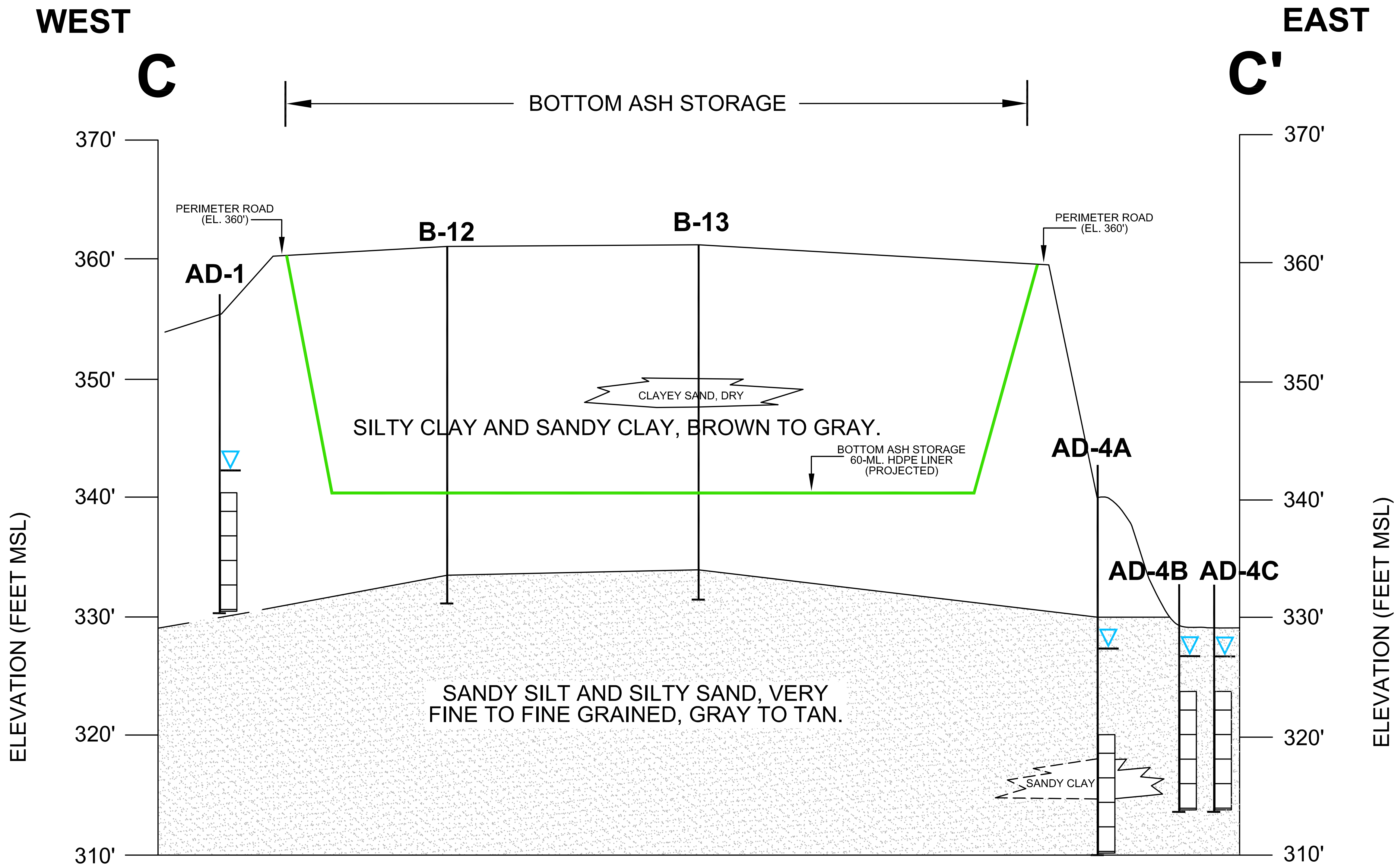

0 200'
HORIZONTAL SCALE

NOTE: BASE OF BOTTOM ASH STORAGE HAS A 60-ML. HDPE LINER AT ELEVATION 340.0' , TAKEN FROM FREESE AND NICHOLS "HYDRAULIC ANALYSIS OF WELSH POWER PLANT ASH PONDS, AMERICAN ELECTRIC POWER COMPANY", DATED DECEMBER 2010.

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (3/4/16)
- 🟩 PROJECTED BASE OF ASH STORAGE (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS 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\Welsh Power Plant\2016 Final Reports\Primary Ash Pond WELL Network Evaluation\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 8/26/2015 10:07 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
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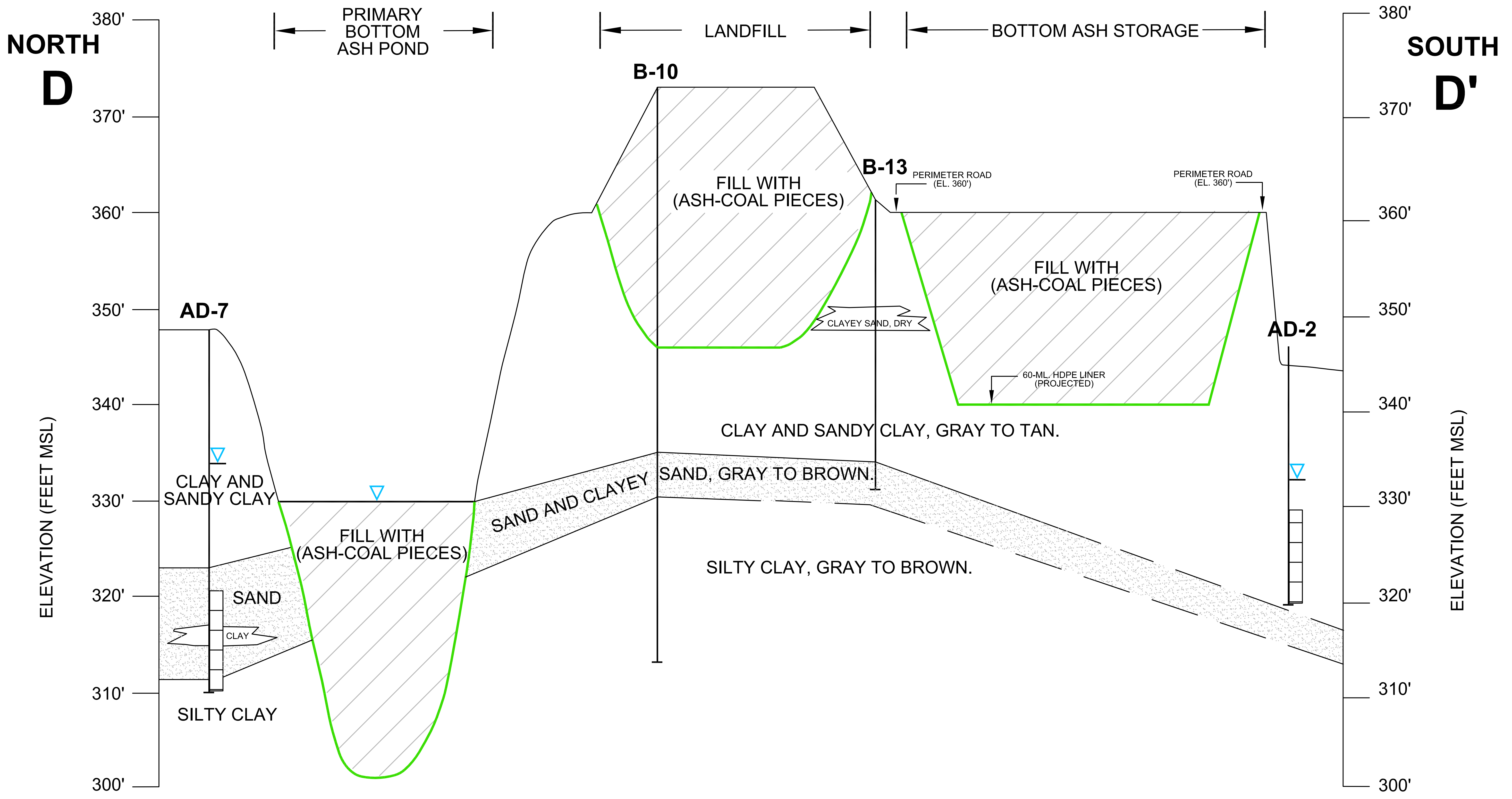

0 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
🟩	BASE OF CCR UNIT

J. ROBERT WELSH POWER PLANT
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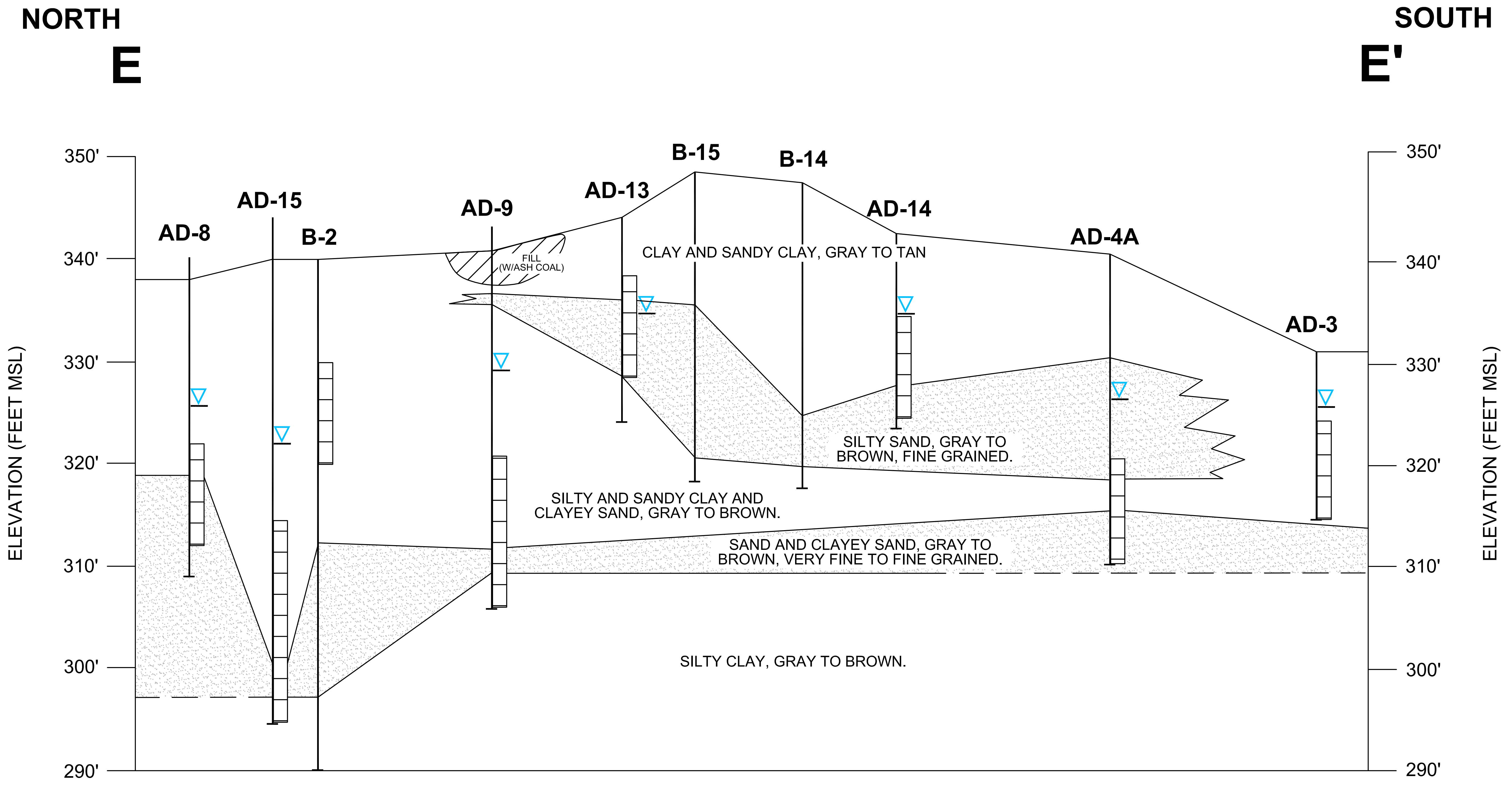
PITTSBURG, TITUS COUNTY, TEXAS

**CROSS SECTION
D - D'**

ARCADIS

FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 3/11/2016 12:06 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 3/11/2016 12:52 PM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
—	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8

Legend

- ⊕ Monitoring Well Location
- ● Piezometer Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◐ Soil Boring
- ▭ Site Features
- 340.82 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction

0 450 900
SCALE IN FEET

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

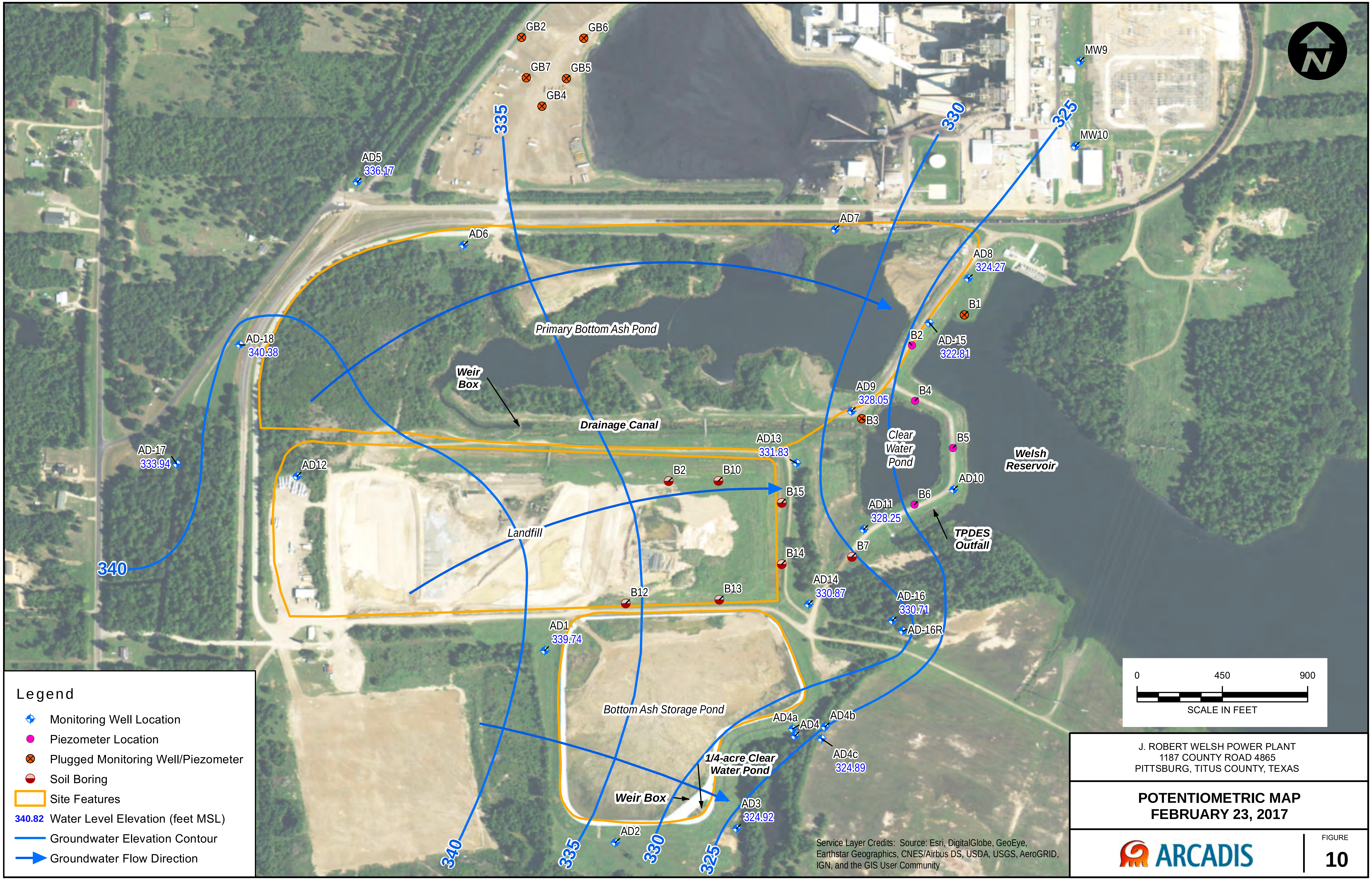
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP MARCH 4, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 9 - Mar2016_POT.mxd



Legend

- ⊕ Monitoring Well Location
- ● Piezometer Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- ▭ Site Features
- **340.82** Water Level Elevation (feet MSL)
- — Groundwater Elevation Contour
- → Groundwater Flow Direction

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

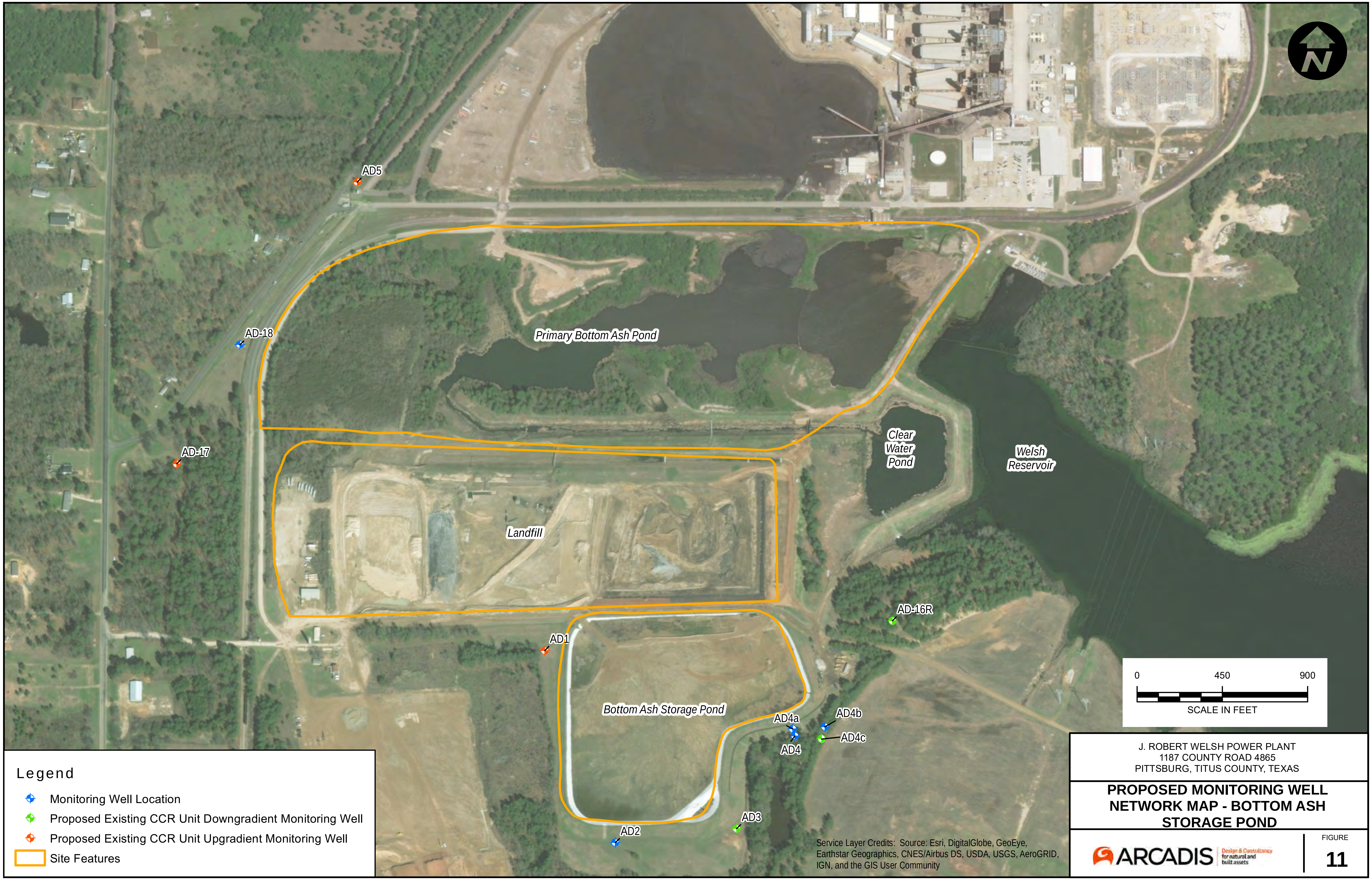
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

POTENTIOMETRIC MAP
FEBRUARY 23, 2017

ARCADIS

FIGURE
10

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 10 - Feb2017_POT.mxd



Legend

● Monitoring Well Location

● Proposed Existing CCR Unit Downgradient Monitoring Well

● Proposed Existing CCR Unit Upgradient Monitoring Well

▭ Site Features

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP - BOTTOM ASH STORAGE POND

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Bottom Ash Storage\fig 11 - proposed wells.mxd

Appendix A

Boring/Well Construction Logs

AD-1

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) TX (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4, Box 221 (Street, RFD or other) Pittsburg (City) TX (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check):
☒ New Well ☐ Deepening
☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'48"N
94°50'47"W
N

6) WELL LOG:
Date Drilling:
Started 1-11 19 2001
Completed 1-11 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	25

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0 -	25	gray silty clay with some hard red streaks

AP-1

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other
If Gravel Packed give interval ... from 13 ft. to 25 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	15	Sch 40
2	N	#10 slot screen	15	25	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 13 ft. to 0 ft. No. of sacks used 6-50#
ft. to ft. No. of sacks used
Method used bentonite
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level 12'8" ft. below land surface Date 1-11-01
Artesian flow gpm. Date

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print) WELL DRILLER'S LICENSE NO. TX-52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-2

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'37"N
94°50'44"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 19 2001
Completed 4/26 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	25

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0	2	top soil
2	5	red & gray clay w/ silt
5	10	red & gray clay w/ silt
10	25	gray silty clay w/ tan streaks
		AP-2

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other
If Gravel Packed give interval ... from 12 ft. to 25 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	15	Sch 40
2	N	#10 slot screen	15	25	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 12 ft. to +2 ft. No. of sacks used 5-50#
ft. to ft. No. of sacks used
Method used bentonite pellets
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ft. below land surface Date
Artesian flow gpm. Date

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print) WELL DRILLER'S LICENSE NO. TX-52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-3

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'38"N
94°50'37"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 ~~19~~ 2001
Completed 4/26 ~~19~~ 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	17

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______
If Gravel Packed give interval ... from 5 ft. to 17 ft.

From (ft.)	To (ft.)	Description and color of formation material
0	12	gray silty clay w/ tan streaks
12	15	very stiff gray/blood red clay
15	17	very stiff gray clay w/ red nodules and tan streaks

AP-3

(Use reverse side if necessary)

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	7	Sch 40
2	N	#10 slot screen	7	17	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 2 ft. to 5 ft. No. of sacks used 2 1/2 - 50#
______ ft. to ______ ft. No. of sacks used ______
Method used bentonite pellets
Cemented by ______
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: NA
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ______ (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS ______ (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-4

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'43"N
94°50'33"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 2001
Completed 4/26 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	30

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0	5	red silty clay with gray streaks
5 -	30	gray silty clay with red streaks
		AD-4

(*Use reverse side if necessary*)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other
If Gravel Packed give interval ... from 16 ft. to 30 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	19	Sch. 40
2	N	#10 Slot screen	19	29	Sch. 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 16 ft. to 2 ft. No. of sacks used 8-50#
ft. to ft. No. of sacks used
Method used bentonite pellets
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ft. below land surface Date
Artesian flow gpm. Date

12) PACKERS: NA Type Depth

13) TYPE PUMP:
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other NA
Depth to pump bowls, cylinder, jet, etc., ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

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ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-4A**
TOTAL DEPTH:	**30'**
TOP OF CASING ELEV.:	**342.85 ft. NGVD**
GROUND SURFACE ELEV.:	**340.19 ft. NGVD**

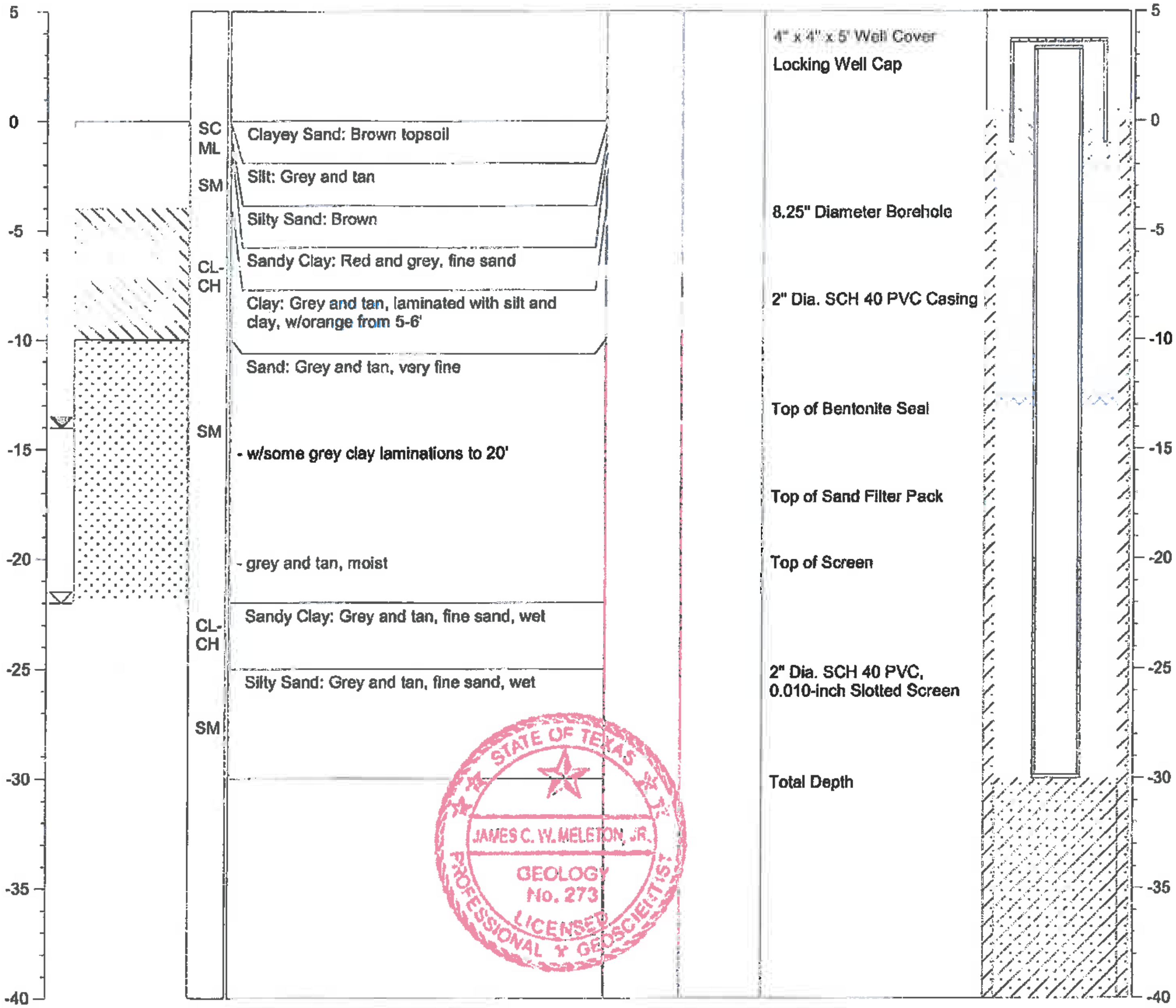
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04527**
Longitude: 94.84258

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown topsoil
ML	Silt: Grey and tan
SM	Silty Sand: Brown
CL-CH	Sandy Clay: Red and grey, fine sand
	Clay: Grey and tan, laminated with silt and clay, w/orange from 5-6'
SM	Sand: Grey and tan, very fine - w/some grey clay laminations to 20' - grey and tan, moist
CL-CH	Sandy Clay: Grey and tan, fine sand, wet
SM	Silty Sand: Grey and tan, fine sand, wet

WELL DESCRIPTION:

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED
PROFESSIONAL GEOSCIENTIST

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ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.: **AD-4B**
TOTAL DEPTH: **15'**
TOP OF CASING ELEV.: **333.23 ft. NGVD**
GROUND SURFACE ELEV.: **329.55 ft. NGVD**

CLIENT: **AEP**
PROJECT: **Ash Disposal Area**
SITE LOCATION: **Welsh Power Plant**
PROJECT NO.: **S-08-0109**
LOGGED BY: **James Meleton, Jr.**

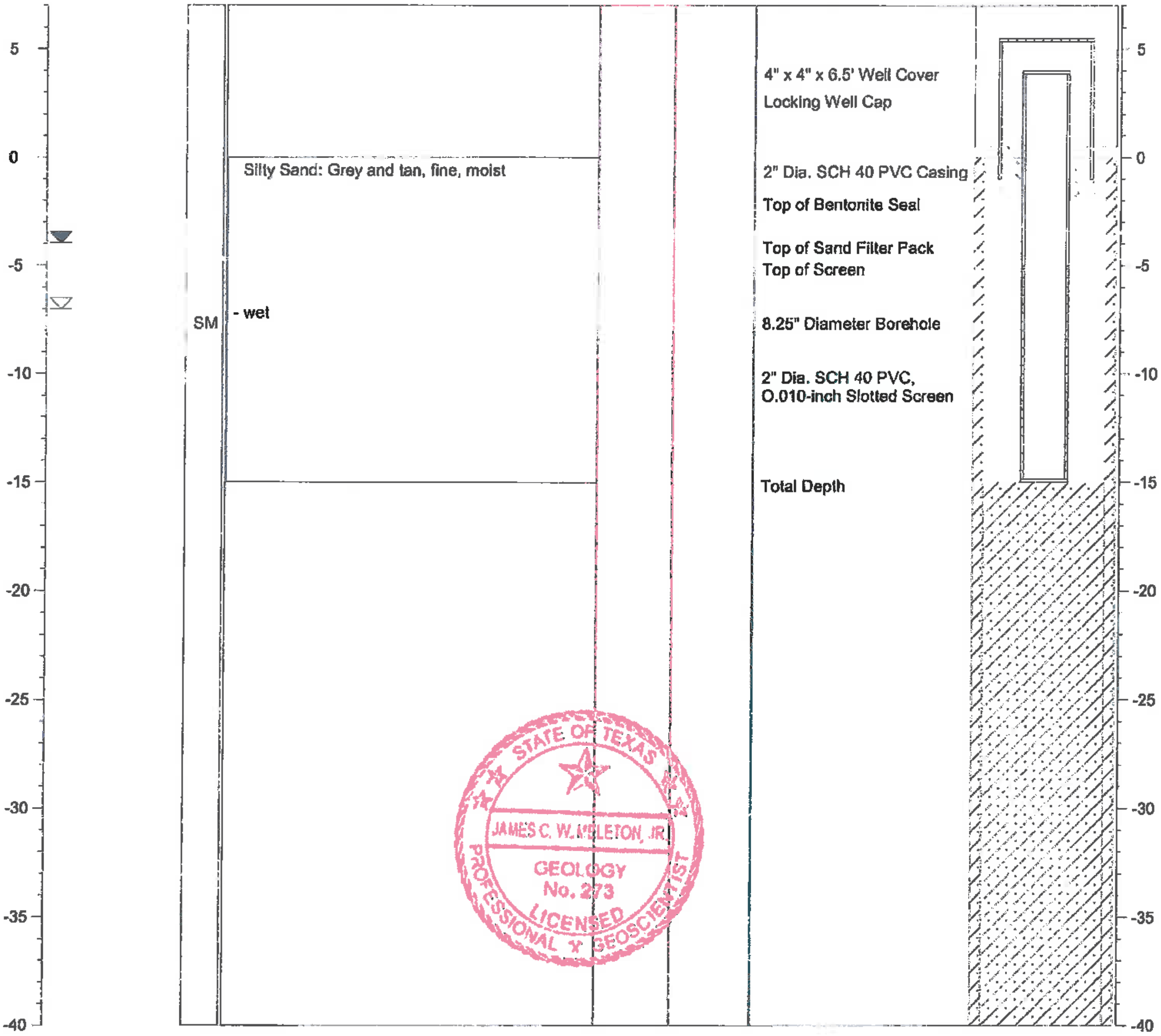
DRILLING CO.: **WEST Drilling**
DRILLER: **Tom McCullough**
METHOD OF DRILLING: **Hollow-stem Auger**
SAMPLING METHODS: **Split-spoon**
DATE DRILLED: **9/23/09**

NOTES: **Latitude: 33.04531**
Longitude: 94.84230

▼ Water level during drilling
▽ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
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ENVIRONMENTAL SERVICES OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-4C**
TOTAL DEPTH:	**15'**
TOP OF CASING ELEV.:	**333.28 ft. NGVD**
GROUND SURFACE ELEV.:	**329.15 ft. NGVD**

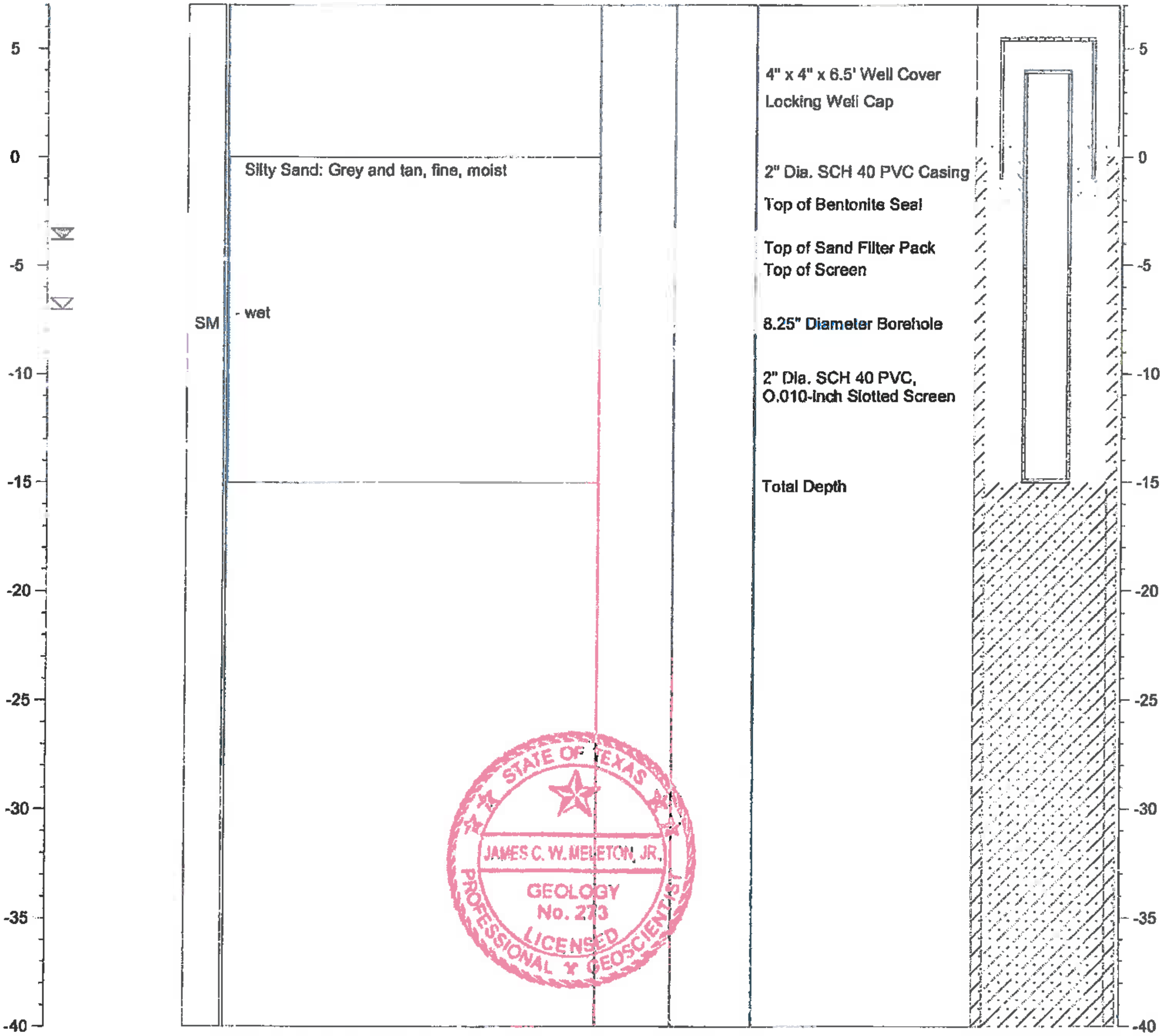
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/23/09**

NOTES: **Latitude: 33.04507**
Longitude: 94.84244

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
PROFESSIONAL GEOSCIENTIST LICENSED

AD-5

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4, Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell

If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) 33°03'13"N 94°51'00"W

N

6) WELL LOG:
Date Drilling:
Started 1-11 19 2001
Completed 1-11 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	30

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0	10	red & gray clay with orange streaks
10	20	gray/black clay with tan clay
20	25	stiff clay with lignite streak
25	30	fine gray sand

AP-5

(*Use reverse side if necessary*)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other

If Gravel Packed give interval ... from 16 ft. to 30 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	20	Sch 40
2	N	#10 slot screen	20	30	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 16 ft. to 0 ft. No. of sacks used
ft. to ft. No. of sacks used
Method used bentonite
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

13) TYPE PUMP: ☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other
Depth to pump bowls, cylinder, jet, etc., ft.

✓10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS:
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

11) WATER LEVEL:
Static level 11' 9" ft. below land surface Date 1-11-01
Artesian flow gpm. Date

✓15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS: NA Type Depth

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

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ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

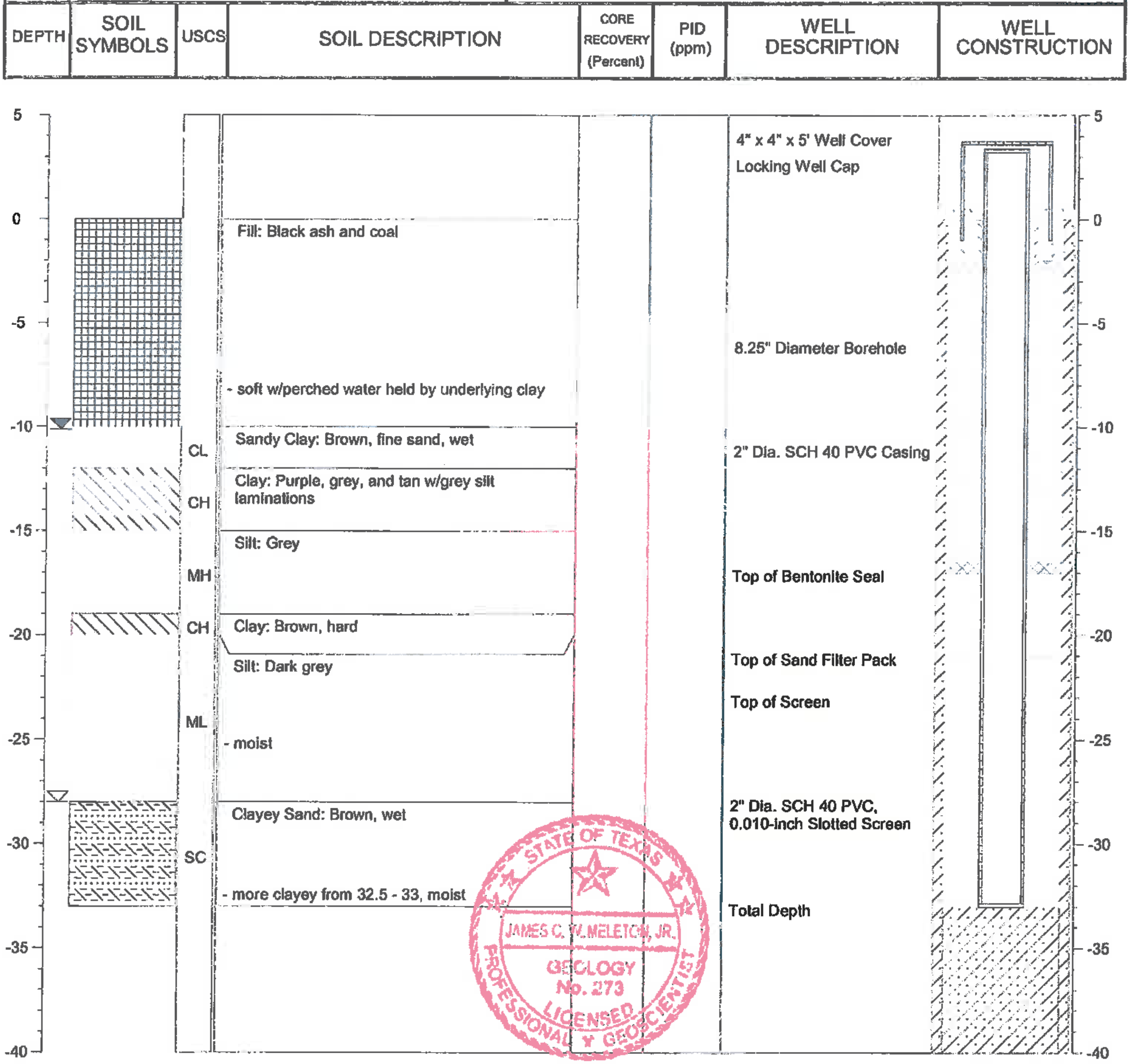
BORING/WELL NO.:	**AD-6**
TOTAL DEPTH:	**33'**
TOP OF CASING ELEV.:	**346.33 ft. NGVD**
GROUND SURFACE ELEV.:	**343.31 ft. NGVD**

CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/23/09**

NOTES: **Latitude: 33.05235**
Longitude: 94.84757

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



Fill: Black ash and coal
- soft w/perched water held by underlying clay

Sandy Clay: Brown, fine sand, wet

Clay: Purple, grey, and tan w/grey silt laminations

Silt: Grey

Clay: Brown, hard

Silt: Dark grey
- moist

Clayey Sand: Brown, wet
- more clayey from 32.5 - 33, moist

4" x 4" x 5' Well Cover
Locking Well Cap

8.25" Diameter Borehole

2" Dia. SCH 40 PVC Casing

Top of Bentonite Seal

Top of Sand Filter Pack

Top of Screen

2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen

Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED
PROFESSIONAL GEOSCIENTIST

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ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-7**
TOTAL DEPTH:	**38'**
TOP OF CASING ELEV.:	**350.82 ft. NGVD**
GROUND SURFACE ELEV.:	**347.86 ft. NGVD**

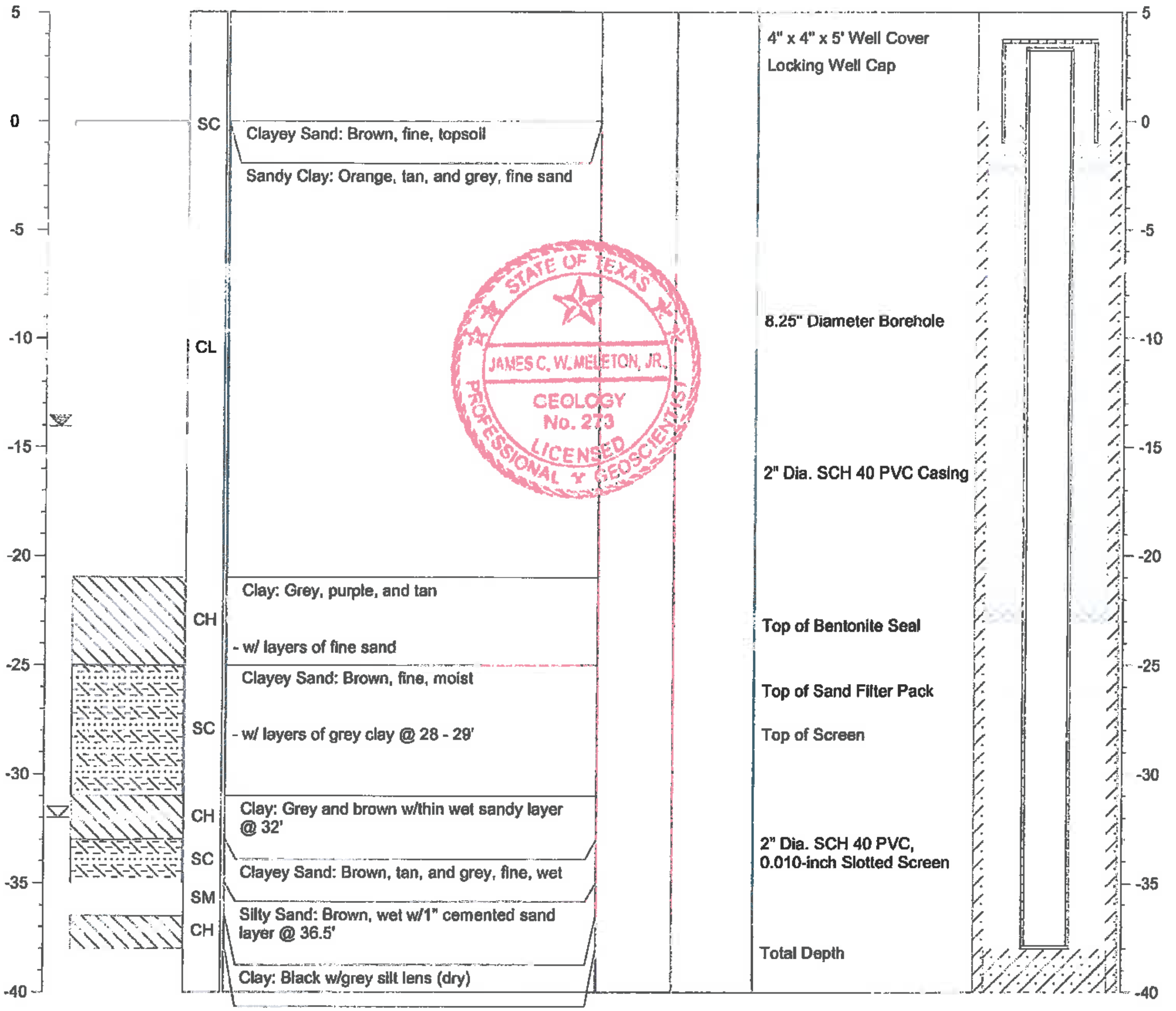
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/24/09**

NOTES: **Latitude: 33.05257**
Longitude: 94.84219

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, fine, topsoil
CL	Sandy Clay: Orange, tan, and grey, fine sand
CH	Clay: Grey, purple, and tan - w/ layers of fine sand
SC	Clayey Sand: Brown, fine, moist - w/ layers of grey clay @ 28 - 29'
CH	Clay: Grey and brown w/thin wet sandy layer @ 32'
SC	Clayey Sand: Brown, tan, and grey, fine, wet
SM	Silty Sand: Brown, wet w/1" cemented sand layer @ 36.5'
CH	Clay: Black w/grey silt lens (dry)

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

JAMES C. W. MELETON, JR.
No. 273

E·A·G·L·E
ENVIRONMENTAL SERVICES OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-8**
TOTAL DEPTH:	**29'**
TOP OF CASING ELEV.:	**340.01 ft. NGVD**
GROUND SURFACE ELEV.:	**337.53 ft. NGVD**

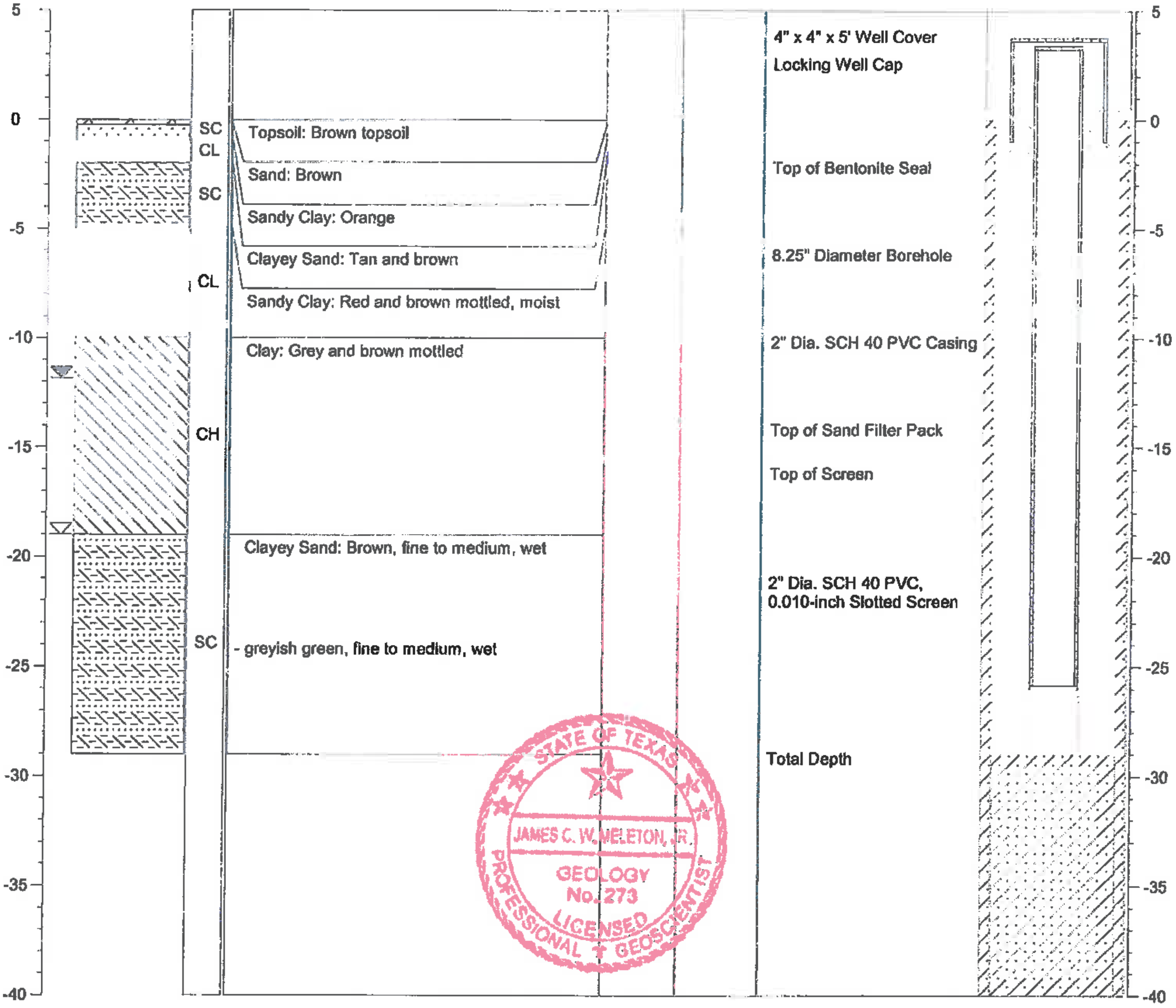
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/21/09**

NOTES: **Latitude: 33.05187**
Longitude: 94.84026

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



JAMES C. W. MELETON, JR.
GEOLOGY
No. 273

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-9**
TOTAL DEPTH:	**35'**
TOP OF CASING ELEV.:	**343.09 ft. NGVD**
GROUND SURFACE ELEV.:	**340.32 ft. NGVD**

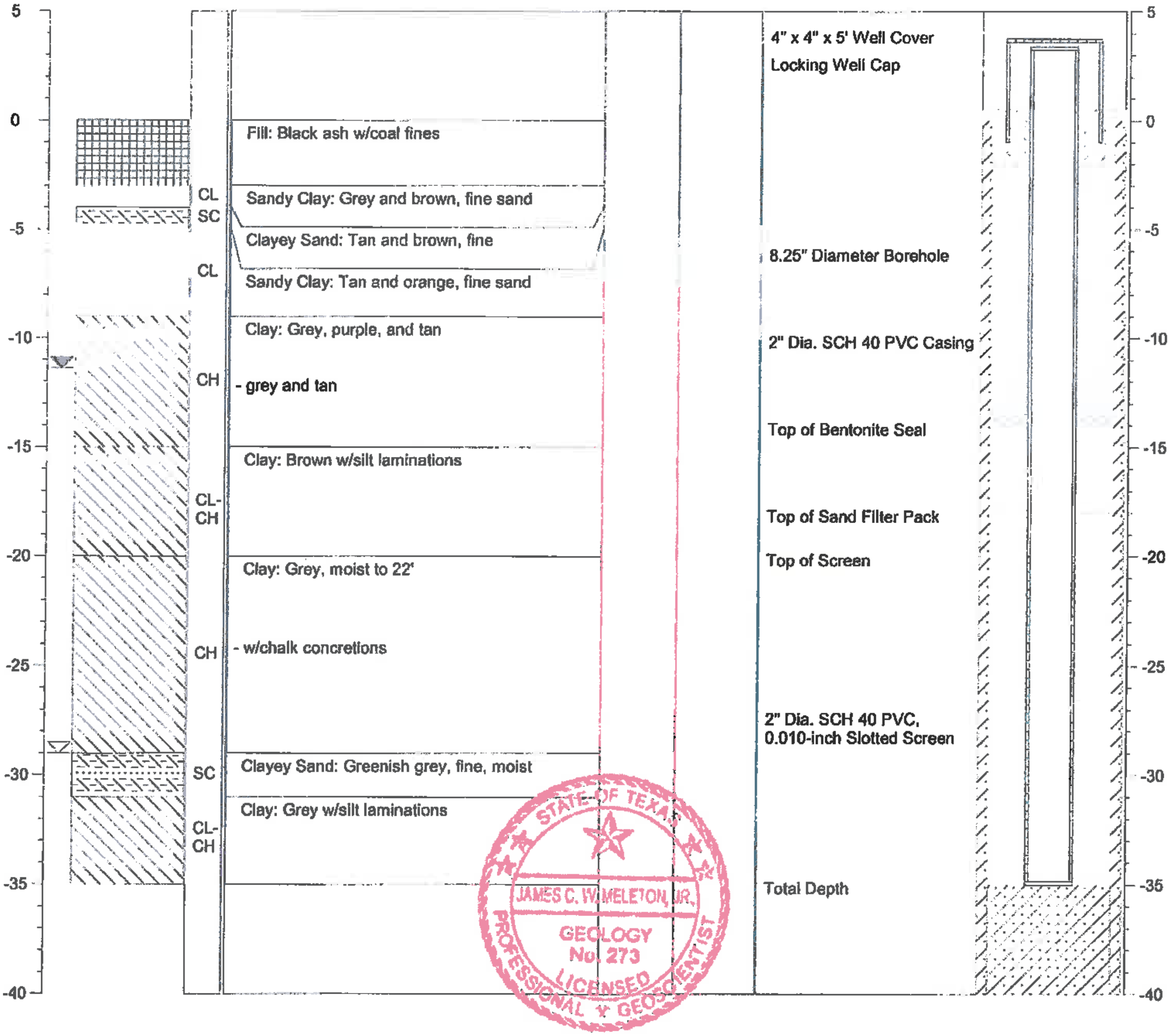
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/21/09**

NOTES: **Latitude: 33.04995**
Longitude: 94.84196

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Fill: Black ash w/coal fines
Sandy Clay: Grey and brown, fine sand
Clayey Sand: Tan and brown, fine
Sandy Clay: Tan and orange, fine sand
Clay: Grey, purple, and tan
- grey and tan
Clay: Brown w/silt laminations
Clay: Grey, moist to 22'
- w/chalk concretions
Clayey Sand: Greenish grey, fine, moist
Clay: Grey w/silt laminations

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC,
0.010-inch Slotted Screen
Total Depth

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SOIL BORING LOG

BORING/WELL NO.:	**AD-10**
TOTAL DEPTH:	**35'**
TOP OF CASING ELEV.:	**343.01 ft. NGVD**
GROUND SURFACE ELEV.:	**340.23 ft. NGVD**

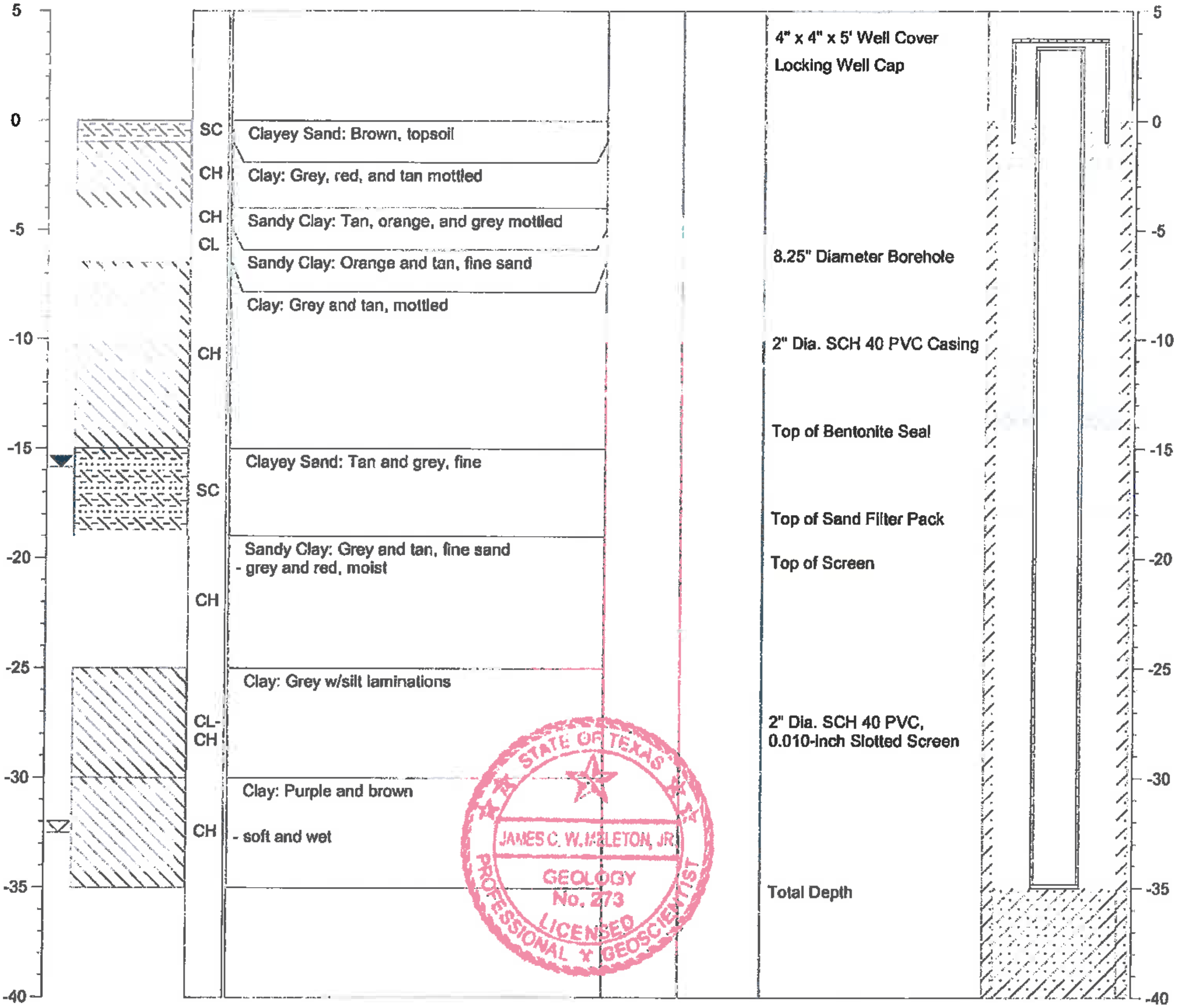
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04881**
Longitude: 94.84047

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
CH	Clay: Grey, red, and tan mottled
CH	Sandy Clay: Tan, orange, and grey mottled
CL	Sandy Clay: Orange and tan, fine sand
CH	Clay: Grey and tan, mottled
SC	Clayey Sand: Tan and grey, fine
CH	Sandy Clay: Grey and tan, fine sand - grey and red, moist
CL-CH	Clay: Grey w/silt laminations
CH	Clay: Purple and brown - soft and wet

WELL DESCRIPTION
4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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SOIL BORING LOG

BORING/WELL NO.:	**AD-11**
TOTAL DEPTH:	**20'**
TOP OF CASING ELEV.:	**342.18 ft. NGVD**
GROUND SURFACE ELEV.:	**339.61 ft. NGVD**

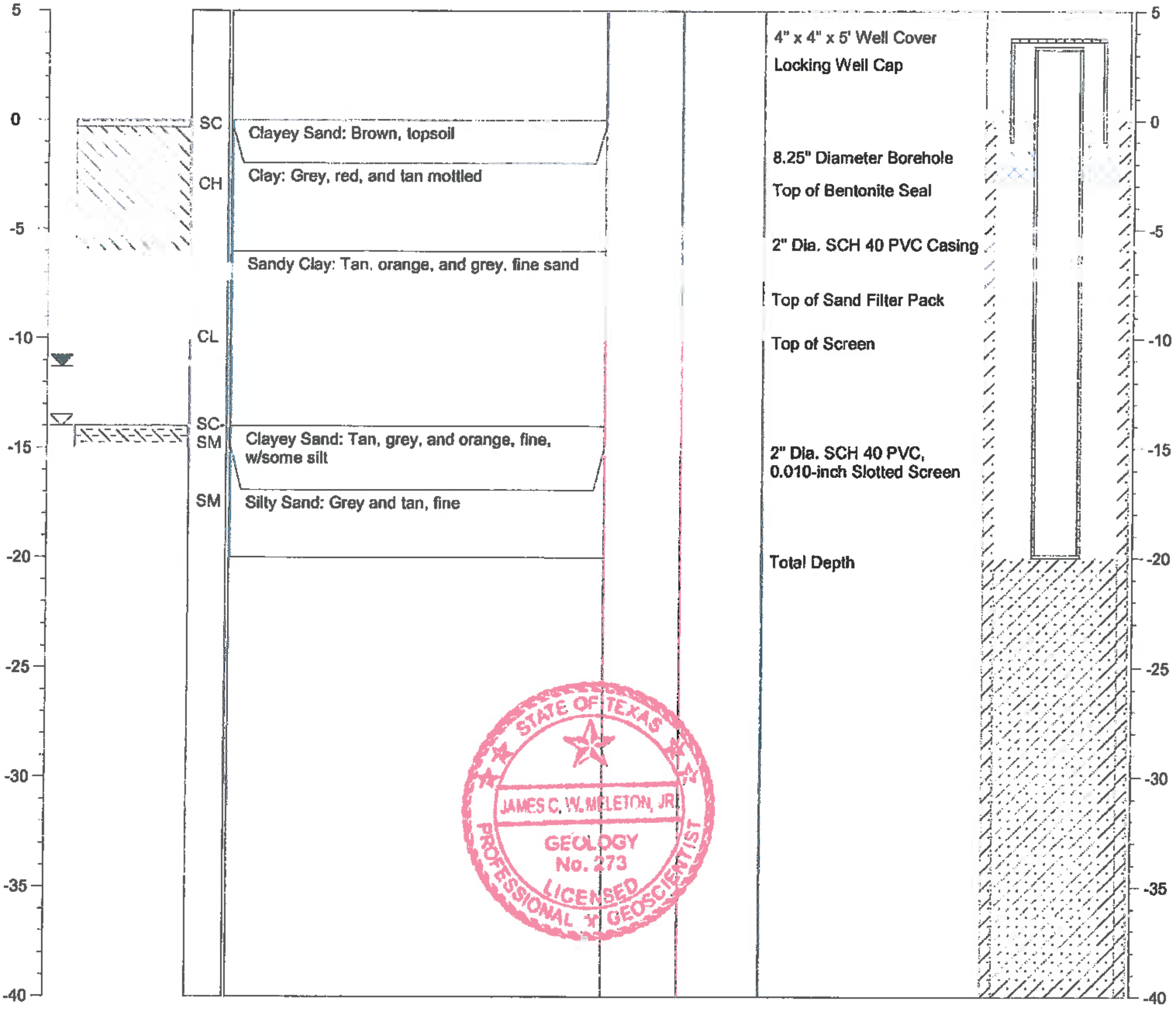
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04824**
Longitude: 94.84177

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
CH	Clay: Grey, red, and tan mottled
CL	Sandy Clay: Tan, orange, and grey, fine sand
SC-SM	Clayey Sand: Tan, grey, and orange, fine, w/some silt
SM	Silty Sand: Grey and tan, fine

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
Top of Bentonite Seal
2" Dia. SCH 40 PVC Casing
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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SOIL BORING LOG

BORING/WELL NO.:	**AD-12**
TOTAL DEPTH:	**30'**
TOP OF CASING ELEV.:	**369.33 ft. NGVD**
GROUND SURFACE ELEV.:	**366.27 ft. NGVD**

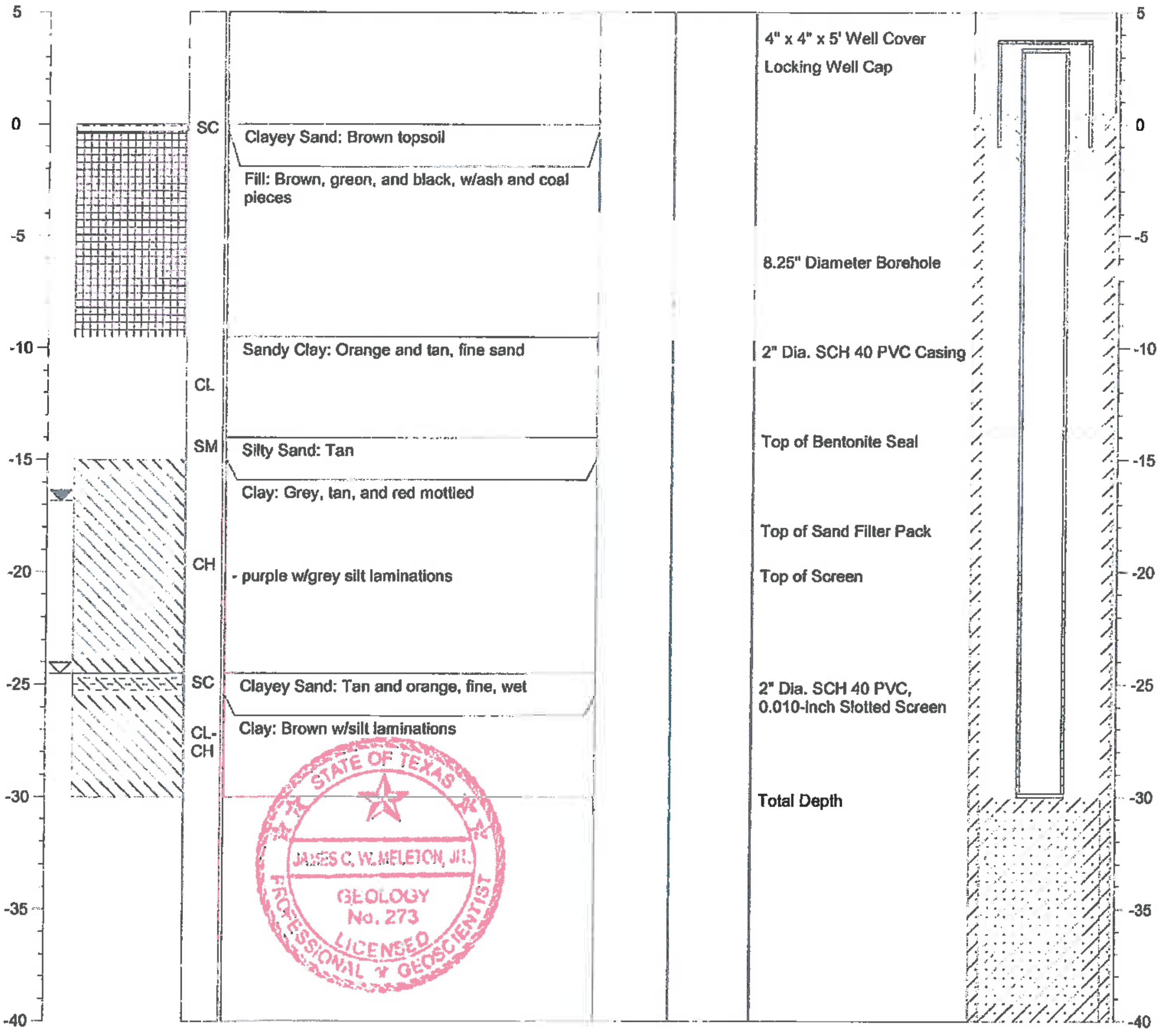
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/24/09**

NOTES: **Latitude: 33.04901**
Longitude: 94.84977

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



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SOIL BORING LOG

BORING/WELL NO.: **AD-13**
TOTAL DEPTH: **20'**
TOP OF CASING ELEV.: **347.00 ft. NGVD**
GROUND SURFACE ELEV.: **344.12 ft. NGVD**

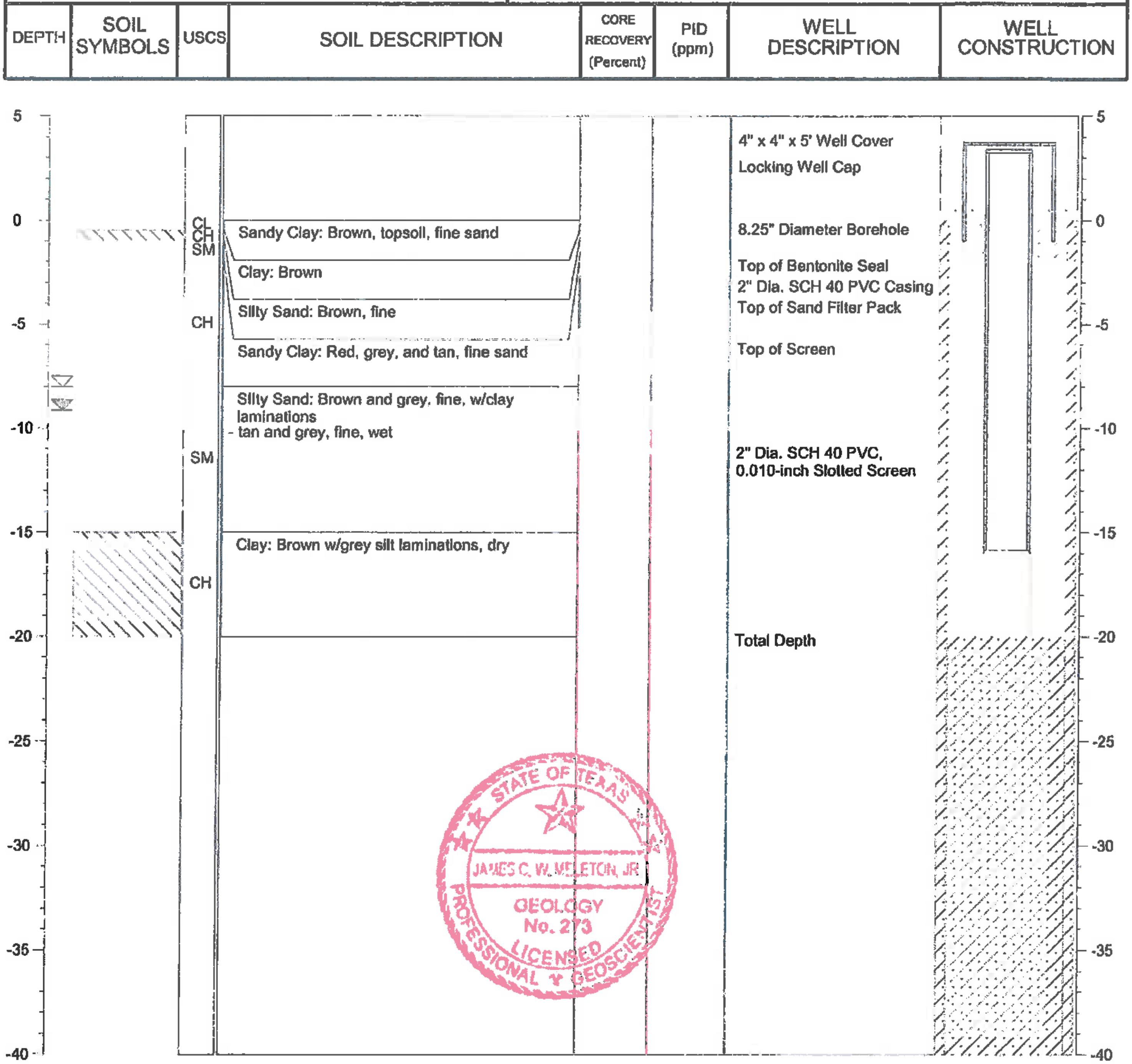
CLIENT: **AEP**
PROJECT: **Ash Disposal Area**
SITE LOCATION: **Welsh Power Plant**
PROJECT NO.: **S-08-0109**
LOGGED BY: **James Meleton, Jr.**

DRILLING CO.: **WEST Drilling**
DRILLER: **Tom McCullough**
METHOD OF DRILLING: **Hollow-stem Auger**
SAMPLING METHODS: **Split-spoon**
DATE DRILLED: **9/22/09**

NOTES: **Latitude: 33.04918**
Longitude: 94.84275

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



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SOIL BORING LOG

BORING/WELL NO.:	**AD-14**
TOTAL DEPTH:	**18.5'**
TOP OF CASING ELEV.:	**345.43 ft. NGVD**
GROUND SURFACE ELEV.:	**342.32 ft. NGVD**

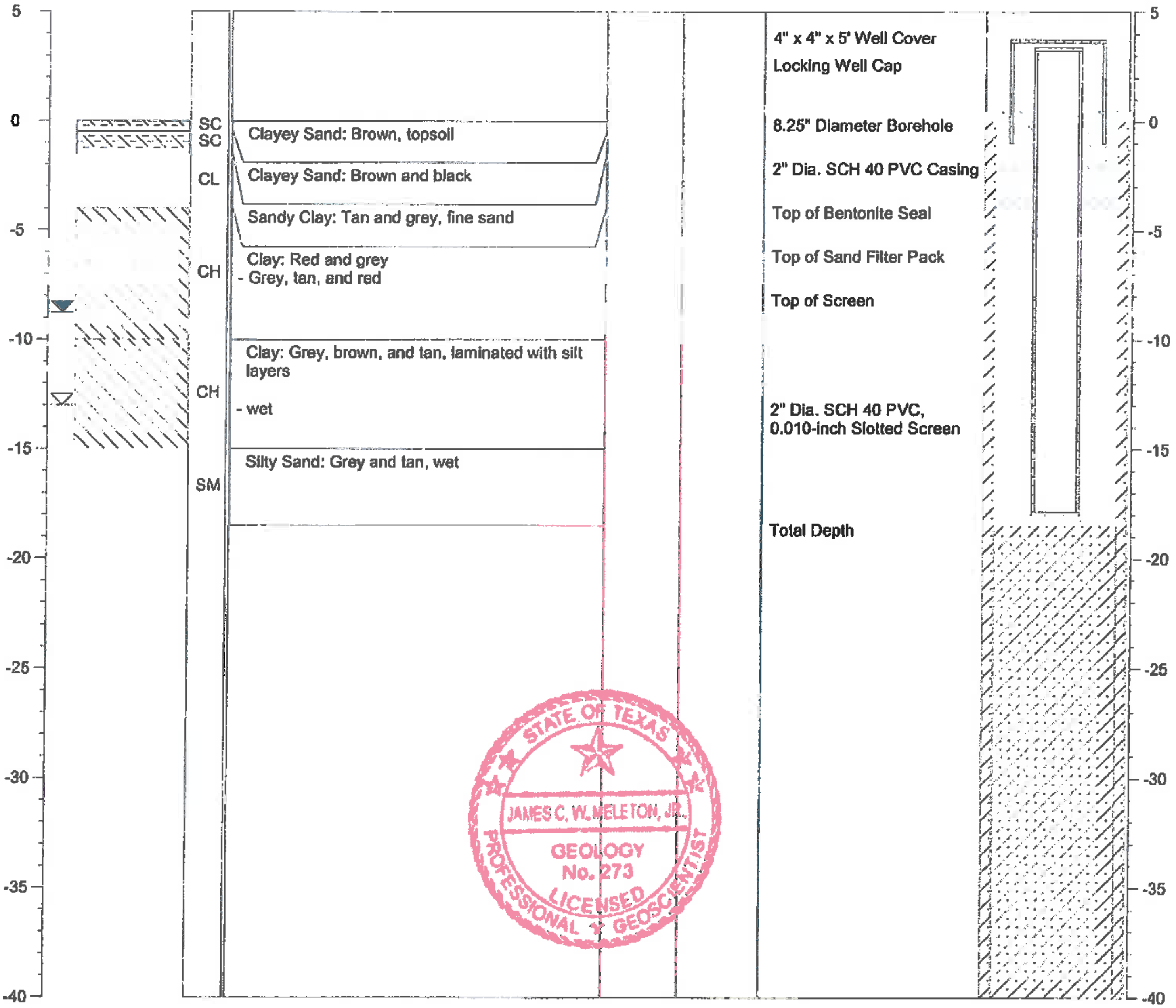
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04715**
Longitude: 94.84256

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Clayey Sand: Brown, topsoil
Clayey Sand: Brown and black
Sandy Clay: Tan and grey, fine sand
Clay: Red and grey
- Grey, tan, and red
Clay: Grey, brown, and tan, laminated with silt layers
- wet
Silty Sand: Grey and tan, wet

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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GEOLOGY
No. 273
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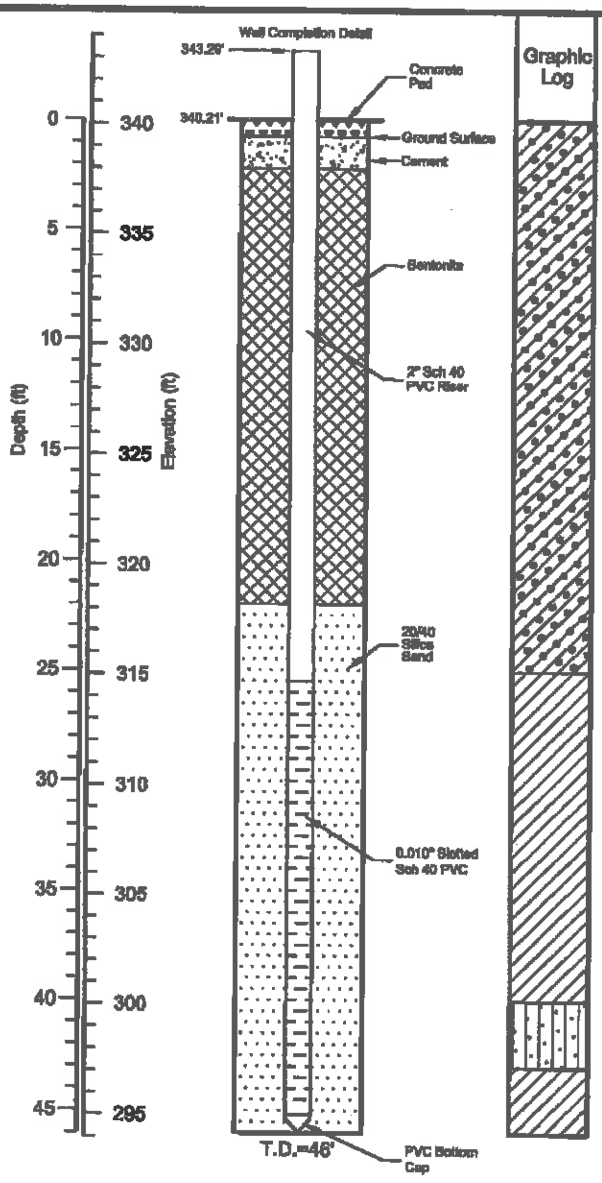


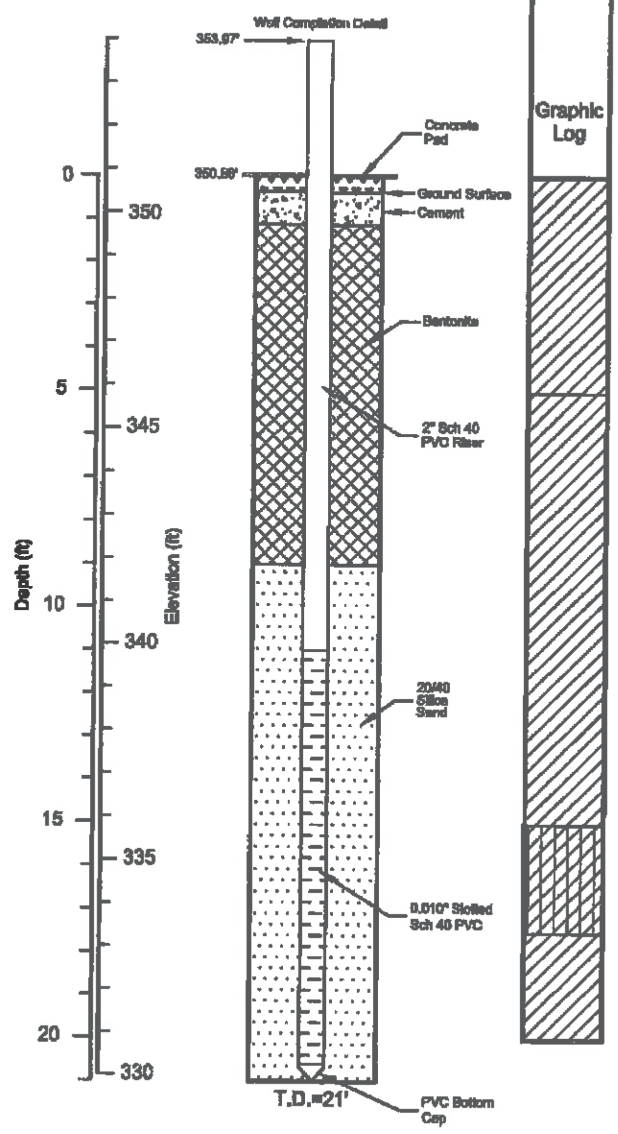
PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		SC	Clayey SAND: reddish brown - 2" lense of brown sand - 3" lense of brown sand	16	48	37	18	19
	Direct Push		CL	Sandy Lean CLAY: reddish brown, very moist - less moisture	22	51	36	19	17
			SM	Silty SAND: light brown & light gray, wet.	27	24	26	NP	-
			CL	Lean CLAY: orangish brown & light gray, mottled, with sand	28	94	45	21	24

STEVEN R. WEMPLE
2176
1-22-16

west
DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/12/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-15
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/12/15	DRAWN BY: HDS	PROJECT NO.: — SCALE: AS SHOWN
Depth to Water: —	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg



Depth (ft)	PID Reading (ppm)	Sampling Device	Sample Interval	Description Interva (feet bgs)	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
0		Direct Push		CL	Lean CLAY w/ Sand: light brown & light gray - orangish brown, with silt	16	82	26	16	10
5				CL	Lean CLAY w/ Sand: orangish-brown & light gray	22	88	31	19	12
15				CL-ML	Silty CLAY: orange w/ brown, wet	30	69	27	20	7
20				CL	Sandy, Lean CLAY: brown w/ orange, stiff	26	66	46	26	20

STEVEN R. WEMPLE
2176
1-22-16

West DRILLING environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/10/15
Drilling Method: H.S.A.
Bit Diameter: 7.25"
Depth to Water: –

Logged by: Robert Williams, PE
Driller: Robert Williams
Date Completed: 12/10/15
Depth to Product: NA

Welsh Power Station
Pittsburg, Texas

DRAWN BY: HDS
CHECKED BY: SRW

Log of Boring AD-16

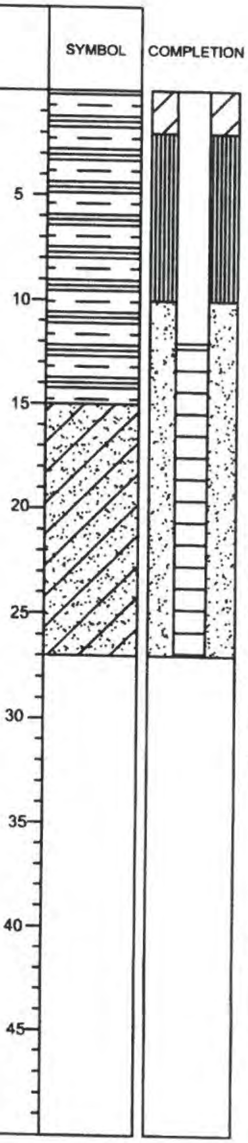
PROJECT NO.: —
SCALE: AS SHOWN
FILE NAME: JR Welsh Power Plant LOGS.dwg

WELL LOG

DEPTH	SAMPLE / ANALYZED	TYPE	ORGANIC VAPOR (ppm)	SAMPLE DESCRIPTION
		SS		(0-15') SILTY CLAY (CL), BROWN TO ORANGE-BROWN, STIFF, DRY.
5		SS		
		SS		
		SS		
10		SS		
		SS		
15		SS		
		SS		(15-18') SILTY CLAY AND SANDY CLAY, ORANGE-BROWN TO LIGHT GRAY, MOIST.
		SS		(18-27') SILTY CLAY AND SANDY CLAY, DARK BROWN TO GRAY, MOIST TO WET.
20		SS		
		SS		
25		SS		
		SS		
30				TOTAL DEPTH = 27' BGS
35				
40				
45				

Kenneth J. Brandner
Geology
1787

Kenneth J Brandner
4-27-17



AD-16R
WELL

AEP
CLIENT

BOTTOM ASH STORAGE POND
PROJECT

WELSH POWER PLANT
LOCATION

4/12/17
DATE

HSA
DRILLING METHOD

2" PVC, 2' AGL-12' BGL
CASING

2" PVC, 12'-27' BGS
SCREEN

0-2' BGS
CEMENT

2-10' BGS
BENTONITE

10-27' BGS
SAND PACK

350.55' / 353.49'
GROUND ELEV. / TOP OF CASING ELEV.

CT - CUTTINGS
SB - SPLIT BARREL(5')
SS - SPLIT SPOON(2')

▽ HC LEVEL
▼ WATER LEVEL

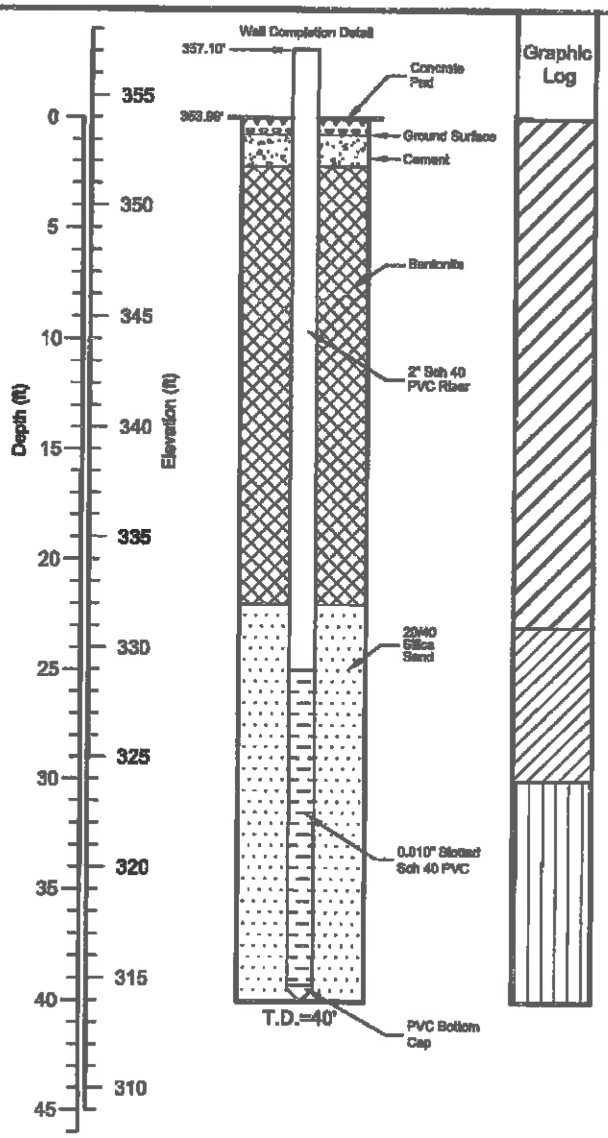
▨ SAND
▨ SILT
▨ CLAY
▨ FILL/CONCRETE
▨ BENTONITE
▨ GRAVEL

START: FINISH:

PAGE 1 OF 1

ARCADIS Design & Consultancy for natural and built assets

711 N. CARANCAHUA, #1080
CORPUS CHRISTI, TEXAS 78401
TEL: (361) 883-1353 FAX: (361) 883-7565



PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		CH	Fat CLAY: reddish-brown					
				- light gray to light brown, reddish brown w/ Sand and gravel lenses	24	97	83	30	53
				- light brown					
				- brown Sand lenses, wet					
				- gray, w/ some Silt					
					18	90	53	25	28
	Direct Push		CL	Lean CLAY with Sand: gray	22	81	43	22	21
			ML	Sandy SILT: gray	23	63	26	NP	-

Depth (ft): 0 5 10 15 20 25 30 35 40

STEVEN R. WEMPLE
SOIL SCIENCE
LICENSE NUMBER
2176

1/22/16

WEST DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

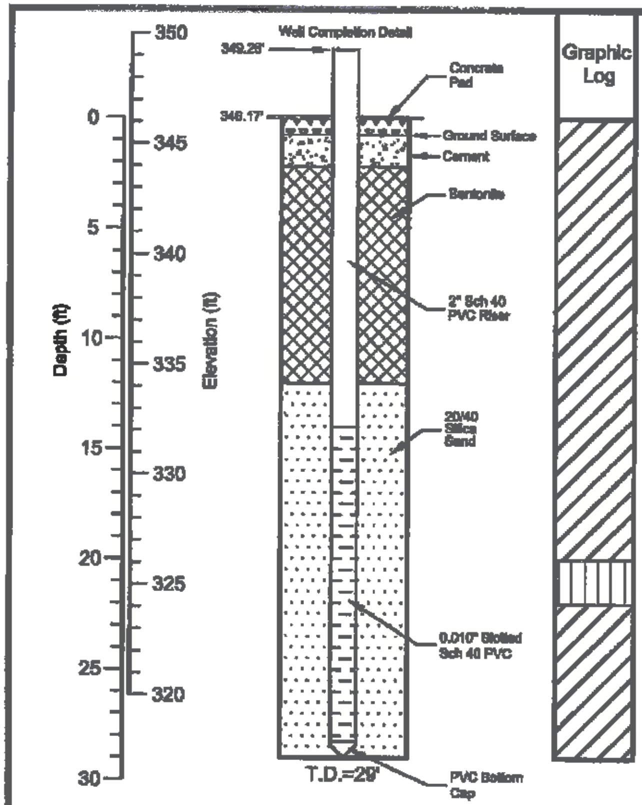
DATE: 12/10/15
Drilling Method: H.S.A.
Bit Diameter: 7.25"
Depth to Water: --

Logged by: Robert Williams, PE
Driller: Robert Williams
Date Completed: 12/11/15
Depth to Product: NA

Welsh Power Station
Pittsburg, Texas
DRAWN BY: HDS
CHECKED BY: SRW

Log of Boring
AD-17

PROJECT NO.: --
SCALE: AS SHOWN
FILE NAME: JR Welsh Power Plant LOGS.dwg



PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		CH	Fat CLAY: light brown & light gray, sandy					
				- reddish brown and light gray, with Sand					
					19	38	50	24	26
				- gray with silt					
				- gray, stiff					
			ML	SILT: gray, with Clay and Sand, wet	29	86	26	NP	-
			CH	Fat CLAY: light gray, silty w/ Sand, very stiff	20	85	50	23	27

STEVEN R. WEMPLE
LICENSE NUMBER 2176

1-22-16

west DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/11/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-18
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/11/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: —	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg

Project: AEP Welsh Power Plant
Project Location: Cason, TX
Project Number: TXL0064

Log of Boring GB-1

Sheet 1 of 2

Date(s) Drilled **July 23, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **37 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **367 feet MSL**
Groundwater Level and Date Measured	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Bentonite Chips**	Location **On the Northern edge of proposed chemical pond along the screening berm.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
367	0					Other		Black COAL, a few fine roots and organics.						
			ST											Shelby tube pulled black COAL
			SS	10										SPT 4, 5, 5, 5. 24" recovered
362	5				Soft to Firm	SC		Reddish Brown fine SAND, little clay, trace silt, Dry. Natural Ground.						SPT 4, 5, 6, 7. 24" recovered
			SS	11										
					Soft	SM		Reddish brown fine SAND with silt, trace clay. Vertical sand seams in sample, Dry.						SPT 3, 5, 6, 8. 24" recovered.
			SS	11										
357	10		ST						23.6	22	48.9	5.4E-07		Shelby tube sample, 18" recovered.
					Soft	SC		Reddish brown well graded fine SAND, trace silt and clay. Damp.						SPT 5, 6, 6, 9. 24" recovered
			SS	12	Firm	CL		Greyish red CLAY, little sand, horizontal sand seams, Dry.						
					Soft	SC		Brownish red fine SAND, little clay, Damp.						SPT 7, 6, 7, 9. 24" recovered.
			SS	13	Firm	SC-CL		Four-inch CLAY seam, little fine sand.						
					Firm	CL		Reddish grey CLAY, little sand, oxidized iron ore. Dry						
352	15				Soft	SM		Brownish red fine SAND, trace clay, thin clay seams. Moist.						SPT 8, 9, 9, 9. 24" recovered.
			SS	18					17.74	14	40.1			
			ST						16.25	NP	28.9	3.6E-05		Shelby tube samples look like SC. 17" recovered.
														SPT 9, 8, 9, 11. 24 inches recovered.
347	20		SS	17	Soft	Other		Iron oxidized material						
					Soft	SC		Brownish red fine SAND, little clay. Moist.						SPT 5, 7, 8, 50/2. 21" recovered
			SS	15										
			SS	50	Soft	CL		Dark grey CLAY, little fine sand, Wet.						SPT 50/3".
					Very Hard	SP		Dark grey-black cemented SAND, little clay. Wet. Driller comments that cemented sand terminates at 25.5 feet.						
342	25													
			SS	27	Soft to Firm	SC		Dark grey fine SAND, little clay. Moist. Soft sand with lenses of firm clay.						SPT 11, 13, 14, 16. 24" recovered.
					Hard	CL		Dark grey CLAY, little sand, Dry.						
					Soft	SC		Dark grey-black fine SAND, little clay, Wet. Encountered water but water rose to 19 feet after 15 min break.						SPT 11, 16, 30, 14. 24" recovered.
			SS	46										
			SS	37										SPT 11, 15, 22, 25. 24" recovered.
337	30				Hard	CL								

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, TX
Project Number: TXL0064

Log of Boring GB-1

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
337	30	▧	SS	37	Hard	CL	▨	Dark grey CLAY, little fine sand, occasional horizontal sand seams. Wet. (cont.)						SPT 11, 15, 22, 25. 24" recovered.
		▧	SS	29	Soft	ML	▥	Dark grey-black fine SAND, with clay, frequent hard clay lenses (1-3"), Wet.	26.37	NP	57.5			SPT 6, 11, 18, 24. 24 recovered.
332	35		SS	34	Hard	CL	▨	Black CLAY, trace to little fine sand, trace silt. Dry						SPT 9, 16, 18, 23. 24" recovered.
								Bottom of Boring at 37 feet bgs						
327	40													
322	45													
317	50													
312	55													
307	60													
302	65													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-02

Sheet 1 of 1

Date(s) Drilled **August 14, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **30 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **364.56 feet MSL**
Groundwater Level and Date Measured **21.53 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Well Completion**	Location **Western edge of proposed chemical pond near perimeter fence.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	REMARKS AND OTHER TESTS
364.6	0				Soft	Other	Coal					
					Soft	CL	Greyish brown CLAY, with little silt, little sand, damp.					
			SS	4								SPT 2, 2, 2. 12" recovered.
			SS	13								SPT 4, 7, 6, 12.
359.6	5		ST									Shelby Tube Sample
					Firm	CH	Brownish tan CLAY with silt, little sand, Damp. Occasional sand and iron ore.					SPT 8, 12, 17, 21
			SS	29				23.71	38	77.3		
			SS	80								SPT 20, 30, 50/5. 17" recovered
354.6	10				Soft	SC	Red-orange fine SAND, little clay, damp. Occasional iron ore.					
					Soft	CL	Brownish tan CLAY, little silt, little sand, Damp.					SPT 15, 20, 24, 31. 18" recovered.
			SS	44	Soft	SM	Red-orange fine SAND, little clay, Damp.					
												SPT 11, 12, 9, 32.
			SS	21				20.35	NP	33.5		
												SPT 6, 6, 12, 6.
349.6	15		SS	18								
					Soft	SM-SC	Light brown fine SAND, with little silt, little sand, Damp.					
												SPT 12, 25, 50/5.
					Firm	CL	Black CLAY, with fine sand, Wet.					
			SS	75	Soft	SM-SC	Dark red fine SAND, little clay, little silt, Wet.					
					Soft-Firm	SC	Dark grey fine SAND, little clay, Wet. Occasional clay seams.					SPT 9, 16, 12, 15.
			SS	28								
344.6	20											SPT 9, 17, 21, 27.
			SS	38	Firm	SC	Frequent clay lenses.	22.55	13	36.6		
							8/11/09 ▼					
												SPT 22, 35, 50/4".
			SS	65								
												SPT 10, 15, 18, 28.
339.6	25		SS	33								
					Soft	SC	Less clay lenses, Wet.					SPT 12, 27, 37, 50/5".
			SS	64								
												SPT 19, 24, 21, 50/5".
			SS	44								
					Hard	CL	Dark grey CLAY, little to trace silt, Wet. Bottom of Boring at 30 feet bgs					
334.6	30											

Figure

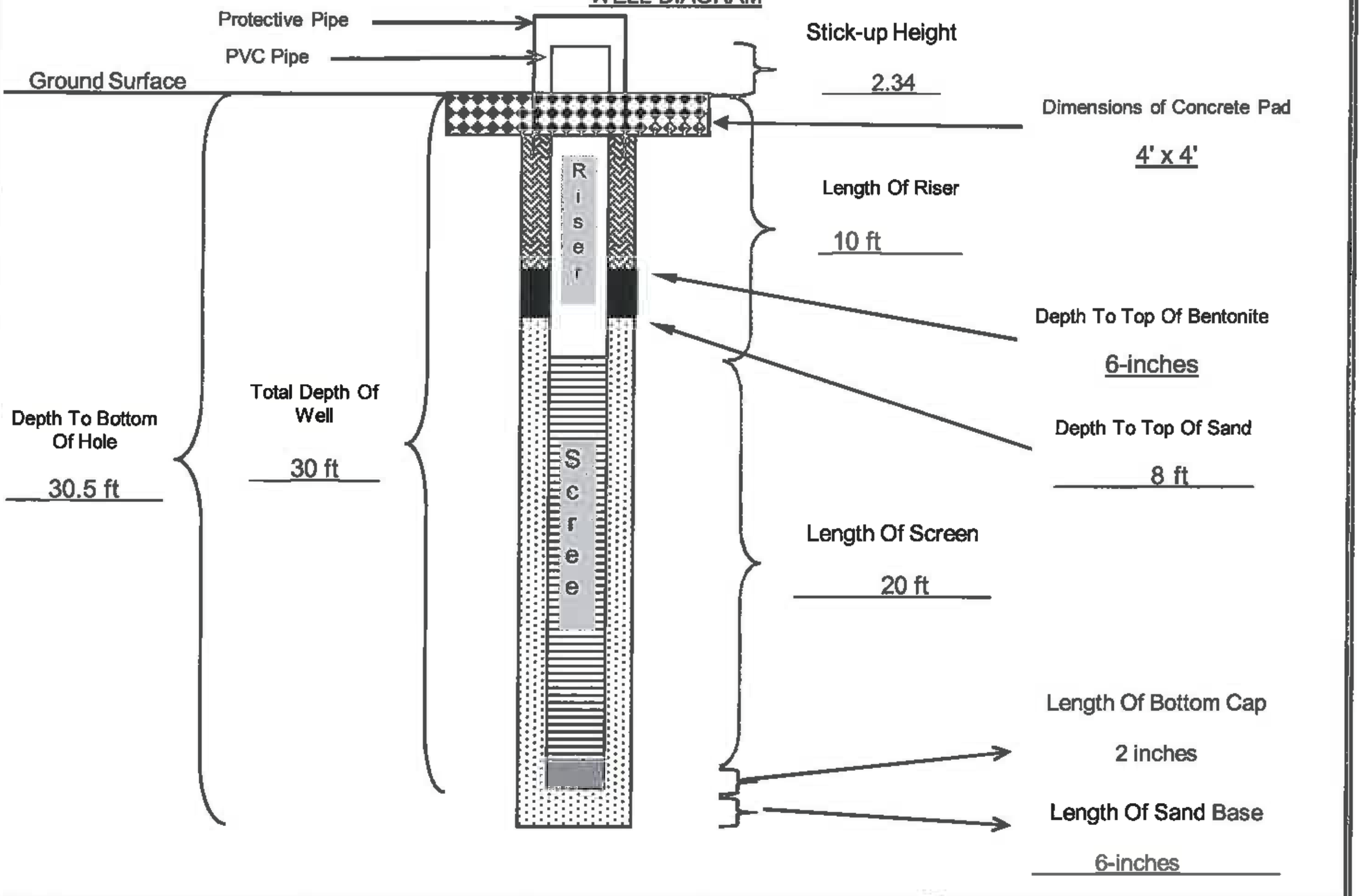
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		GB-02
JOB NO.:	TXL0064		
DATE/TIME:	8/7/2009	WELL NO.:	
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	364.56 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	354.56 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	334.06 (ft, msl)	CEMENT TYPE:	Not used-sealed with bentonite chips
NORTHING: 747.0223	EASTING: -2442.888	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	4 bags lbs
RISER DIAMETER:	2 (in) Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in) Length: 20 (ft)	AMOUNT SAND USED:	13 bags lbs
BOREHOLE DIAMETER:	8 (in)	STATIC WATER:	21.53 depth from TOC
DRILLING TECHNIQUE:	Hollow stem Size: (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.34

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Depth To Bottom Of Hole: 30.5 ft

Total Depth Of Well: 30 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2 inches

Length Of Sand Base: 6-inches

▨	Cement/Bentonite Grout	░	Sand Pack	▩	Neat Concrete	■	Bentonite	▬	Bottom Cap

QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush Chohan
DATE:	August 7th, 2009	CHECKED BY:	DATE:

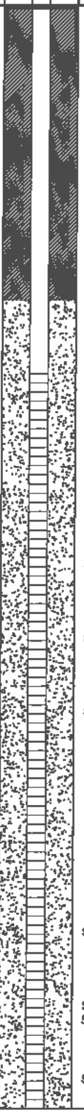
Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-03

Sheet 1 of 2

Date(s) Drilled **August 7, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **31 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **359.91 feet MSL**
Groundwater Level and Date Measured **21.89 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Well Completion**	Location **Southwest corner of proposed chemical pond near screening pile.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
359.9	0				Soft	Other		Coal						
354.9	5				Soft	CH		Shelby Tube						Shelby tube sample.
			ST							43	96.1			
					Firm	CH		Light brown-grey CLAY, little silt, occasional sand seams (fine), Damp.						SPT 29, 22, 19, 21.
			SS	41					24.04	29	90.4			
					Soft	CH		Brownish dark grey CLAY, trace sand, trace silt, Wet.						SPT 6, 12, 15, 20.
349.9	10		SS	27										
					Soft	SC		Dark orange red SAND, little clay, trace silt, Wet. Occasional clay seam (dark grey).						SPT 17, 29, 24, 25.
			SS	53										
					Soft	SC		Clay lenses.						SPT 7, 15, 17, 40.
			SS	32										
344.9	15													SPT 9, 17, 30, 20.
			SS	47	Soft	SC		Clay lense						
					Soft	SC		Dark grey fine SAND with clay, occasional clay lense, Wet.						SPT 11, 50/4".
			SS	50	Firm	CL		Dark grey CLAY, little fine sand, Wet.						
					Soft	SC		Dark grey fine SAND, little clay, occasional clay seam, iron ore, Wet.						SPT 11, 27, 17, 21.
339.9	20		SS	44										
								8/11/09▼						
334.9	25													SPT 27, 40, 50/4".
			SS	90										
					Firm	SC		Dark grey clay lense						SPT 11, 15, 40, 50/3".
			SS	55										
			SS	55										SPT 17, 50/5.5".
329.9	30													



Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-03

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
329.9	30	▨	SS	65	Hard	CL	▨	Dark gray CLAY, trace silt, trace fine sand.						SPT 17, 50/5.5".
								Bottom of Boring at 31 feet bgs						
324.9	35													
319.9	40													
314.9	45													
309.9	50													
304.9	55													
299.9	60													
294.9	65													

Figure

WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

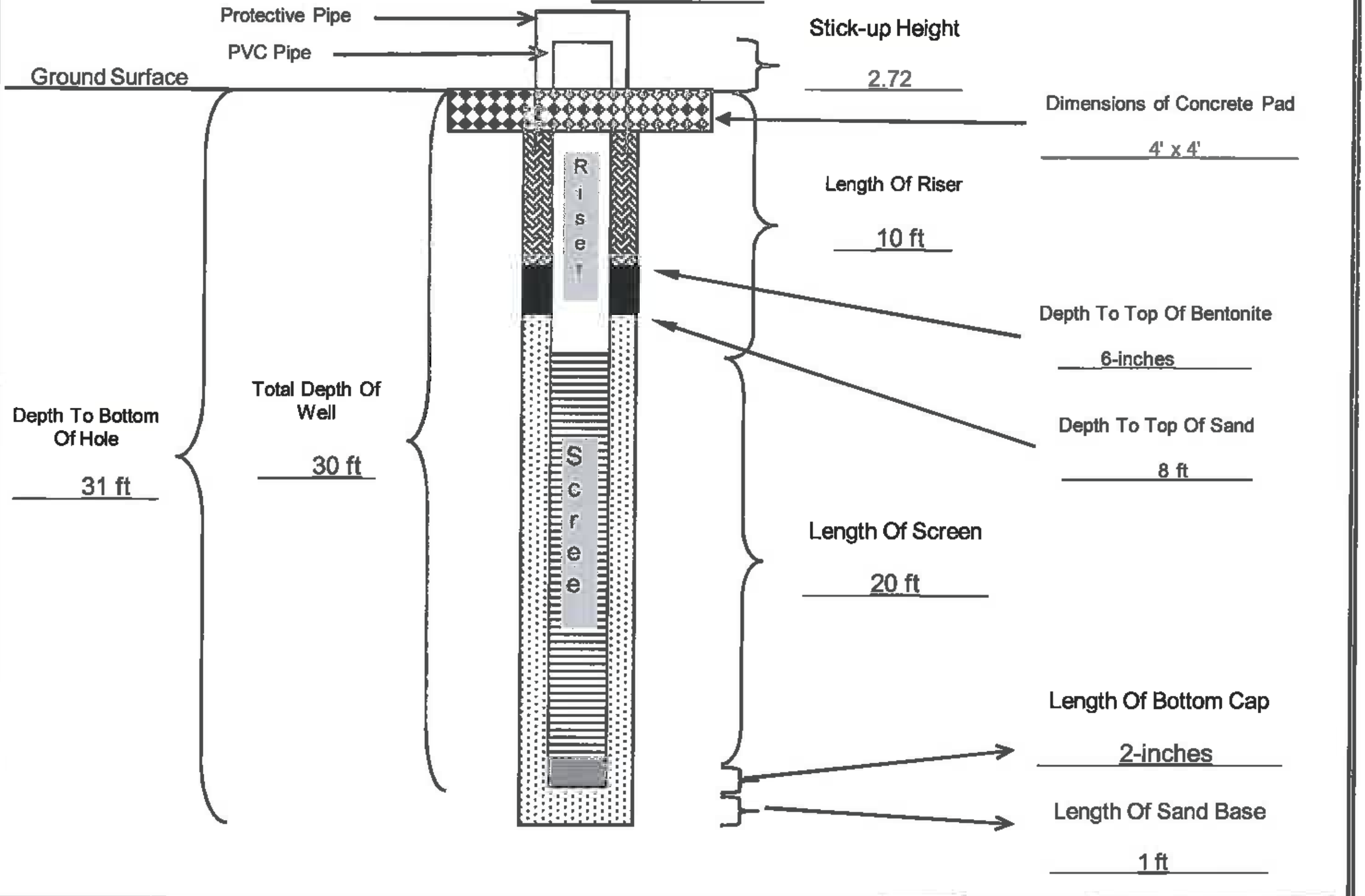
Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: 8/7/2009
WELL LOCATION:
WELL NO.: GB-03
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION: 359.57 (ft, msl)
TOP OF SCREEN ELEVATION: 349.57 (ft, msl)
BOTTOM OF WELL ELEVATION: 328.57 (ft, msl)
NORTHING: 460.5803 EASTING: -2507.6332
SCREEN MATERIAL: PVC
SCREEN MANUFACTURER:
RISER MATERIAL: PVC
RISER MANUFACTURER:
RISER DIAMETER: 2 (in) Length: 10 (ft)
SCREEN DIAMETER: 2 (in) Length: 20 (ft)
BOREHOLE DIAMETER: 8 (in)
DRILLING TECHNIQUE: Hollow Stem Size: 8 (in)

BENTONITE TYPE: Western Bentonite
MANUFACTURER: PDS
CEMENT TYPE: None used-sealed with bentonite chips
CEMENT MANUFACTURER:
SAND PACK TYPE AND SIZE: Silica 20/40
SAND MANUFACTURER: Uninum
DRILLING CONTRACTOR: Total Support Services
AMOUNT BENTONITE USED: 4 bags lbs
AMOUNT CEMENT USED: bags lbs
AMOUNT SAND USED: 12 bags lbs
STATIC WATER: 21.89 depth from TOC
ENCOUNTERED WATER: depth from ground

WELL DIAGRAM



Stick-up Height
2.72

Dimensions of Concrete Pad
4' x 4'

Length Of Riser
10 ft

Depth To Top Of Bentonite
6-inches

Depth To Top Of Sand
8 ft

Length Of Screen
20 ft

Length Of Bottom Cap
2-inches

Length Of Sand Base
1 ft

Depth To Bottom Of Hole
31 ft

Total Depth Of Well
30 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC
INSTALLED BY: Total Support Services
DATE: 7-Aug-09
OBSERVED BY: Kush S. Chohan
CHECKED BY:
DATE:

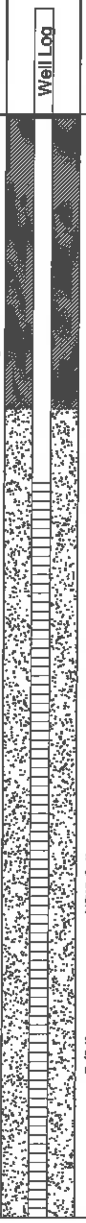
Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-04

Sheet 1 of 2

Date(s) Drilled **July 24, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **34 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **357.22 feet MSL**
Groundwater Level and Date Measured **20.54 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Well Completion**	Location **Southeast corner of proposed chemical evaportation pond. Located in a grassy field.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	REMARKS AND OTHER TESTS
357.2	0	▨			Soft	SM-SC	Reddish brown fine SAND, little silt, trace clay, damp.					SPT 1, 3, 6, 6. 24" recovered.
		▨	SS	9	Soft	Other	COAL					
		▨			Firm	SC	Brownish red SAND, little clay, trace silt. Damp.					
		▨			Firm	CL	Reddish pink CLAY, some fine sand, Dry.					SPT 4, 4, 4, 4. 24" recovered.
		▨	SS	8				24.49	47	90.2		
		▨			Soft	Other	Oxidized SAND and clay with iron ore.					SPT 5, 6, 8, 4. 18" recovered.
352.2	5	▨	SS	14	Soft	CH	Light reddish brown CLAY and sand mixture, Dry.					
		☒	ST		Soft	SC	Reddish brown SAND, little clay, Dry.	28.4	38	61.1	7.7E-09	12" Shelby tube. 9" recovered.
		▨	SS	17	Firm	CH	Light brownish tan CLAY, little sand, occasional sand seams, Dry.					SPT 3, 4, 13, 15. 27" recovered.
347.2	10											
342.2	15	▨			Soft	SC	Red/yellowish brown SAND, some clay, Wet.					SPT 3, 7, 3, 15. 24" recovered.
		▨	SS	10	Firm	SC	Occasional clay lenses.	6.95	14	47		
337.2	20	☒	ST				8/11/09 ▼					Shelby tube. 12" driven 0" pulled. Gravel material encountered.
		▨	SS	19	Soft to Firm	SM	Black to dark grey fine/med SAND, little clay, occasional clay lenses, Wet.					SPT 7, 10, 9, 13. 24" recovered.
332.2	25	▨			Soft	SM	Well graded light grey fine/med SAND, trace silt, Wet.					SPT 17, 24, 50/5.5". 19" recovered.
		▨	SS	74				22.29	NP	13.5		
		▨			Firm	CL	Dark grey clay lense, Wet.					
					Firm	SM-SC	Well graded light grey fine/med SAND, trace silt, Wet.					
327.2	30											



Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-04

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
327.2	30	☒	ST		Hard	ML	▥	Dark grey CLAY, little sand, Wet.						12" Shelby tube. Bent shelby tube.
		☒	ST						21.3	NP	84.2	2.0E-08		12" Shelby tube.
		▧	SS	38	Hard	CL	▨	Dark grey CLAY, trace sand, Wet.	25.44	18	92.5			SPT 15, 19, 19, 25. 24" recovered.
								Bottom of Boring at 34 feet bgs						
322.2	35													
317.2	40													
312.2	45													
307.2	50													
302.2	55													
297.2	60													
292.2	65													

WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

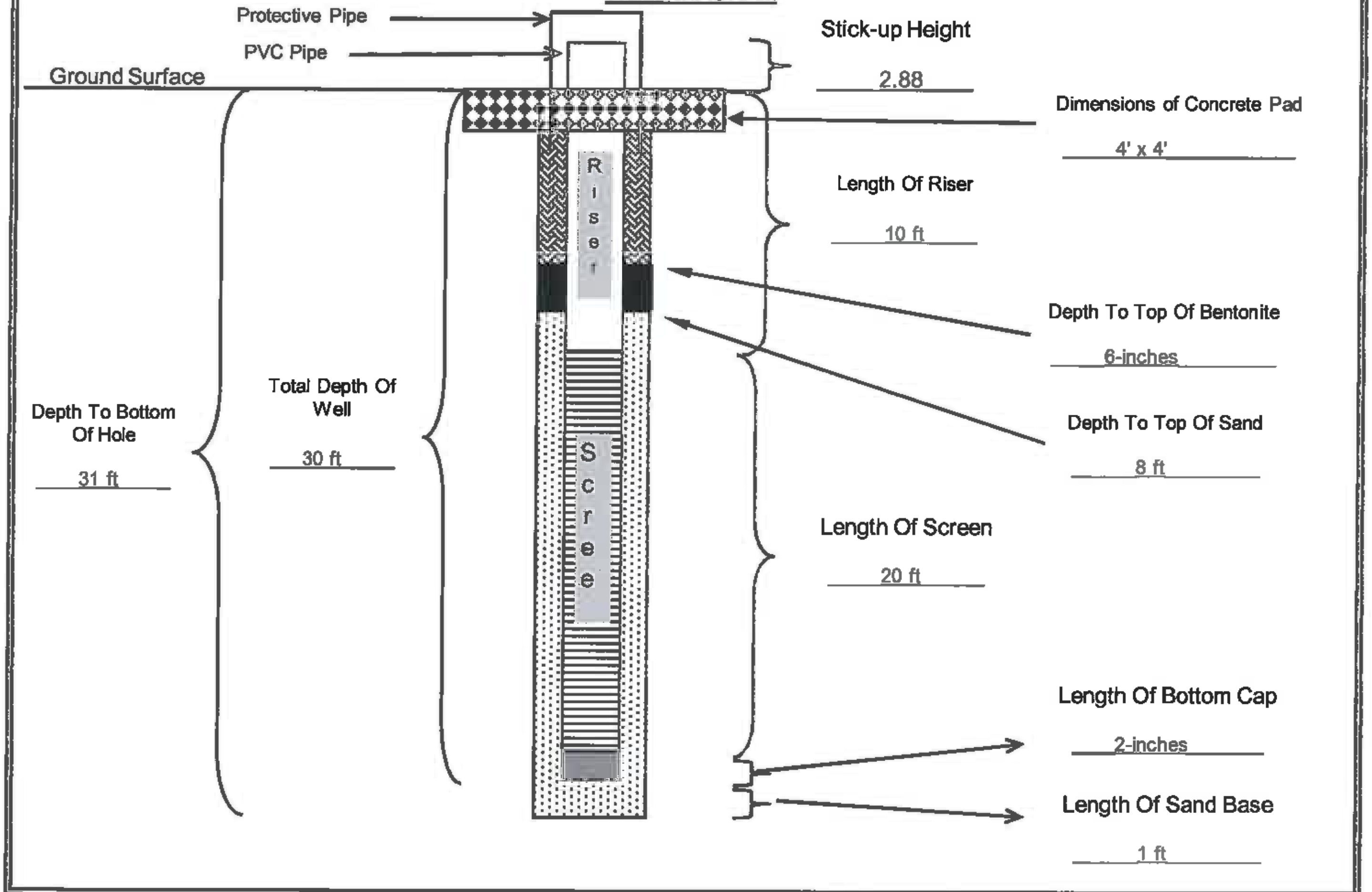
Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: 24-Jul-09
WELL LOCATION:
WELL NO.: **GB-04**
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION: 357.22 (ft, msl)
TOP OF SCREEN ELEVATION: 347.22 (ft, msl)
BOTTOM OF WELL ELEVATION: 326.22 (ft, msl)
NORTHING: -384.9666 EASTING: -2353.7375
SCREEN MATERIAL: PVC
SCREEN MANUFACTURER:
RISER MATERIAL: PVC
RISER MANUFACTURER:
RISER DIAMETER: 2 (in) Length: 10 (ft)
SCREEN DIAMETER: 2 (in) Length: 20 (ft)
BOREHOLE DIAMETER: 6.75 (in)
DRILLING TECHNIQUE: Hollow Stem Size: 6.75 (in)

BENTONITE TYPE: Western Bentonite
MANUFACTURER: PDS
CEMENT TYPE:
CEMENT MANUFACTURER:
SAND PACK TYPE AND SIZE: Silica 20/40
SAND MANUFACTURER: Uninum
DRILLING CONTRACTOR: Total Support Services
AMOUNT BENTONITE USED: 3 bags lbs
AMOUNT CEMENT USED: bags lbs
AMOUNT SAND USED: 7 bags lbs
STATIC WATER: 20.54 depth from TOC
ENCOUNTERED WATER: depth from ground

WELL DIAGRAM



Stick-up Height 2.88
Dimensions of Concrete Pad 4' x 4'
Length Of Riser 10 ft
Depth To Top Of Bentonite 6-inches
Depth To Top Of Sand 8 ft
Depth To Bottom Of Hole 31 ft
Total Depth Of Well 30 ft
Length Of Screen 20 ft
Length Of Bottom Cap 2-inches
Length Of Sand Base 1 ft

▨ Cement/Bentonite Grout ░ Sand Pack ▦ Neat Concrete ■ Bentonite ▩ Bottom Cap

QA/QC
INSTALLED BY: Total Support Services
DATE: 24-Jul-09
OBSERVED BY: Kush S. Chohan
CHECKED BY:
DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-05

Sheet 1 of 2

Date(s) Drilled	**July 24, 2009**	Logged By	**Kush S. Chohan**	Checked By	
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type		Total Depth of Borehole	**30.5 feet bgs**
Drill Rig Type	**Mobil B61**	Drilling Contractor	**Total Support Services**	Approximate Surface Elevation	**357.49 feet MSL**
Groundwater Level and Date Measured	**15.3 feet measured on 8-11-09**	Sampling Method(s)	**SPT, Tube**	Hammer Data	**140 lb, 30 in drop, Auto-hammer**
Borehole Backfill	**Well Completion**	Location	**Eastern edge of proposed chemical evaporation pond.**		

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.5	0				Soft	SW-SM		Dark fine SAND with brown organic material and roots.						SPT 2, 2, 5, 5. 24" recovered
			SS	7	Firm	CH		Dark red/grey CLAY, trace silt. Dry.	23.37	44	68.6			
			SS	11								7E-07		SPT 4, 4, 7, 9. 24" recovered.
352.5	5		SS	14										SPT 5, 6, 8, 13. 24 recovered
						CH		Trace of sand						
			ST		Soft	CH		Dark red fine SAND, trace clay, Damp.	16.5	41	73.8	3.2E-08		Shelby tube. Pushed 12 recovered 9".
			SS	18	Firm	CH		Light tan CLAY, trace sand, Dry.						SPT 5, 7, 11, 11. 24" recovered.
					Soft	SC		Dark red SAND, trace of CLAY, Damp.						
					Firm	CL		Light tan CLAY, trace fine sand, Dry.						
					Soft	SC		Dark red SAND, little clay, frequent clay seams, Damp						SPT 6, 7, 11, 14. 24" recovered.
347.5	10		SS	18										
						SC		Frequent clay seams						SPT 11, 22, 13, 14. 24" recovered.
					Soft	SC		Red/orange fine SAND, trace clay, trace coarse sand, poorly sorted, Moist.						
			SS	35										
			SS	77										SPT 17, 27, 50/5". 17" recovered.
					Firm	CL		Brownish grey CLAY, trace sand, Moist.						
					Soft	SC		Tanish grey fine SAND, some clay, Wet.						
342.5	15													
			ST					8-11-09 ▼	19.9	13	35.7	6.6E-07		Shelby tube. Pushed 12" recovered 9".
			SS	23					27.98	NP	32.3			SPT 11, 13, 10, 14. 24" recovered.
					Soft	SM		Dark grey coarse SAND/GRAVEL mix, some fine sand, trace clay, Wet.						
					Soft	SM-SC		Red fine SAND, trace clay, Moist. cemented. Moist.						SPT 7, 8, 11, 13. 24" recovered.
			SS	19										
					Firm	SC		Black fine SAND, occasional clay, Wet.						
337.5	20													
					Firm	CL		Dark grey CLAY, little sand, Wet.						SPT 8, 10, 12, 15. 24" recovered.
			SS	22	Firm	SM		Black fine SAND, some medium sand, some clay, Wet.	32.23	NP	35.5			
					Firm	CL		Dark grey CLAY, little sand, Wet.						
					Firm	SM		Black fine SAND, some medium sand, some clay, Wet.						SPT 6, 11, 17, 21. 24" recovered.
			SS	28	Firm	SM		Frequent clay seams						
					Firm	SM		Frequent clay seams.						
			ST											Shelby tube. 12" driven 0 recovered.
332.5	25													SPT 15, 19, 21, 27. 24" recovered.
			SS	40	Hard	CL		Dark grey CLAY, trace of sand, Dry.						
			SS	22										SPT 10, 11, 11, 50/5". 23" recovered.
					Very Hard	CL		Dark grey CLAY, frequent iron stone/ore. Rig chatter driller comments						
			ST						24.9	15	75.0	1.0E-07		Shelby tube. 12" driven 9" recovered.
327.5	30													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-05

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
327.5	30	☒	ST		Hard	CL	▨	Dark grey CLAY, trace of sand, Dry. (cont.)	24.9	15	75.0	1.0E-07		Shelby tube. 12" driven 9" recovered.
								Bottom of Boring at 30.5 feet bgs						
322.5	35													
317.5	40													
312.5	45													
307.5	50													
302.5	55													
297.5	60													
292.5	65													

Figure

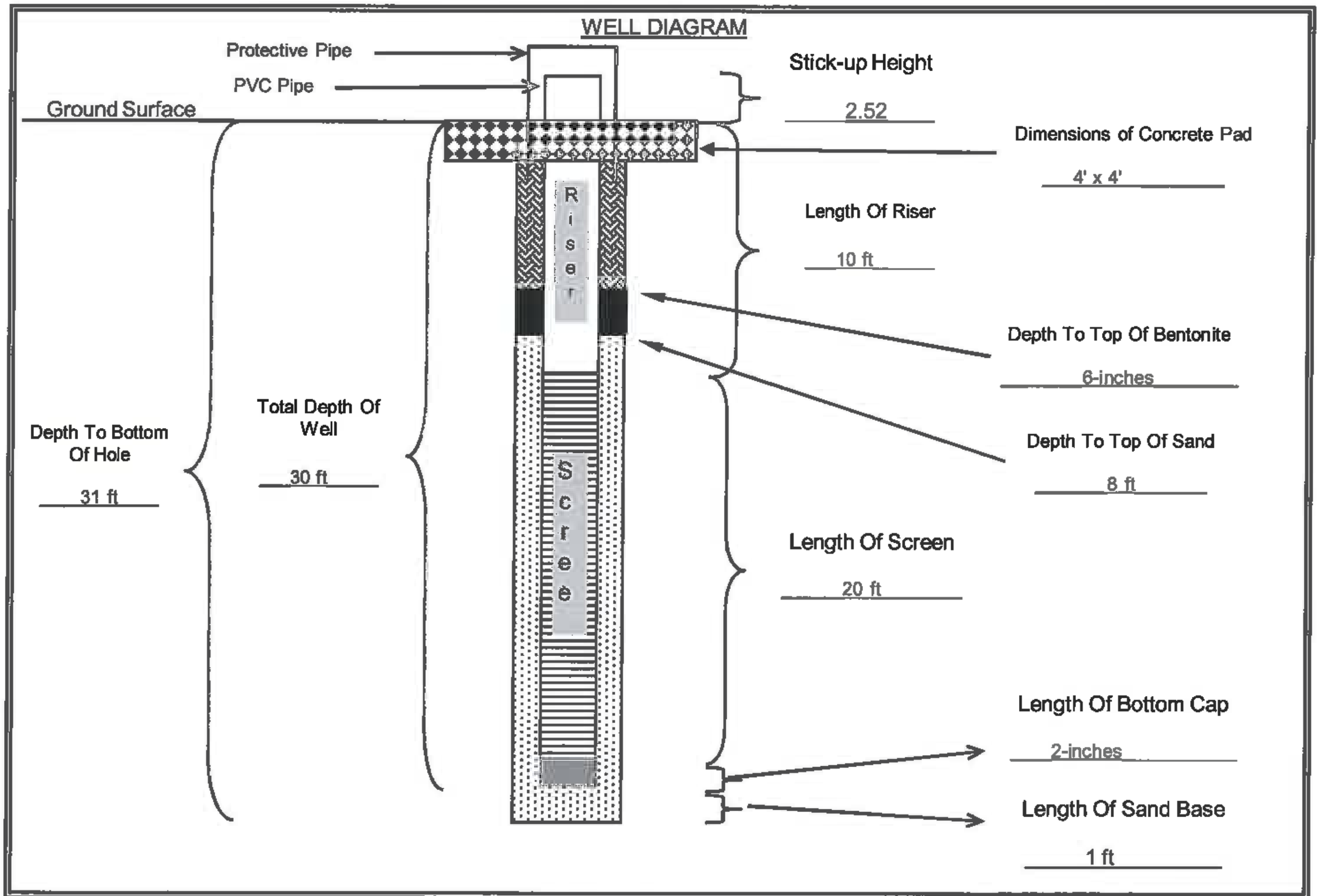
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		
JOB NO.:	TXL0064		
DATE/TIME:	August 6 2009	WELL NO.:	GB-05
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	357.49 (ft, msl)		BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	347.49 (ft, msl)		MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	326.49 (ft, msl)		CEMENT TYPE:	
NORTHING: 529.1865	EASTING: -2243.9973		CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC		SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:			SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC		DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:			AMOUNT BENTONITE USED:	3 bags lbs
RISER DIAMETER:	2 (in)	Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in)	Length: 20 (ft)	AMOUNT SAND USED:	7 bags lbs
BOREHOLE DIAMETER:	8 (in)		STATIC WATER:	17.33 depth from TOC
DRILLING TECHNIQUE:	Hollow Stem	Size: 8 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.52

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Depth To Bottom Of Hole: 31 ft

Total Depth Of Well: 30 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 1 ft

▨ Cement/Bentonite Grout · ░ Sand Pack · ▦ Neat Concrete · ■ Bentonite · ▩ Bottom Cap

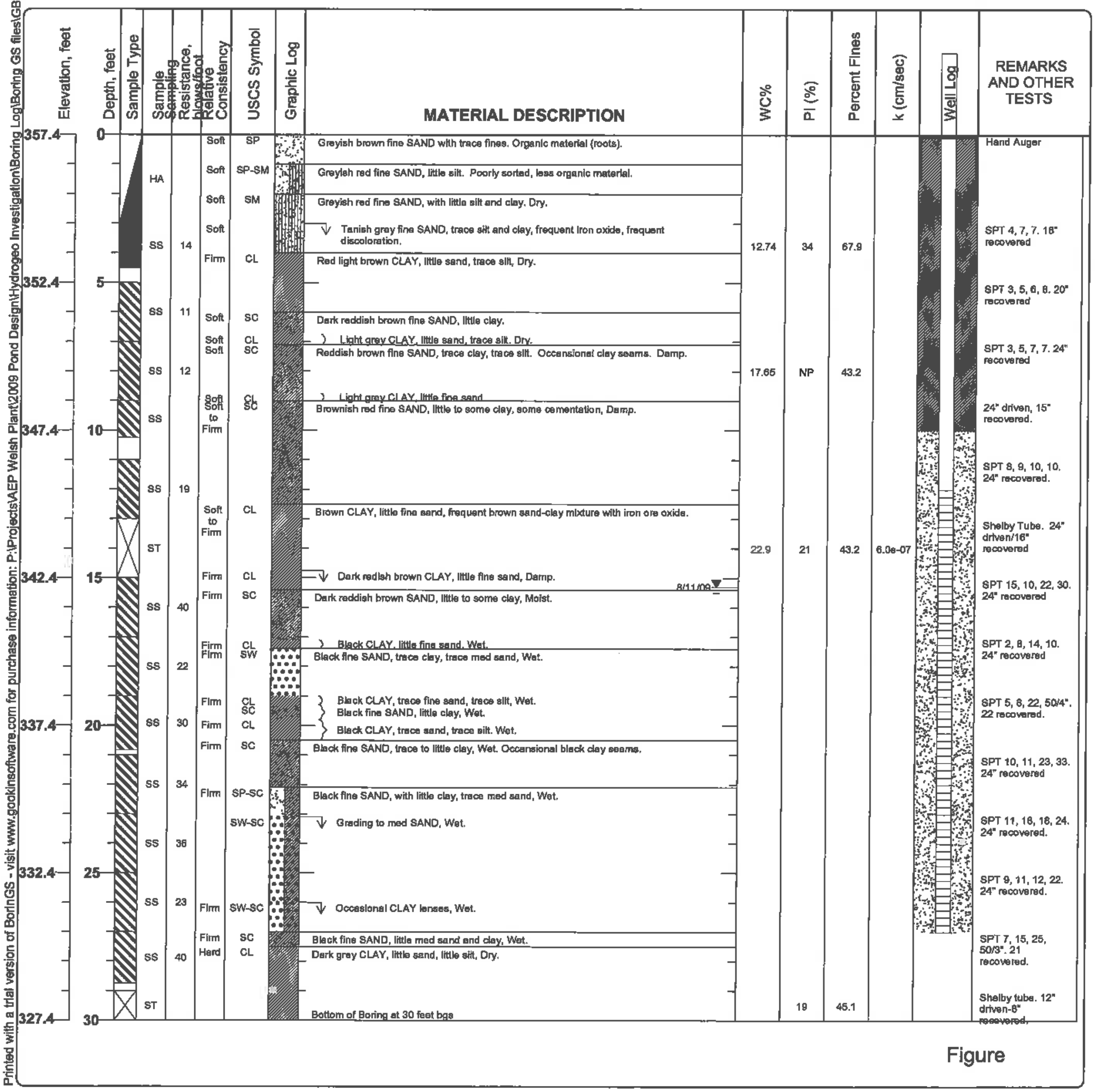
QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush Chohan
DATE:	6-Aug-09	CHECKED BY:	DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-06

Sheet 1 of 1

Date(s) Drilled	**7/23/2009**	Logged By	**Kush S. Chohan**	Checked By	
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type		Total Depth of Borehole	**30 feet bgs**
Drill Rig Type	**Mobil B61**	Drilling Contractor	**Total Support Services**	Approximate Surface Elevation	**357.41 feet MSL**
Groundwater Level and Date Measured	**15.3 feet measured on 8/11/09**	Sampling Method(s)	**SPT, Tube, Other**	Hammer Data	**140 lb, 30 in drop, auto hammer**
Borehole Backfill	**Well Completion**	Location	**Northeast corner of proposed chemical pond in the middle of open grass field.**		



Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.4	0				Soft	SP		Greyish brown fine SAND with trace fines. Organic material (roots).						Hand Auger
			HA		Soft	SP-SM		Greyish red fine SAND, little silt. Poorly sorted, less organic material.						
					Soft	SM		Greyish red fine SAND, with little silt and clay. Dry.						
					Soft			Tanish grey fine SAND, trace silt and clay, frequent iron oxide, frequent discoloration.						SPT 4, 7, 7. 16" recovered
			SS	14	Firm	CL		Red light brown CLAY, little sand, trace silt, Dry.	12.74	34	67.9			
352.4	5													SPT 3, 5, 6, 8. 20" recovered
			SS	11	Soft	SC		Dark reddish brown fine SAND, little clay.						
					Soft	CL		Light grey CLAY, little sand, trace silt. Dry.						
					Soft	SC		Reddish brown fine SAND, trace clay, trace silt. Occasional clay seams. Damp.						SPT 3, 5, 7, 7. 24" recovered
			SS	12					17.65	NP	43.2			
					Soft	CL		Light grey CLAY, little fine sand						
			SS		Soft to Firm	SC		Brownish red fine SAND, little to some clay, some cementation, Damp.						24" driven, 15" recovered.
347.4	10													
			SS	19										SPT 8, 9, 10, 10. 24" recovered.
					Soft to Firm	CL		Brown CLAY, little fine sand, frequent brown sand-clay mixture with iron ore oxide.						
			ST						22.9	21	43.2	6.0e-07		Shelby Tube. 24" driven/16" recovered
342.4	15				Firm	CL		Dark redish brown CLAY, little fine sand, Damp. 8/11/09 ▼						SPT 15, 10, 22, 30. 24" recovered
			SS	40	Firm	SC		Dark reddish brown SAND, little to some clay, Moist.						
					Firm	CL		Black CLAY, little fine sand, Wet.						SPT 2, 8, 14, 10. 24" recovered
			SS	22	Firm	SW		Black fine SAND, trace clay, trace med sand, Wet.						
					Firm	CL		Black CLAY, trace fine sand, trace silt, Wet.						SPT 5, 8, 22, 50/4". 22 recovered.
						SC		Black fine SAND, little clay, Wet.						
337.4	20		SS	30	Firm	CL		Black CLAY, trace sand, trace silt. Wet.						
					Firm	SC		Black fine SAND, trace to little clay, Wet. Occasional black clay seams.						SPT 10, 11, 23, 33. 24" recovered
			SS	34	Firm	SP-SC		Black fine SAND, with little clay, trace med sand, Wet.						
						SW-SC		Grading to med SAND, Wet.						SPT 11, 16, 16, 24. 24" recovered.
			SS	36										
332.4	25													SPT 9, 11, 12, 22. 24" recovered.
			SS	23	Firm	SW-SC		Occasional CLAY lenses, Wet.						
					Firm	SC		Black fine SAND, little med sand and clay, Wet.						SPT 7, 15, 25, 50/3". 21 recovered.
			SS	40	Hard	CL		Dark grey CLAY, little sand, little silt, Dry.						
			ST					Bottom of Boring at 30 feet bgs		19	45.1			Shelby tube. 12" driven-8" recovered.
327.4	30													

Figure

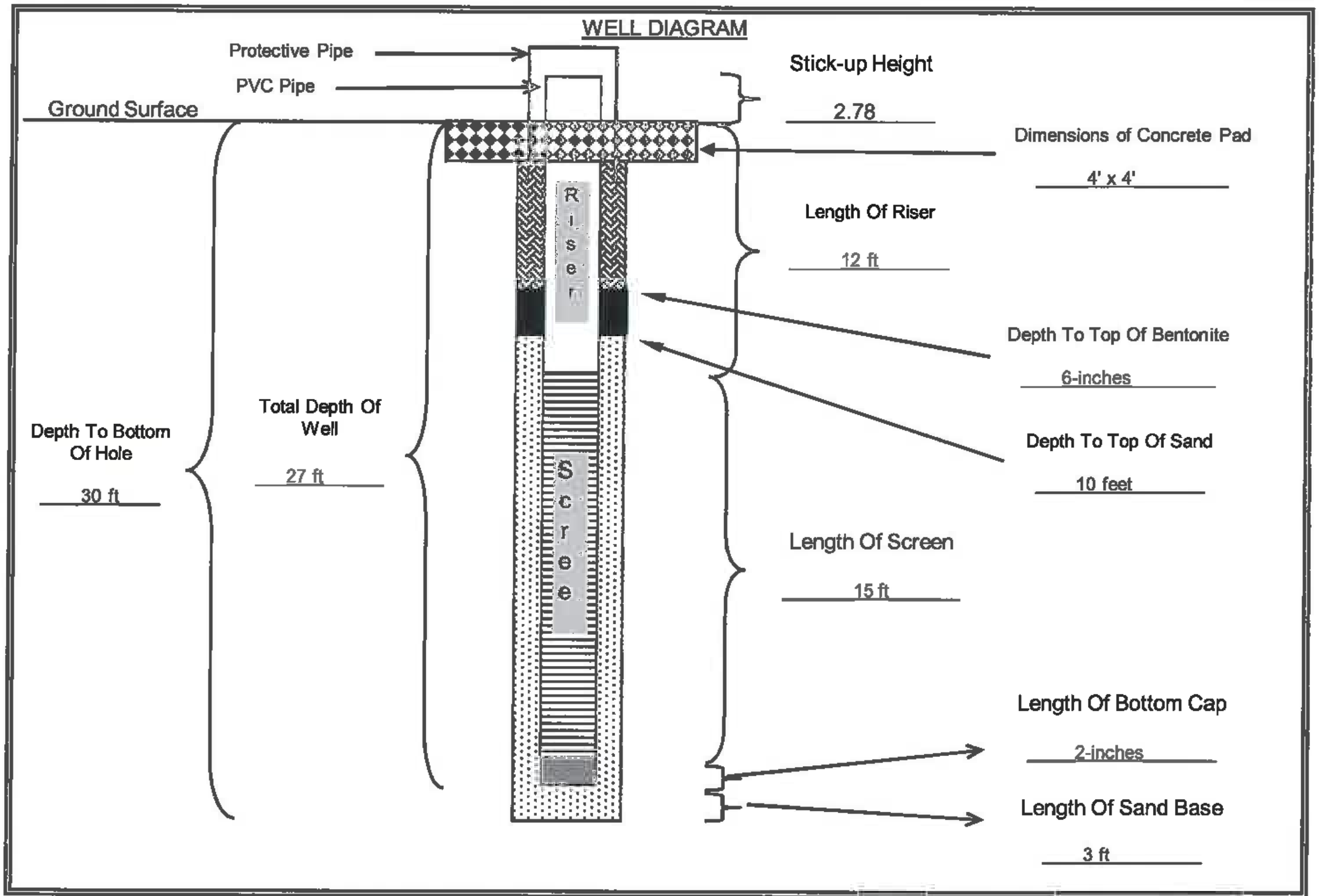
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		
JOB NO.:	TXL0064		
DATE/TIME:	23-Jul-09	WELL NO.:	GB-06
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	357.41 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	345.41 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	327.41 (ft, msl)	CEMENT TYPE:	
NORTHING: 740.4893	EASTING: -2166.134	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	2.5 bags lbs
RISER DIAMETER:	2 (in) Length: 12 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in) Length: 15 (ft)	AMOUNT SAND USED:	7 bags lbs
BOREHOLE DIAMETER:	6.75 (in)	STATIC WATER:	15.3 depth from TOC
DRILLING TECHNIQUE:	Hollow Stem Size: 6.75 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.78

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 12 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 10 feet

Length Of Screen: 15 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 3 ft

Total Depth Of Well: 27 ft

Depth To Bottom Of Hole: 30 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush Chohan
DATE:	23-Jul-09	CHECKED BY:	DATE:

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**GB-07/MW-7**
TOTAL DEPTH:	**34'**
TOP OF CASING ELEV.:	**362.75 ft. NGVD**
GROUND SURFACE ELEV.:	**360.20 ft. NGVD**

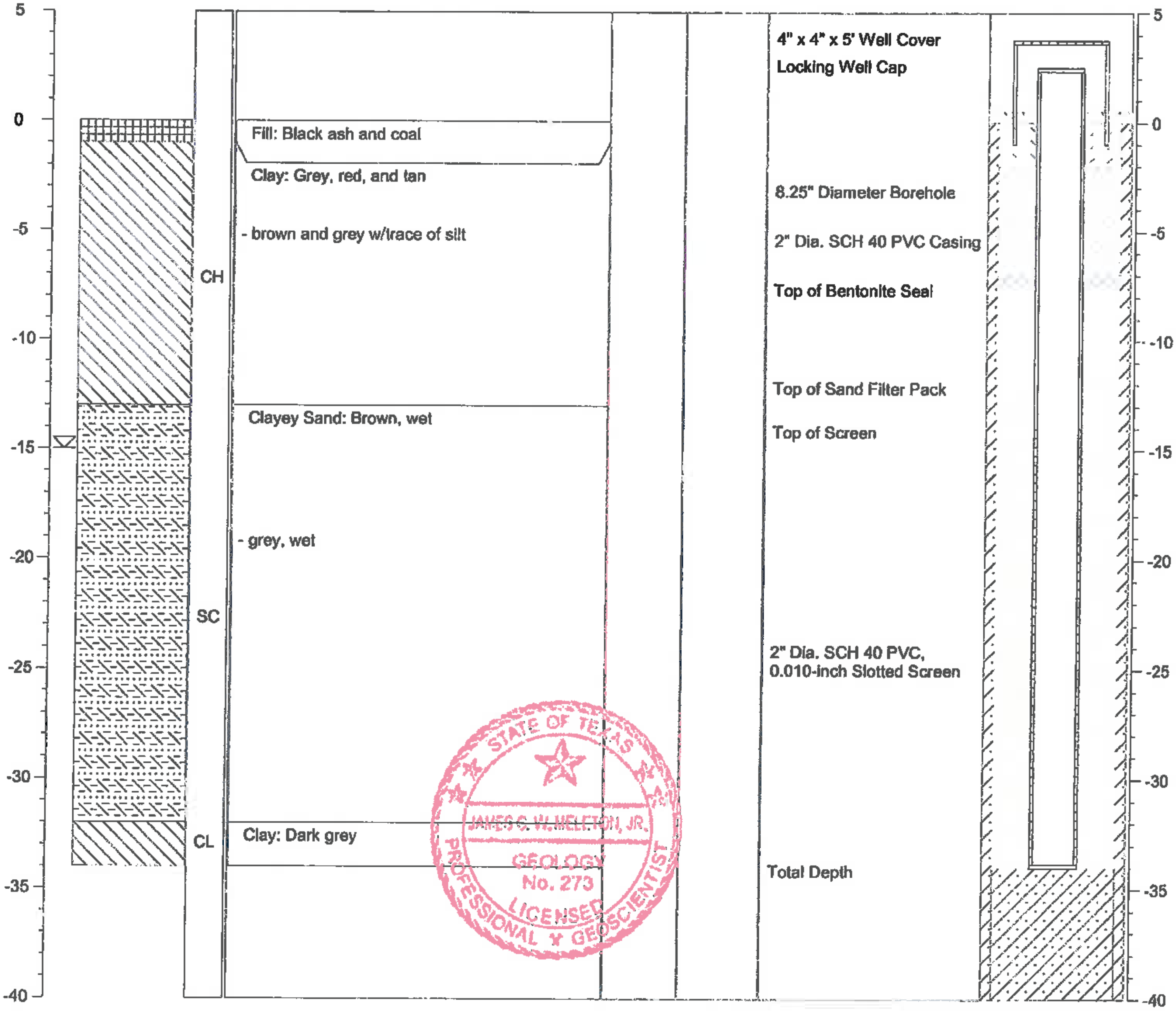
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Metal Cleaning Waste Pond**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0120**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**12/1/09**

NOTES: **Latitude: 33.05455**
Longitude: 94.84674

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Fill: Black ash and coal

Clay: Grey, red, and tan

- brown and grey w/trace of silt

Clayey Sand: Brown, wet

- grey, wet

Clay: Dark grey

4" x 4" x 5' Well Cover
Locking Well Cap

8.25" Diameter Borehole

2" Dia. SCH 40 PVC Casing

Top of Bentonite Seal

Top of Sand Filter Pack

Top of Screen

2" Dia. SCH 40 PVC,
0.010-inch Slotted Screen

Total Depth

JAMES C. W. MELETON, JR.
GEOLOGY
No. 273

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-1

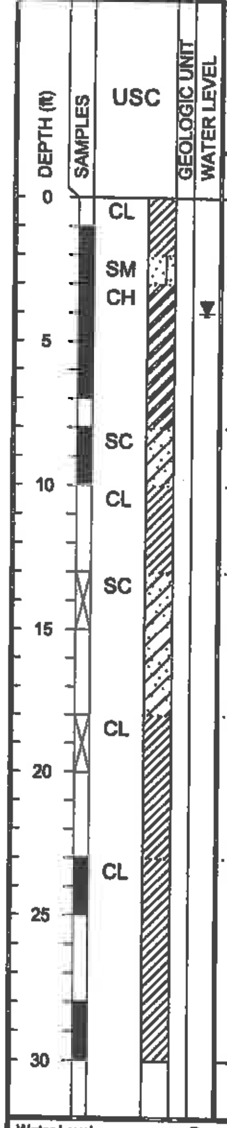
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

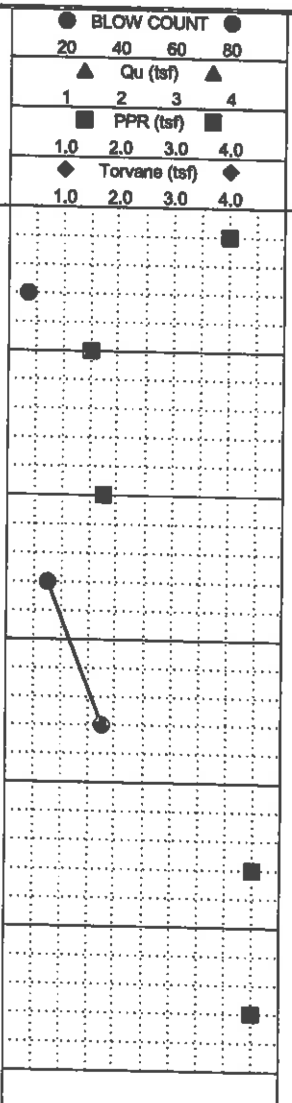
BORING TYPE: Flight Auger

DATE 10/27/09

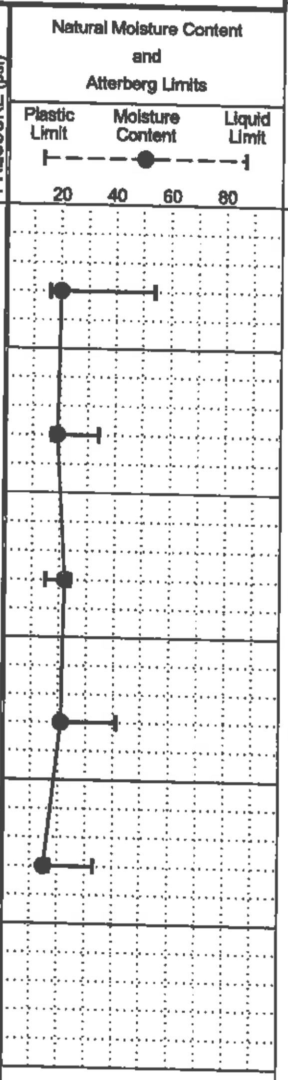
SURFACE ELEVATION 324.1



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA
CL	SANDY LEAN CLAY(CL) very stiff; brownish orange	P=4.0 SF
SM	SILTY SAND(SM) tannish orange	N=7
CH	SANDY FAT CLAY(CH) medium stiff; tannish orange –stiff	P=1.5
SC	CLAYEY SAND(SC) medium dense; tannish orange; with clay seams	P=1.75
CL	SANDY LEAN CLAY(CL) stiff; orange	
SC	CLAYEY SAND(SC) medium dense; orange; saturated; with iron oxide cemented sandstone rock	N=15
CL	LEAN CLAY WITH SAND(CL) hard; dark gray; with clay seams	N=35
CL	SANDY LEAN CLAY(CL) hard; dark brown	P=4.5+
	–grayish brown; laminated with silt	P=4.5+
	Bottom of Boring @ 30'	



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. #)
20	54	16	38	63	+40Sieve=10%, +4 Sieve=1%
19	34	17	17	32	+40 Sieve=7%, +4 Sieve=3%
22	24	15	9	19	+40Sieve=35%, +4 Sieve=22%
21	41	21	20	75	+40 Sieve=2%, +4 Sieve=0%
15	33	17	16	52	+40 Sieve=1%, +4 Sieve=0%

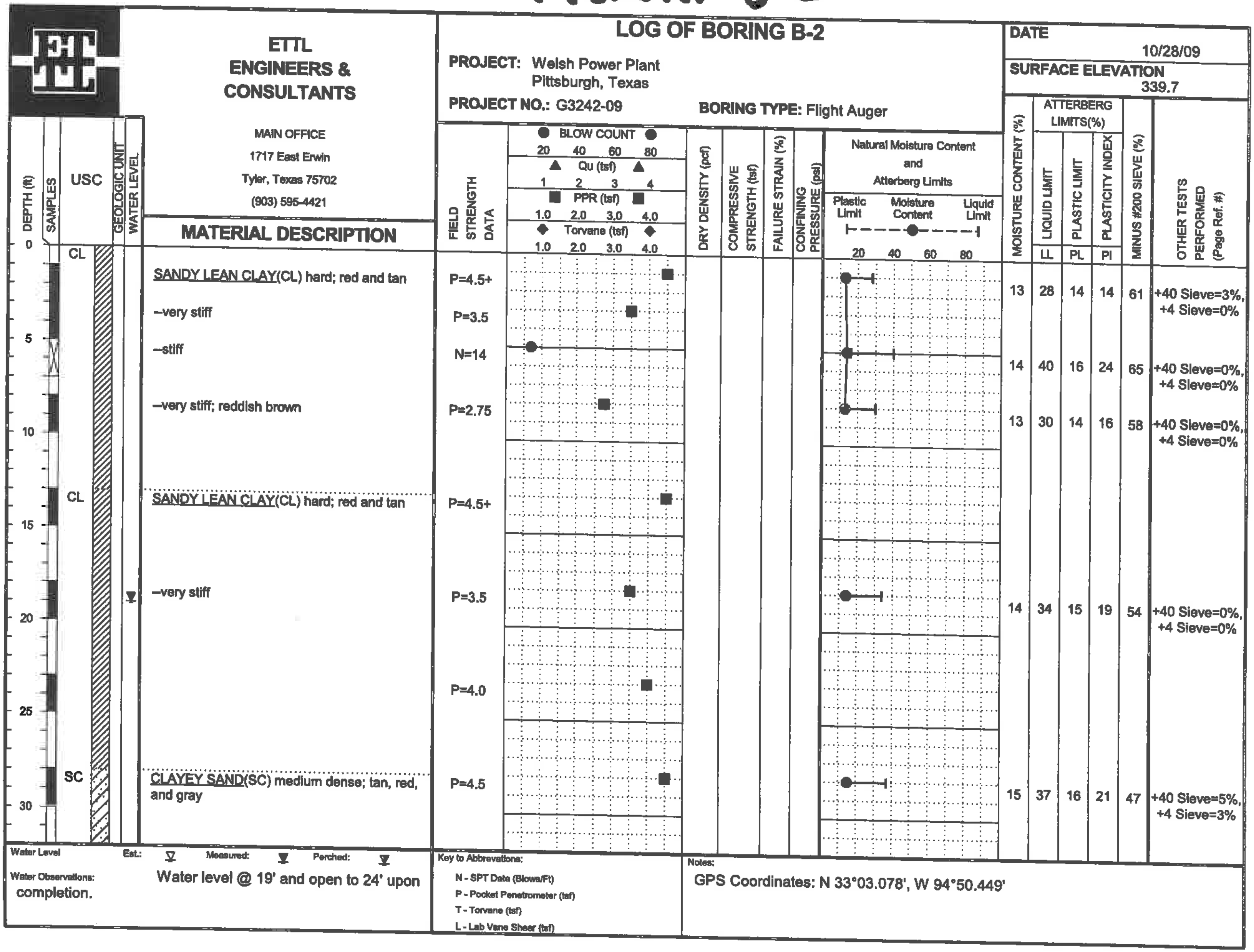
Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 5' while drilling. Water level @ 4' and open to 30' 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 33°03.090', W 94°50.417'

Piezometer B-2



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LOG OF BORING B-2

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/28/09

SURFACE ELEVATION 339.7

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	13	28	14	14	61	+40 Sieve=3%, +4 Sieve=0%
		–very stiff	P=3.5						
5		–stiff	N=14	14	40	16	24	65	+40 Sieve=0%, +4 Sieve=0%
		–very stiff; reddish brown	P=2.75	13	30	14	16	58	+40 Sieve=0%, +4 Sieve=0%
10									
	CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+						
15									
		–very stiff	P=3.5	14	34	15	19	54	+40 Sieve=0%, +4 Sieve=0%
20									
			P=4.0						
25									
	SC	CLAYEY SAND(SC) medium dense; tan, red, and gray	P=4.5	15	37	16	21	47	+40 Sieve=5%, +4 Sieve=3%
30									

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

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-2

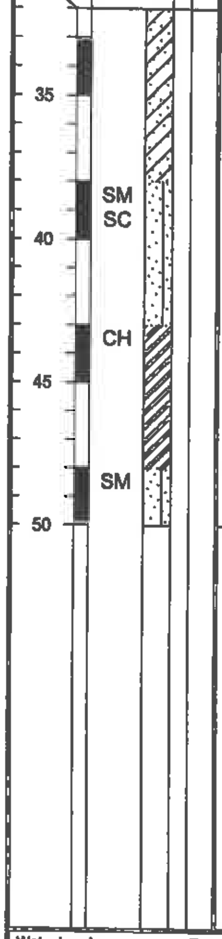
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

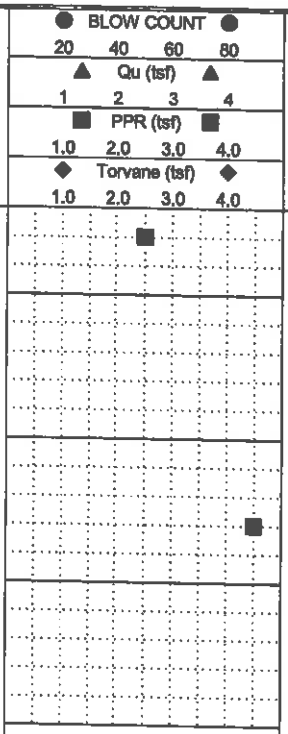
BORING TYPE: Flight Auger

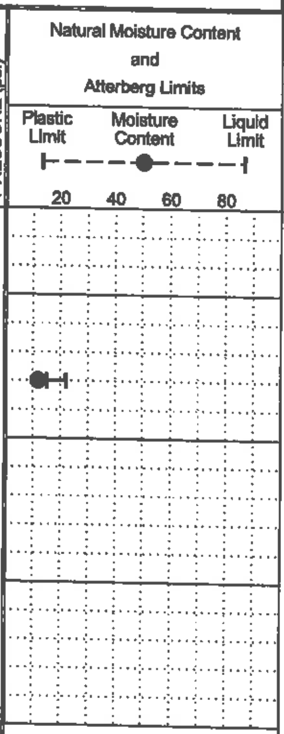
DATE 10/28/09

SURFACE ELEVATION 339.7



DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		--red and tan	P=2.5										
	SM SC	<u>SILTY CLAYEY SAND</u>(SM-SC) red, tan, and gray; saturated	SF					12	22	15	7	48	+40 Sieve=0%, +4 Sieve=0%
	CH	<u>FAT CLAY</u>(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams	P=4.5+										
	SM	<u>SILTY SAND</u>(SM) black and gray	SF										
50		Bottom of Boring @ 50'											





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

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

Piezometer B-2

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

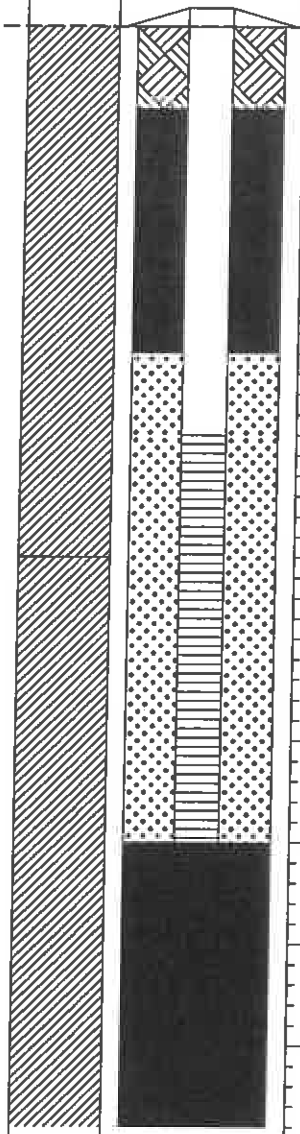
Well No. B-2

Location Pittsburg, Texas

Surface Elev.

Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
							T.O.C. Elev.
0		Ground Surface				0	
		SANDY LEAN CLAY(CL) hard; red and tan					
		--very stiff					
5		--stiff				5	
		--very stiff; reddish brown					
10						10	
		SANDY LEAN CLAY(CL) hard; red and tan					
15						15	
		--very stiff					
20						20	
25						25	



Continued Next Page

Driller Doug Hinds
Logged By James Griffith
Drilling Started 10/28/09
Drilling Completed 10/28/09
Construction Completed
Development Completed
Type of Well

Drilling Method Soild Stem Auger
Borehole Diameter 6.5"
Well Casing 2.0" **Dia.** 0.0' **to** 10.0'
Casing Type PVC
Well Screen 2.0" **Dia.** 10.0' **to** 20.0'
Screen Type Slotted
Slot Size 0.010"
Grout Type Bentonite

Bentonite Seal 2-8' & 20-50'
Filter Pack Qty. 8-20'
Filter Pack Type 20/40 Sand
Static Water Level

Notes:

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-2

Location Pittsburg, Texas

Surface Elev.

Page 2 of 2

Depth Feet Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details

Continued from previous page

CLAYEY SAND(SC) medium dense; tan, red, and gray

30

--red and tan

35

SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated

40

FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams

45

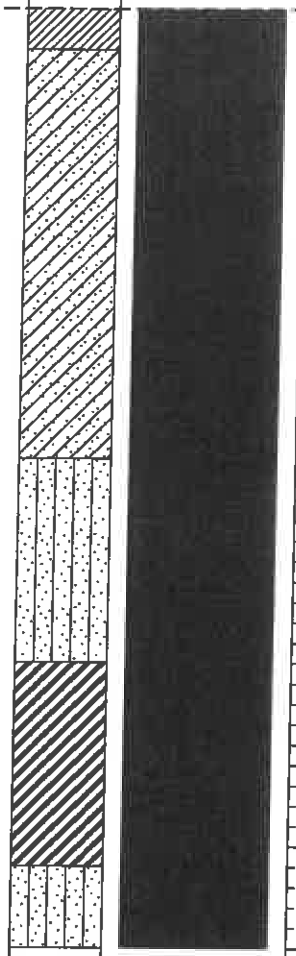
SILTY SAND(SM) black and gray

50

Bottom of Boring @ 50'

55

60



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LOG OF BORING B-3

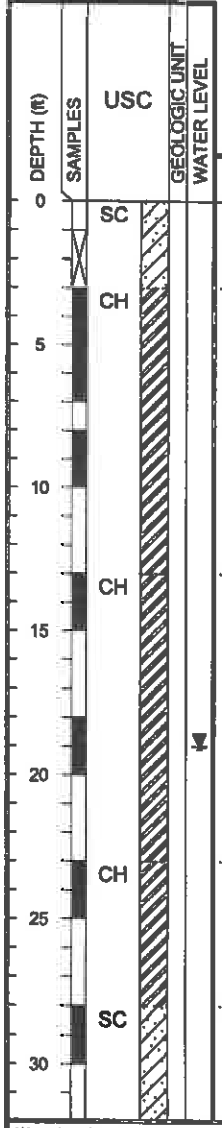
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

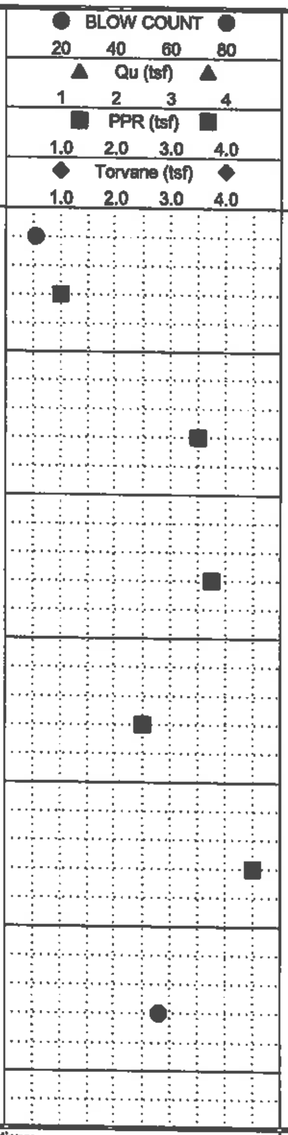
BORING TYPE: Flight Auger

DATE 10/27/09

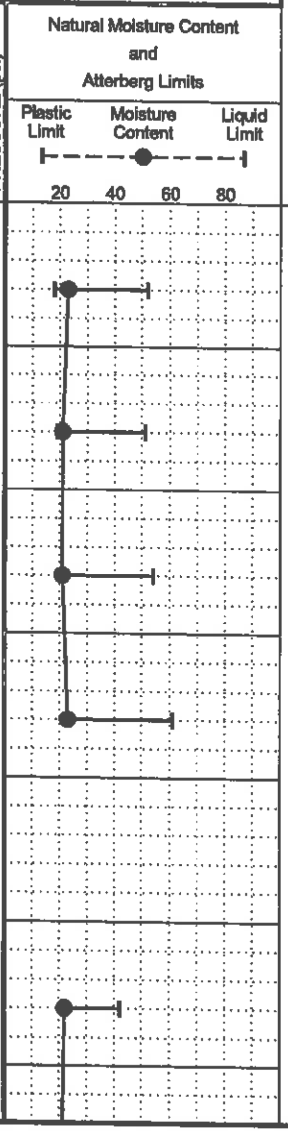
SURFACE ELEVATION 339.6



DEPTH (ft)	USC	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	SC	<u>CLAYEY SAND</u>(SC) medium dense; gray and red	N=11						
	CH	<u>FAT CLAY</u>(CH) stiff; red and tan; with sand seams	P=1.0	23	52	18	34	87	+40 Sieve=3%, +4 Sieve=0%
10		–very stiff	P=3.5	21	51	19	32	86	+40 Sieve=3%, +4 Sieve=0%
15	CH	<u>FAT CLAY WITH SAND</u>(CH) very stiff; brown; with ferric joints	P=3.75	21	54	20	34	85	+40Sieve=10%, +4 Sieve=1%
20		–red and tan; layered; with ferric seams	P=2.5	23	61	24	37	81	+40Sieve=11%, +4 Sieve=0%
25	CH	<u>FAT CLAY</u>(CH) hard; gray; with sand seams	P=4.5+						
30	SC	<u>CLAYEY SAND</u>(SC) very dense; gray; with sand seams	N=56	22	42	22	20	35	+40 Sieve=1%, +4 Sieve=0%



DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)



Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

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

LOG OF BORING B-3

PROJECT: Welsh Power Plant
Pittsburgh, Texas

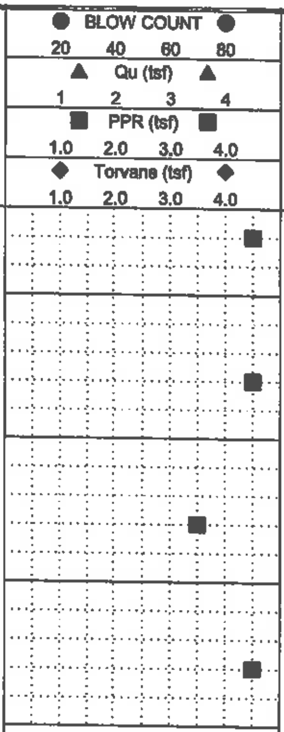
PROJECT NO.: G3242-09

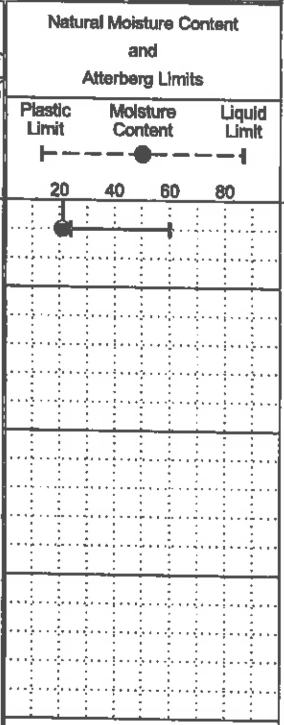
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

DEPTH (ft)	USC	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. #)
35	CH	FAT CLAY(CH) hard; brown; layered and with sand seams	P=4.5+					21	60	24	36	95	+40 Sieve=1%, +4 Sieve=0%
40		--gray and green	P=4.5+										
45	CL	SANDY LEAN CLAY(CL) very stiff; gray and dark green; layered; with sand seams	P=3.5										
50	CH	FAT CLAY(CH) hard; gray and dark green; layered; with silt seams	P=4.5+										
		Bottom of Boring @ 50'											





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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' 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 33°02.998', W 94°50.514'

Piezometer B-4

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

LOG OF BORING B-4

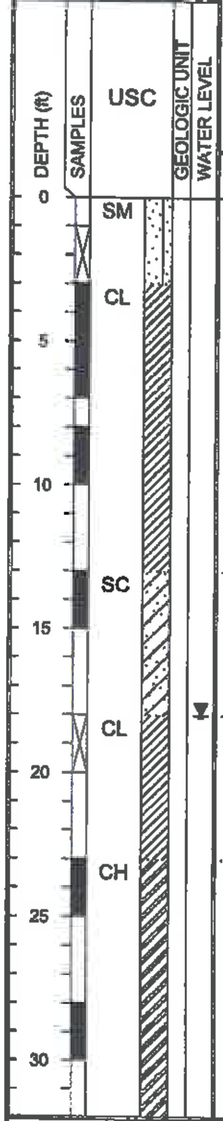
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

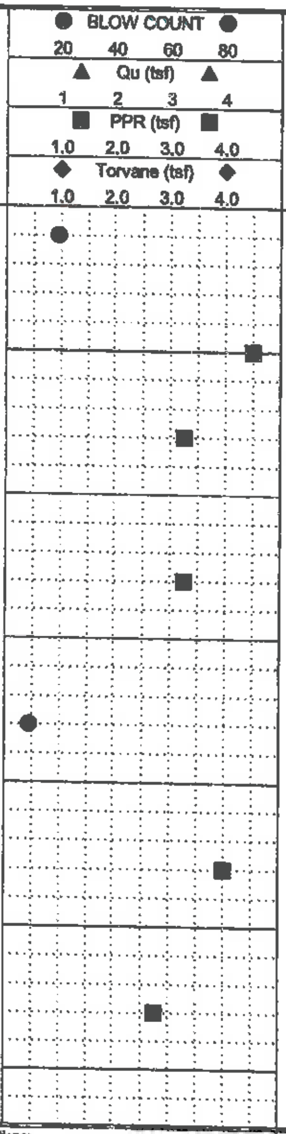
BORING TYPE: Flight Auger

DATE 10/27/09

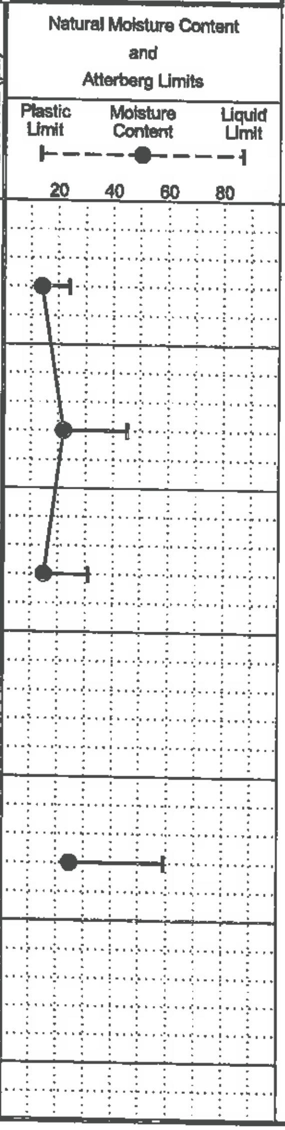
SURFACE ELEVATION 340.6



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) medium dense; tan; with gravel	N=19						
CL	SANDY LEAN CLAY(CL) dark brown	SF						
	–tannish orange		14	24	15	9	59	+40 Sieve=1%, +4 Sieve=0%
	–hard; orangish tan	P=4.5						
		P=3.25	22	45	21	24	94	+40 Sieve=2%, +4 Sieve=0%
	–very stiff; white							
SC	CLAYEY SAND(SC) medium dense; tan –orangish gray; with sand seams	P=3.25	15	31	15	16	40	+40 Sieve=1%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) stiff; orangish tan	N=9						
CH	FAT CLAY(CH) very stiff; orangish tan; with ferric seams	P=4.0	25	59	24	35	88	+40 Sieve=4%, +4 Sieve=0%
	–tannish brown; with iron ore seams	P=2.75						



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-4

PROJECT: Welsh Power Plant
Pittsburgh, Texas

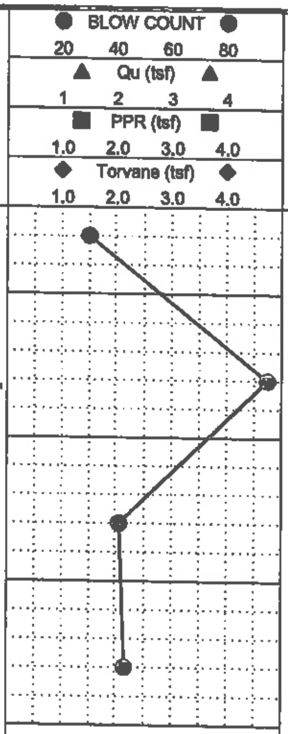
PROJECT NO.: G3242-09

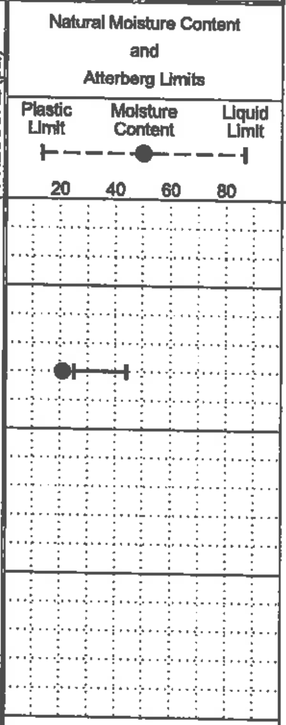
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6

DEPTH (ft)	SAMPLES	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	☒		–hard; light gray; layered and with silt seams	N=30										
40	☒	CL	LEAN CLAY(CL) hard; light gray; layered and with silt seams	N=50/5.75"					21	44	25	19	93	+40 Sieve=1%, +4 Sieve=0%
45	☒		–light gray	N=41										
50	☒		–layered and with sand seams; with lignite	N=43										
			Bottom of Boring @ 50'											





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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

Piezometer B-4

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

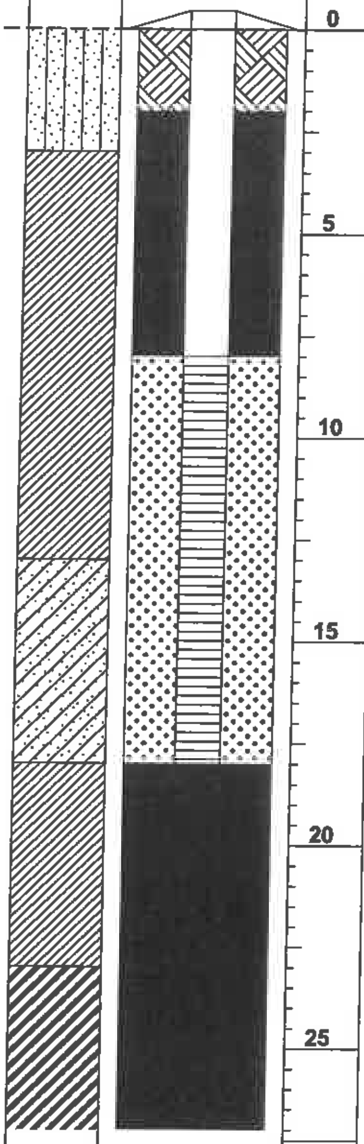
Well No. B-4

Location Pittsburg, Texas

Surface Elev.

Page 1 of 2

Depth Feet Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
						T.O.C. Elev.
0	Ground Surface				0	
	SILTY SAND(SM) medium dense; tan; with gravel					
	SANDY LEAN CLAY(CL) dark brown					
	--tannish orange					
5	--hard; orangish tan				5	
10	--very stiff; white				10	
	CLAYEY SAND(SC) medium dense; tan					
15	--orangish gray; with sand seams				15	
	SANDY LEAN CLAY(CL) stiff; orangish tan					
20					20	
	FAT CLAY(CH) very stiff; orangish tan; with ferric seams					
25					25	



Continued Next Page

Driller Doug Hinds

Logged By James Griffith

Drilling Started 10/27/09

Drilling Completed 10/27/09

Construction Completed

Development Completed

Type of Well

Drilling Method Soild Stem Auger

Borehole Diameter 6.5"

Well Casing 2.0" **Dia.** 0.0' **to** 8.0'

Casing Type PVC

Well Screen 2.0" **Dia.** 8.0' **to** 18.0'

Screen Type Slotted

Slot Size 0.010"

Grout Type Bentonite

Bentonite Seal 2-8' & 18-50'

Filter Pack Qty. 6-18'

Filter Pack Type 20/40 Sand

Static Water Level

Notes:

ETTL Engineers & Consultants Inc.

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

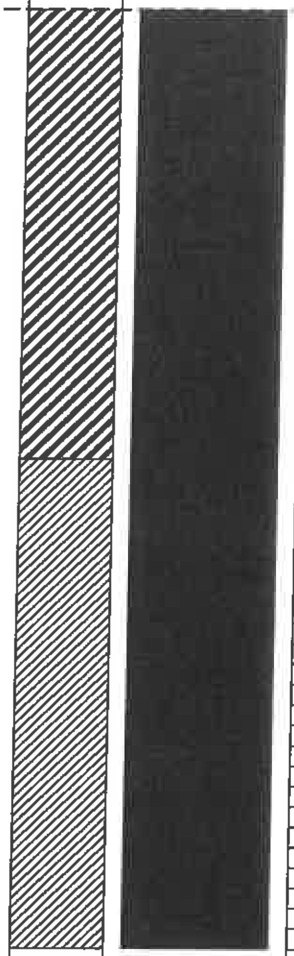
Well No. B-4

Location Pittsburg, Texas

Surface Elev.

Page 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
		Continued from previous page					
		--tannish brown; with iron ore seams					
30						30	
		--hard; light gray; layered and with silt seams					
35						35	
		LEAN CLAY(CL) hard; light gray; layered and with silt seams					
40						40	
		--light gray					
45						45	
		--layered and with sand seams; with lignite					
50		Bottom of Boring @ 50'				50	
55							
60							



Piezometer B-5

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-5

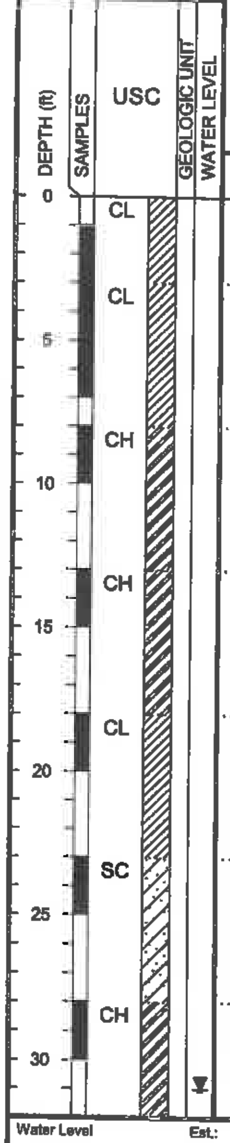
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

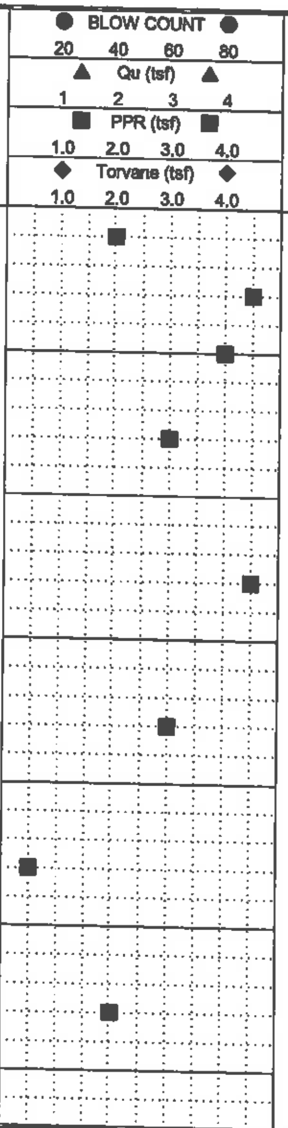
BORING TYPE: Flight Auger

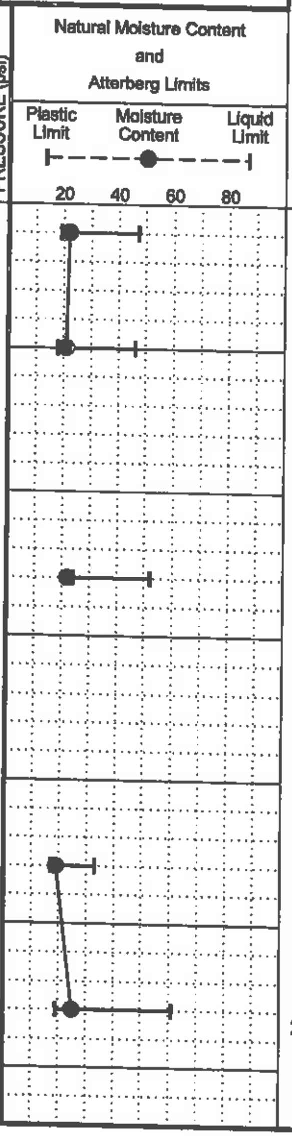
DATE 10/27/09

SURFACE ELEVATION 340.0



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) stiff; red and tan	P=2.0					22	47	19	28	81	+40 Sieve=9%, +4 Sieve=3%
CL	LEAN CLAY(CL) hard; red and tan	P=4.5+										
	–very stiff	P=4.0					21	46	18	28	94	+40 Sieve=3%, +4 Sieve=0%
CH	FAT CLAY(CL) very stiff; brown and tan	P=3.0										
CH	FAT CLAY WITH SAND(CH) hard; red and tan	P=4.5+					22	52	24	28	88	+40 Sieve=3%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams	P=3.0										
SC	CLAYEY SAND(SC) very loose; tan, red, and gray	P=0.5					19	33	17	16	44	+40 Sieve=1%, +4 Sieve=0%
CH	FAT CLAY WITH SAND(CH) stiff; red and gray	P=2.0					25	61	19	42	83	+40 Sieve=5%, +4 Sieve=3%





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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-5

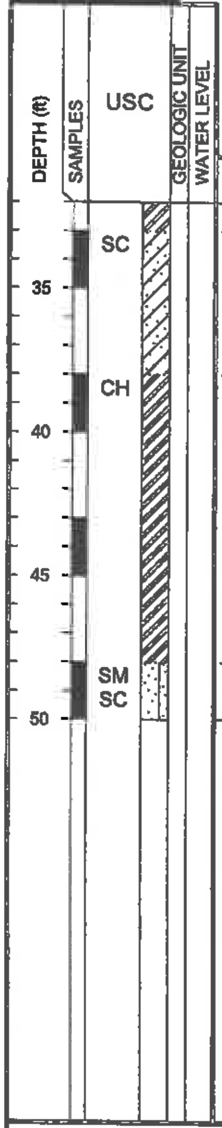
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

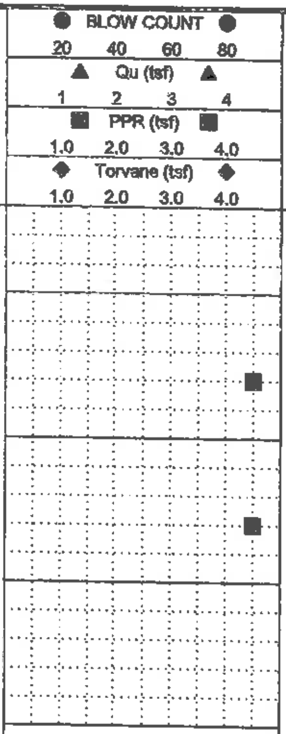
BORING TYPE: Flight Auger

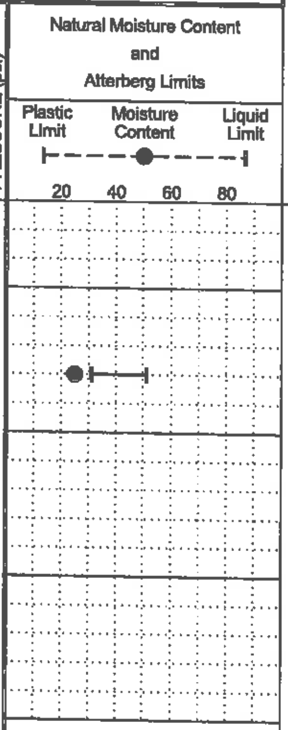
DATE 10/27/09

SURFACE ELEVATION 340.0



DEPTH (ft)	USC	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. #)
	SC	SILTY CLAYEY SAND(SC) gray and red; saturated	SF										
	CH	FAT CLAY(CH) hard; red and gray; with sand seams	P=4.5+					25	51	31	20	87	+40 Sieve=6%, +4 Sieve=0%
		–gray, tan, and red; with sand seams	P=4.5+										
	SM SC	SILTY SAND(SM-SC) red and gray	SF										
50		Bottom of Boring @ 50'											





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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

Rezonaker B-5

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-5

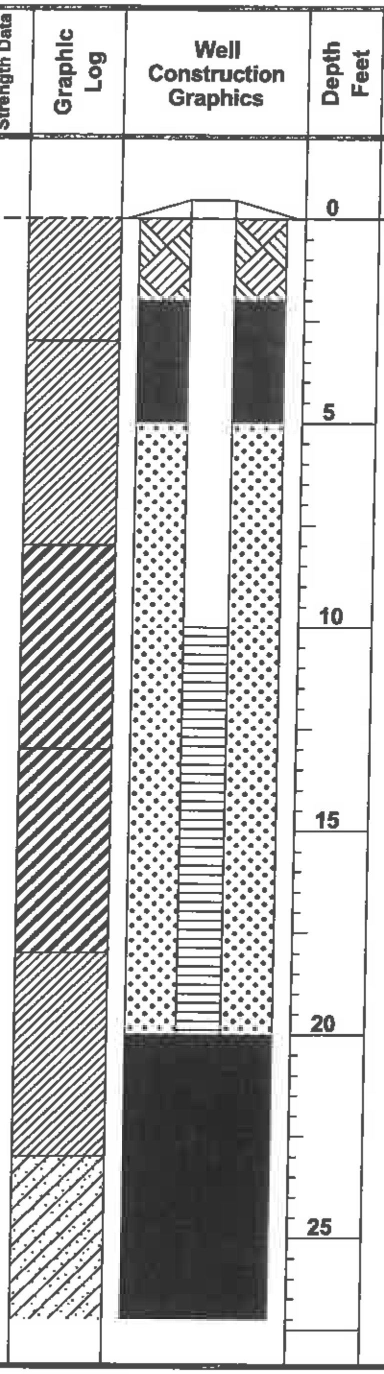
Location Pittsburg, Texas

Surface Elev.

Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description
0		Ground Surface
		LEAN CLAY WITH SAND(CL) stiff; red and tan
		LEAN CLAY(CL) hard; red and tan
5		--very stiff
		FAT CLAY(CL) very stiff; brown and tan
10		
		FAT CLAY WITH SAND(CH) hard; red and tan
15		
		SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams
20		
		CLAYEY SAND(SC) very loose; tan, red, and gray
25		

Continued Next Page



Well Construction Details

T.O.C. Elev.

Driller Doug Hinds	**Drilling Method** Soild Stem Auger	**Bentonite Seal** 2-5' & 20-50'
Logged By James Griffith	**Borehole Diameter** 6.5"	**Filter Pack Qty.** 5-20'
Drilling Started 10/27/09	**Well Casing** 2.0" **Dia.** 0.0' **to** 10.0'	**Filter Pack Type** 20/40 Sand
Drilling Completed 10/27/09	**Casing Type** PVC	**Static Water Level**
Construction Completed	**Well Screen** 2.0" **Dia.** 10.0' **to** 20.0'	
Development Completed	**Screen Type** Slotted	**Notes:**
Type of Well	**Slot Size** 0.010"	
	Grout Type Bentonite	

ETTL Engineers & Consultants Inc.

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-5

Location Pittsburg, Texas

Surface Elev. **Page** 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details

Continued from previous page

FAT CLAY WITH SAND(CH) stiff; red and gray

30

SILTY CLAYEY SAND(SC) gray and red; saturated

35

FAT CLAY(CH) hard; red and gray; with sand seams

40

–gray, tan, and red; with sand seams

45

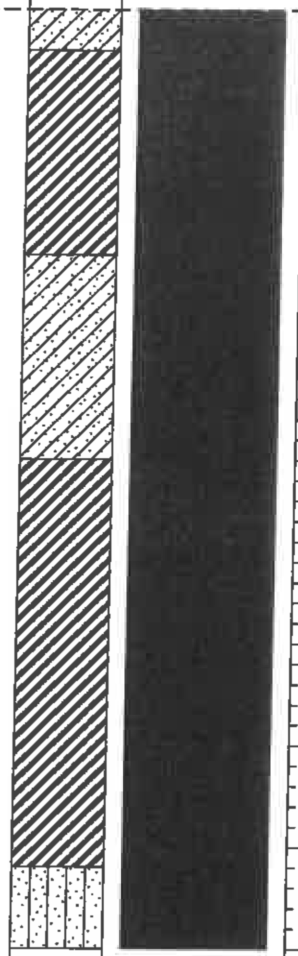
SILTY SAND(SM-SC) red and gray

50

Bottom of Boring @ 50'

55

60



Piezometer B-6

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-6

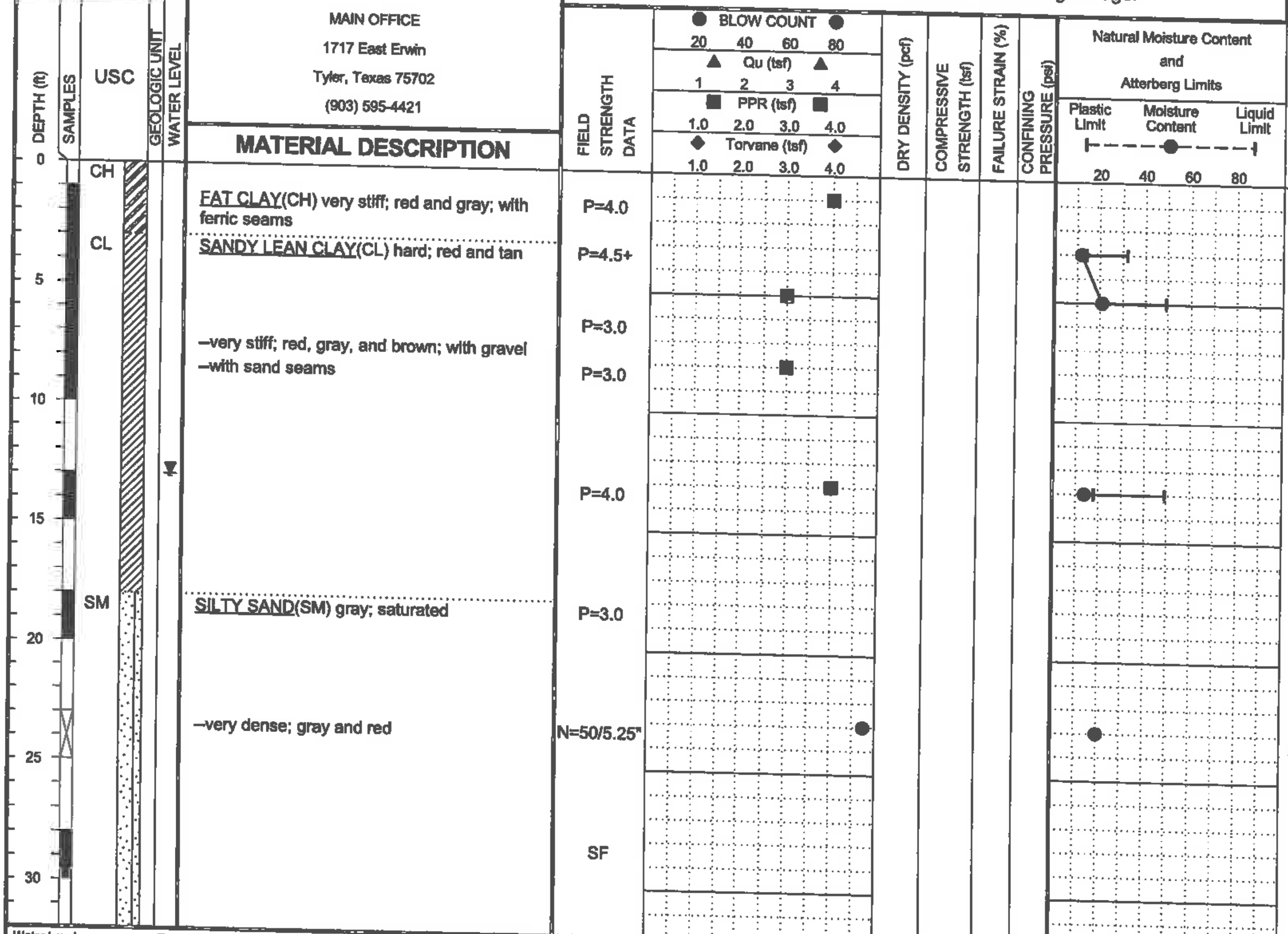
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1



MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
FAT CLAY(CH) very stiff; red and gray; with ferric seams	P=4.0						
SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	12	32	14	18	60	+40 Sieve=0%, +4 Sieve=0%
	P=3.0	21	49	20	29	93	+40 Sieve=2%, +4 Sieve=0%
–very stiff; red, gray, and brown; with gravel –with sand seams	P=3.0						
	P=4.0	14	49	18	31	65	+40 Sieve=0%, +4 Sieve=0%
SILTY SAND(SM) gray; saturated	P=3.0						
–very dense; gray and red	N=50/5.25"	20				18	+40 Sieve=0%, +4 Sieve=0%
	SF						

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-6

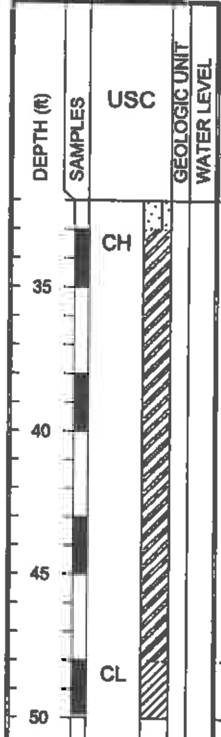
PROJECT: Welsh Power Plant
Pittsburgh, Texas

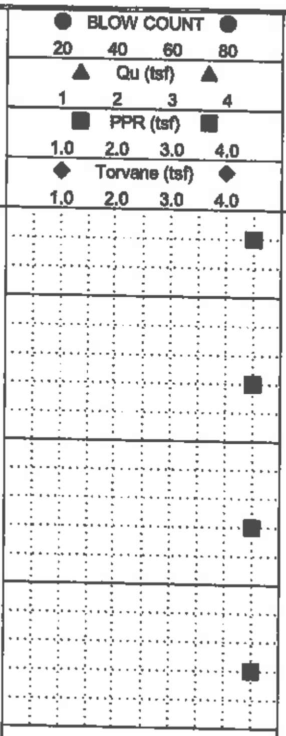
PROJECT NO.: G3242-09

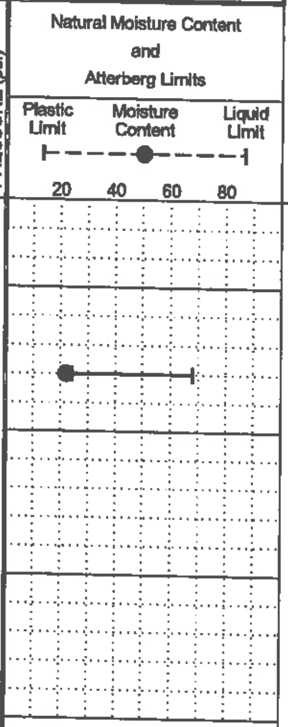
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1







DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	CH	FAT CLAY(CH) hard; brown; with sand seams	P=4.5+										
			P=4.5+					22	68	24	44	95	+40 Sieve=0%, +4 Sieve=0%
		--dark green	P=4.5+										
	CL	LEAN CLAY(CL) hard; dark green; laminated with lignite	P=4.5+										
50		Bottom of Boring @ 50'											

Water Level Est.: ∇ Measured: ▼ Perched: ⊽

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

Piezometer B-6

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

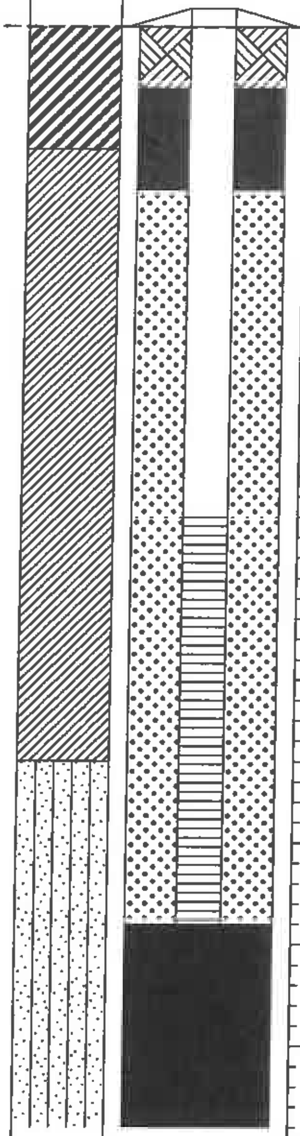
Well No. B-6

Location Pittsburg, Texas

Surface Elev.

Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
							T.O.C. Elev.
0		Ground Surface				0	
		FAT CLAY(CH) very stiff; red and gray; with ferric seams					
		SANDY LEAN CLAY(CL) hard; red and tan					
5						5	
		–very stiff; red, gray, and brown; with gravel					
		–with sand seams					
10						10	
15						15	
		SILTY SAND(SM) gray; saturated					
20						20	
		–very dense; gray and red					
25						25	



Continued Next Page

Driller Doug Hinds

Logged By James Griffith

Drilling Started 10/28/09

Drilling Completed 10/28/09

Construction Completed

Development Completed

Type of Well

Drilling Method Soild Stem Auger

Borehole Diameter 6.5"

Well Casing 2.0" **Dia.** 0.0' **to** 12.0'

Casing Type PVC

Well Screen 2.0" **Dia.** 12.0' **to** 22.0'

Screen Type Slotted

Slot Size 0.010"

Grout Type Bentonite

Bentonite Seal 1.5-4' & 22-50'

Filter Pack Qty. 4-22'

Filter Pack Type 20/40 Sand

Static Water Level

Notes:

ETTL Engineers & Consultants Inc.

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-6

Location Pittsburg, Texas

Surface Elev.

Page 2 of 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details

Continued from previous page

30

FAT CLAY(CH) hard; brown; with sand seams

35

40

--dark green

45

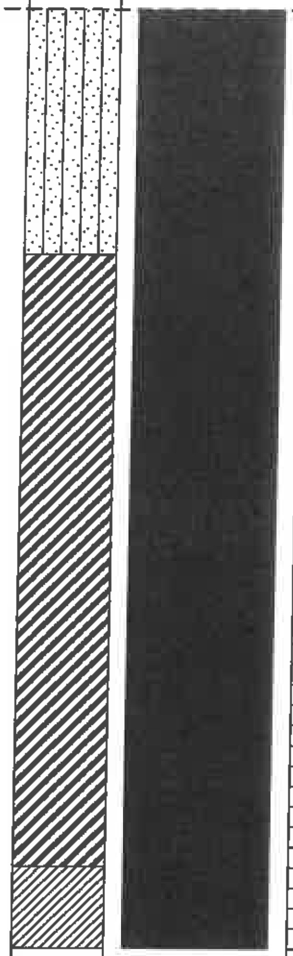
LEAN CLAY(CL) hard; dark green; laminated with lignite

50

Bottom of Boring @ 50'

55

60



ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-7

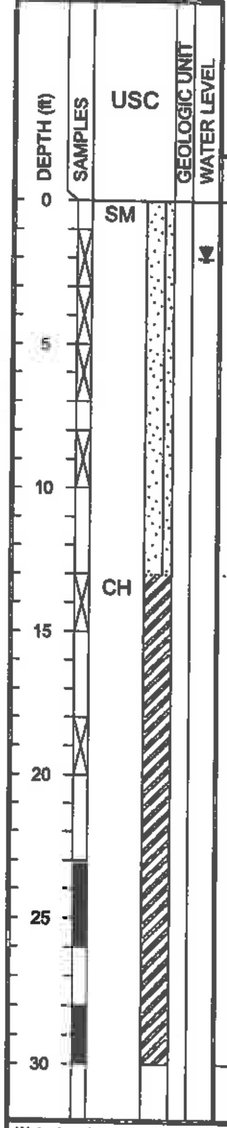
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

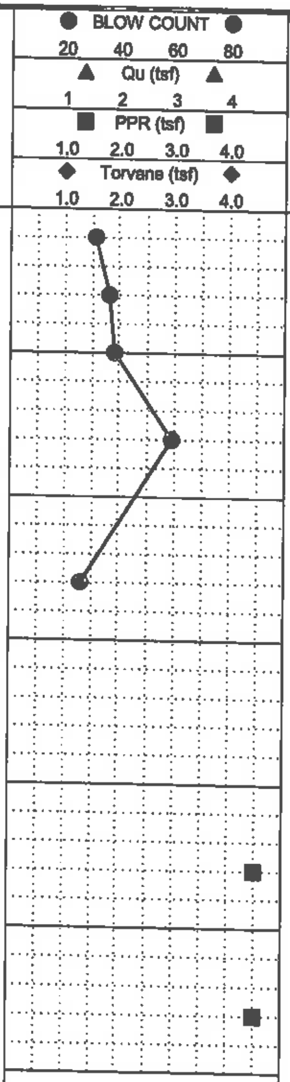
BORING TYPE: Flight Auger

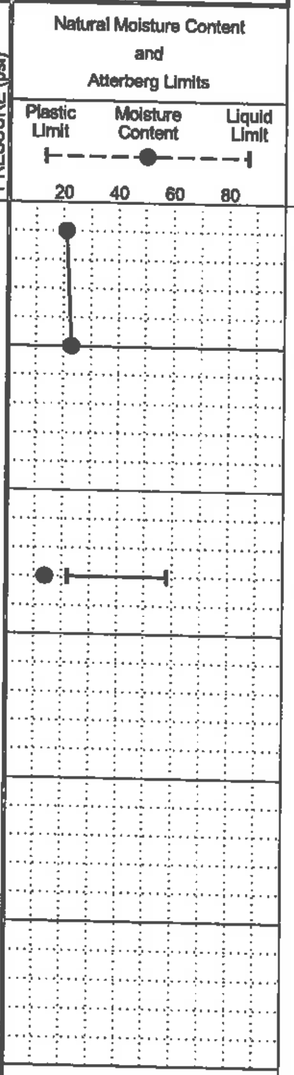
DATE 10/27/09

SURFACE ELEVATION 340.4



USC	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. #)
SM	▼	SILTY SAND(SM) dense; tan	N=31					21				21	+40 Sieve=0%, +4 Sieve=0%
			N=36										
		--gray; saturated	N=38					23				15	+40 Sieve=0%, +4 Sieve=0%
		--very dense	N=59										
CH		FAT CLAY(CH) very stiff; dark gray; with silt and ferric seams	N=26					14	58	22	36	98	+40 Sieve=0%, +4 Sieve=0%
		--hard; gray and black; with trace of lignite	P=4.5+										
		--gray											
			P=4.5+										
		Bottom of Boring @ 30'											





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

Water Observations: Seepage @ 4' while drilling. Water level @ 2' and open to 7' upon completion.

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

Notes:
GPS Coordinates: N 33°02.898', W 94°50.519'

Landfill Boring B-2

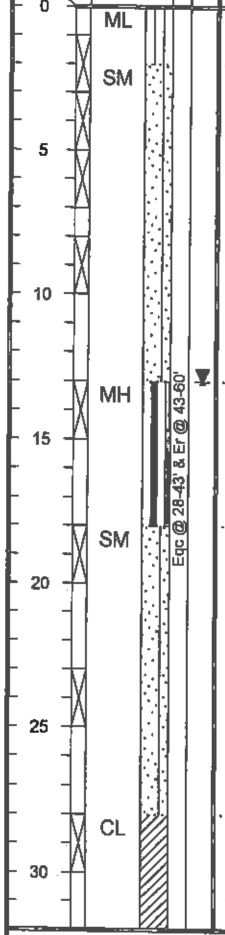
ETTL
ENGINEERS &
CONSULTANTS

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

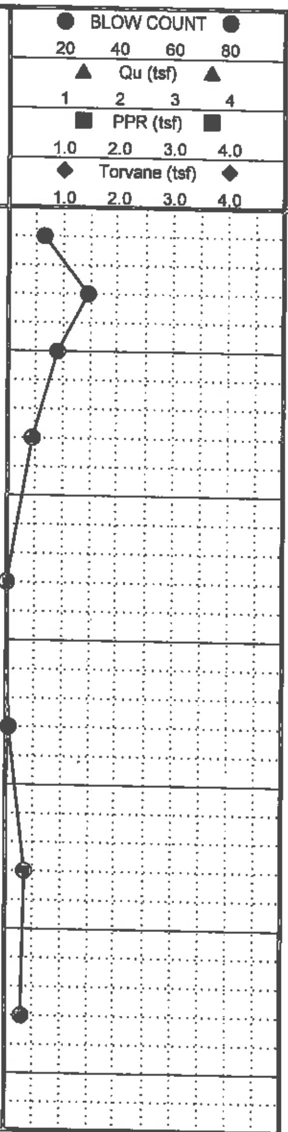
LOG OF BORING B-2

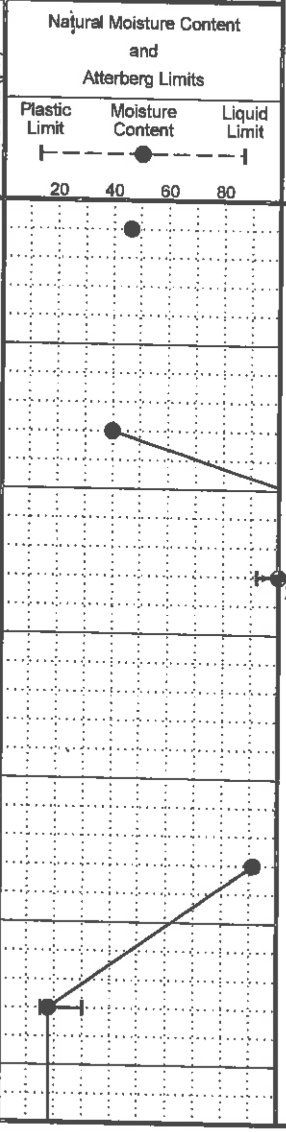
PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** B-61 HDX
PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.8



USC	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. #)
ML / SM	ASH (SILT WITH GRAVEL(ML)) medium dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=13					46				59	+40 Sieve=27% +4 Sieve=16%
		N=29										
	ASH (SILTY SAND(SM)) medium dense; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces	N=18										
	--loose; moist	N=9					40				40	+40 Sieve=19% +4 Sieve=2%
MH	ASH (ELASTIC SILT(MH)) very loose; black; with fine-grained sand and lightly cemented gravel pieces; saturated	N=0					200	134	92	42	100	+40 Sieve=0% +4 Sieve=0%
SM	ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=1										
	--loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					91				61	+40 Sieve=11% +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) medium stiff; dark brown and black; with fine-grained sand and cemented gravel pieces; saturated	N=6					18	30	15	15	63	+40 Sieve=1% +4 Sieve=0%





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

Water Observations: Water level @ 13'.

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

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

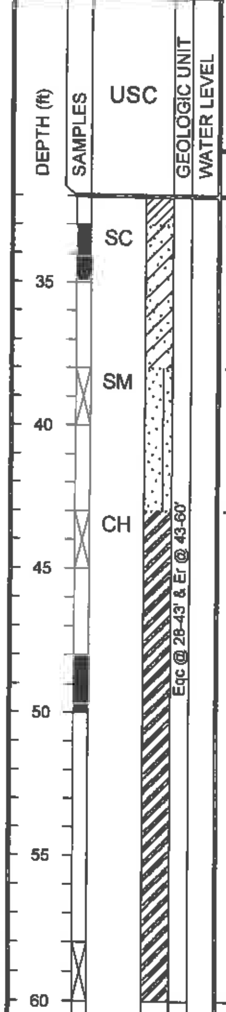
LOG OF BORING B-2 (cont.)

ETTL ENGINEERS & CONSULTANTS

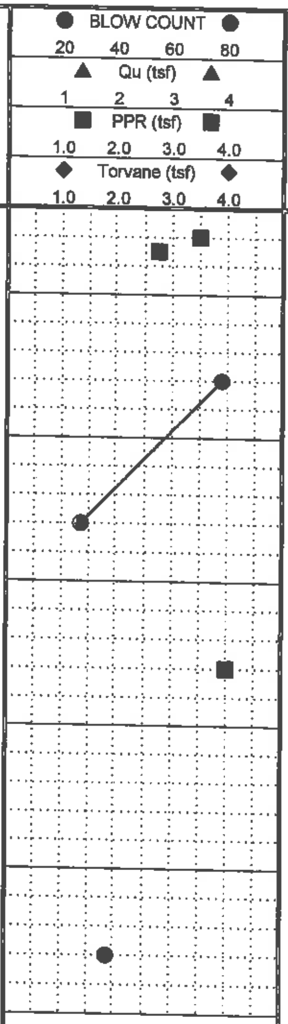
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

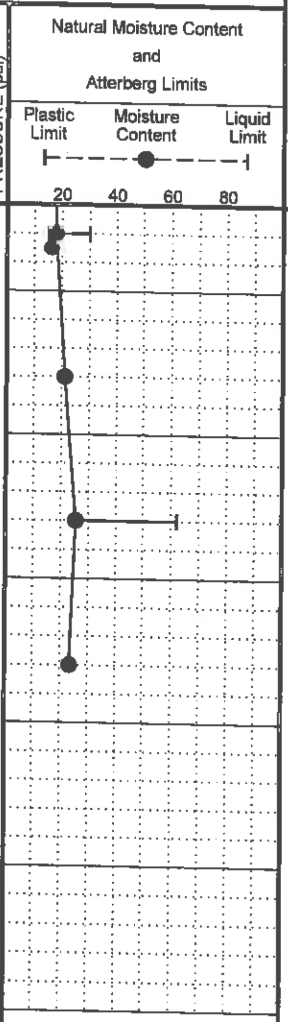
PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.8



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) dense; light brown, light gray and reddish brown; moist; with fine-grained sand; mottled	P=3.5 P=2.75	110	1.39	4.3	21	18 16	30	15	15	39	+40 Sieve=0% +4 Sieve=0%
SM	SILTY SAND(SM) very dense; light brown, yellowish brown and light gray; moist; mottled; with fine-grained sand	N=78					21				24	+40 Sieve=0% +4 Sieve=0%
CH	FAT CLAY(CH) very stiff; dark brown and light brown; moist; with sand seams; laminated	N=27					25	62	26	36	96	+40 Sieve=2% +4 Sieve=0%
	--dark brown with light gray; moist; with silt seams	P=4.0	98				24					
	--hard; dark brown; moist	N=37										
	Bottom of Boring @ 60'											





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

Water Observations: Water level @ 13'.

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

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

Landfill boring B-10

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-10

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

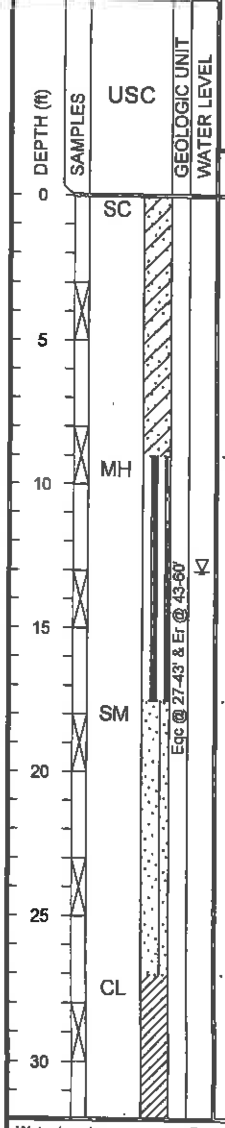
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

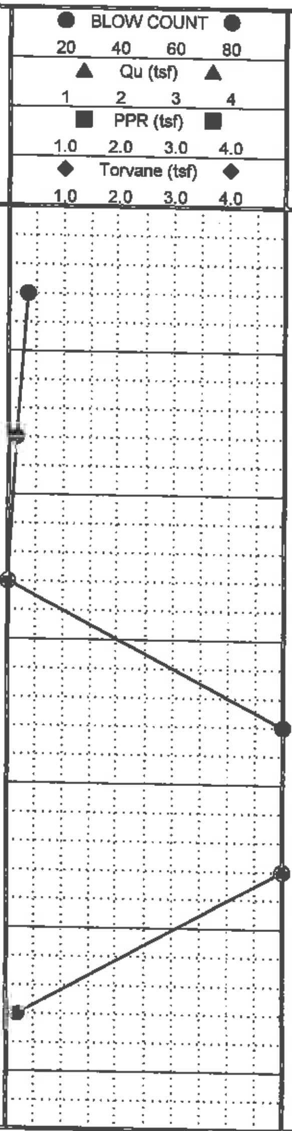
DATE 10/8/14

SURFACE ELEVATION 373.2

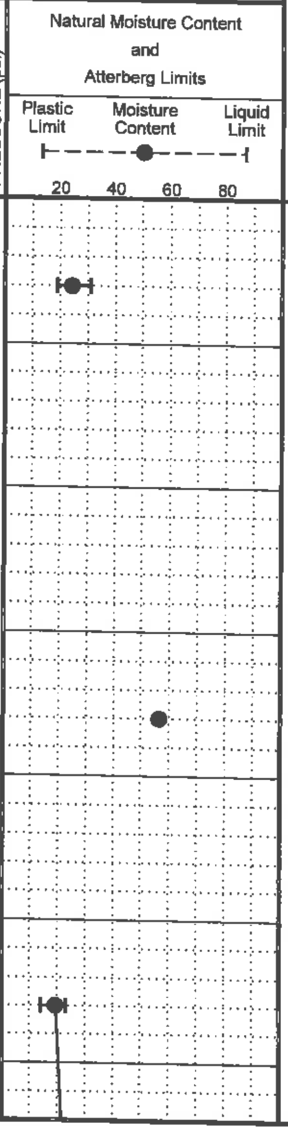


MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	ASH (CLAYEY SAND(SC)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7	24	31	19	12	41	+40 Sieve=21% +4 Sieve=11%
MH	ASH (ELASTIC SILT(MH)) very loose; black; moist	N=3						
	--wet	N=0						
SM	ASH (SILTY SAND WITH GRAVEL(SM)) very dense; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist; cemented layer from 17.5' to 21'	N=50/1"	56				14	+40 Sieve=71% +4 Sieve=28%
	--cemented layer from 23' to 27'	N=50/4"						
CL	SANDY LEAN CLAY(CL) medium stiff; grayish brown and yellowish brown; saturated; mottled	N=4	19	23	14	9	57	+40 Sieve=1% +4 Sieve=0%



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

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

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-10 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

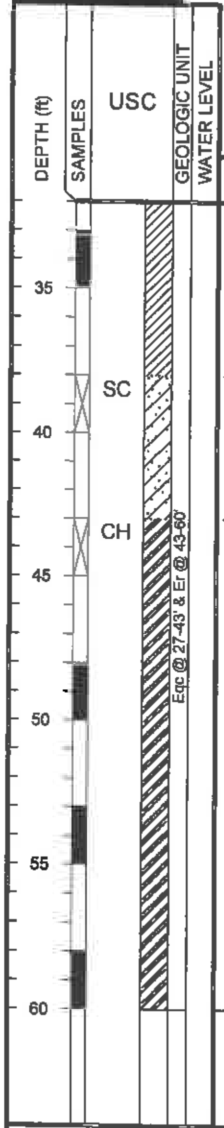
PROJECT NO.: G4207-146

DRILL RIG: B-61 HDX

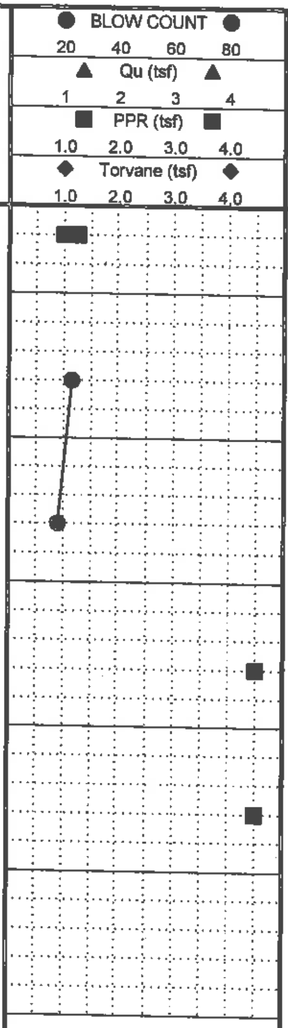
BORING TYPE: Rotary Wash/Flight Auger

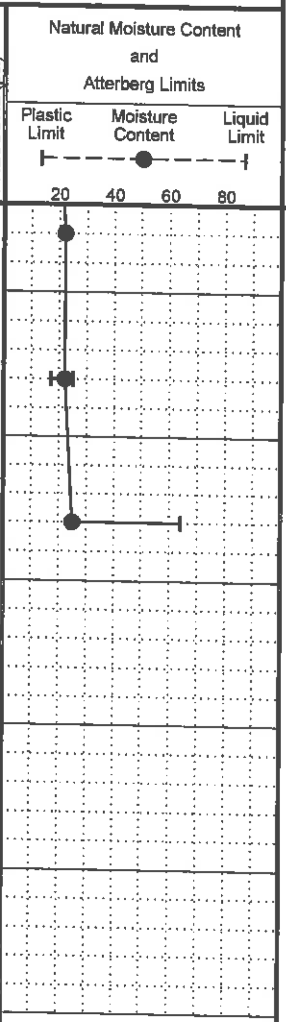
DATE 10/8/14

SURFACE ELEVATION 373.2



DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35			P=1.25 P=1.0	107	2.10	6.1	21	22					
40	SC	CLAYEY SAND(SC) medium dense; reddish brown and grayish brown; moist; mottled	N=23					22	25	17	8	27	+40 Sieve=3% +4 Sieve=0%
45	CH	FAT CLAY(CH) very stiff; dark brown with light gray; with silt seams; moist	N=18					25	64	24	40	90	+40 Sieve=7% +4 Sieve=0%
50		--hard	P=4.5+										
55			P=4.5+										
60		Bottom of Boring @ 60'											





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

Water Observations: Seepage @ 13' while drilling.

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

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

Landfill Boring B-12

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-12

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

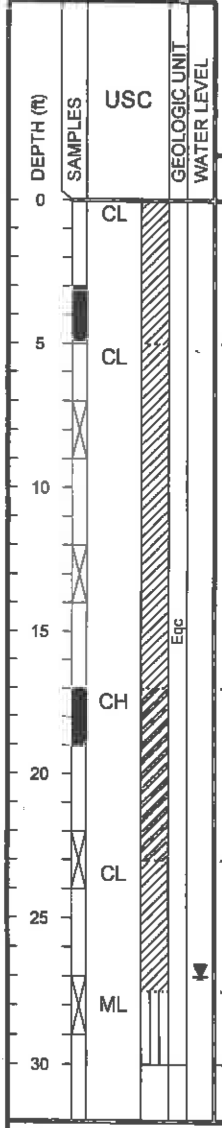
DRILL RIG:

PROJECT NO.: G4207-146

BORING TYPE: Flight Auger

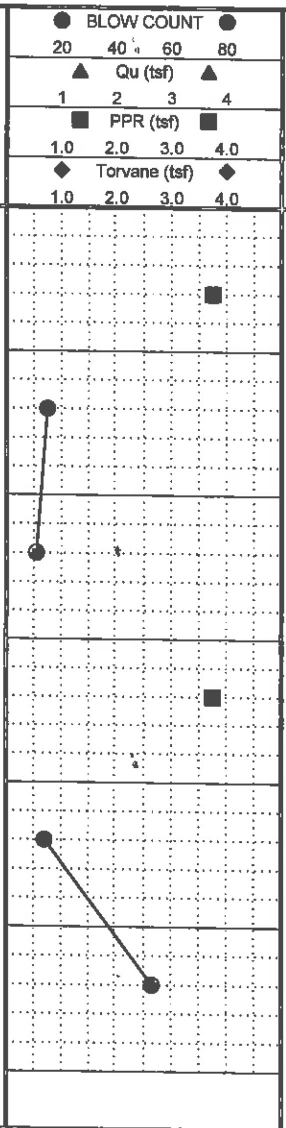
DATE 10/15/14

SURFACE ELEVATION 361.7

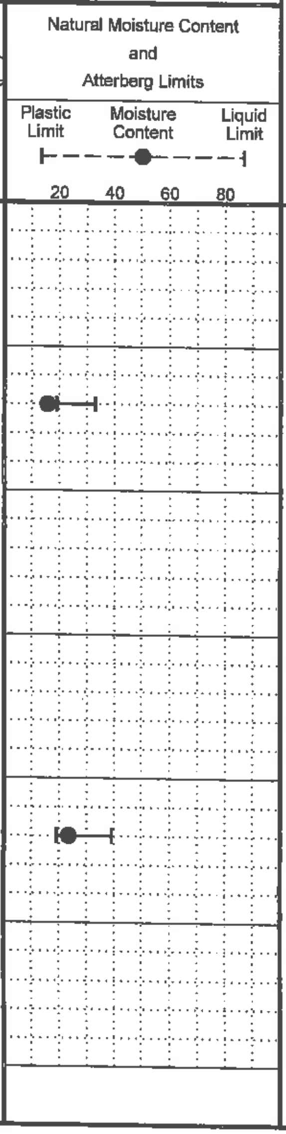


MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) stiff; light gray and reddish brown; moist; mottled	P=3.75						
CL	SANDY LEAN CLAY(CL) stiff; light brown, light gray and reddish brown; moist; mottled	N=15	16	33	19	14	58	+40 Sieve=1% +4 Sieve=0%
	--grayish brown and brown; moist	N=11						
CH	FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; moist; mottled; with ferric seams	P=3.75						
CL	LEAN CLAY(CL) stiff; light gray and brownish gray; moist; layered with silt	N=14	24	39	19	20	93	+40 Sieve=1% +4 Sieve=0%
ML	SILT WITH SAND(ML) very dense; light brown and yellowish brown; moist; with clay seams	N=53						
	Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



ATTERBERG LIMITS(%)

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

Water Observations: Water level @ 27' 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:

GPS Coordinates: N33.04713°, W94.84486°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Land RU Boring B-13

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-13

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

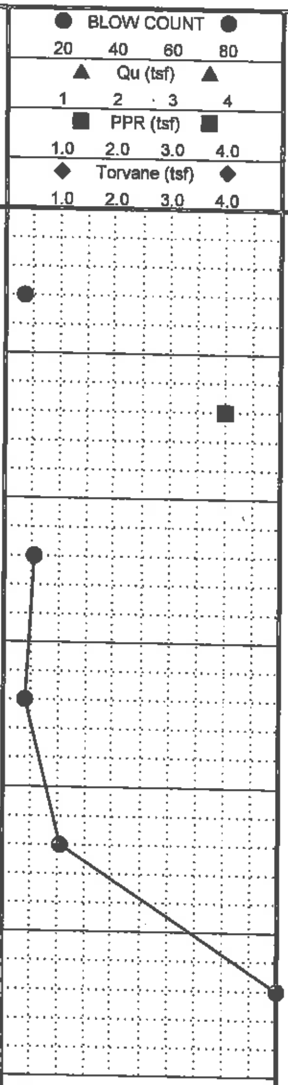
DRILL RIG:

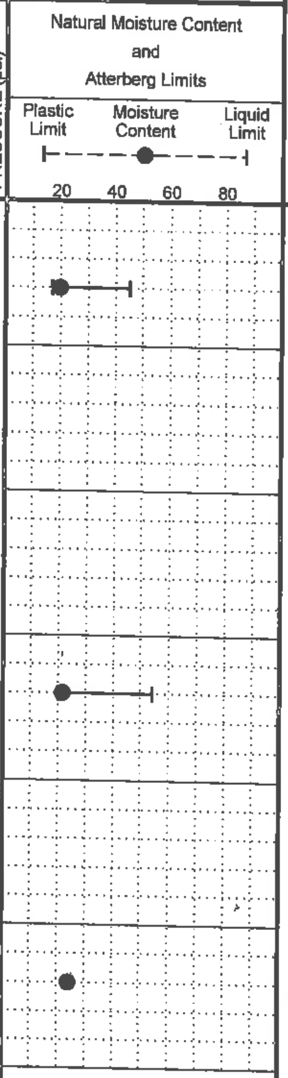
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.4

DEPTH (ft)	USC	GEOLOGIC UNIT	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0–8	CL	Eqc	LEAN CLAY WITH SAND(CL) medium stiff; reddish brown with light gray; moist	N=7	20	45	17	28	76	+40 Sieve=1% +4 Sieve=0%
	CL		SANDY LEAN CLAY(CL) very stiff; light brown, gray and reddish brown; moist; mottled	P=4.0						
	SC		CLAYEY SAND(SC) medium dense; grayish brown; moist							
	CH		FAT CLAY WITH SAND(CH) medium stiff; reddish brown and light gray; moist; mottled	N=11						
				N=8	22	54	20	34	79	+40 Sieve=1% +4 Sieve=0%
	CL		LEAN CLAY(CL) very stiff; light gray and grayish brown; moist; layered with silt	N=21						
	ML		SILT WITH SAND(ML) very dense; light gray and yellowish brown; wet; with clay seams	N=50/5"	24				80	+40 Sieve=0% +4 Sieve=0%
30			Bottom of Boring @ 30'							





DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

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

Water Observations: Water level @ 28' 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:

GPS Coordinates: N33.047160°, W94.84384°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-14

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-14

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

DRILL RIG:

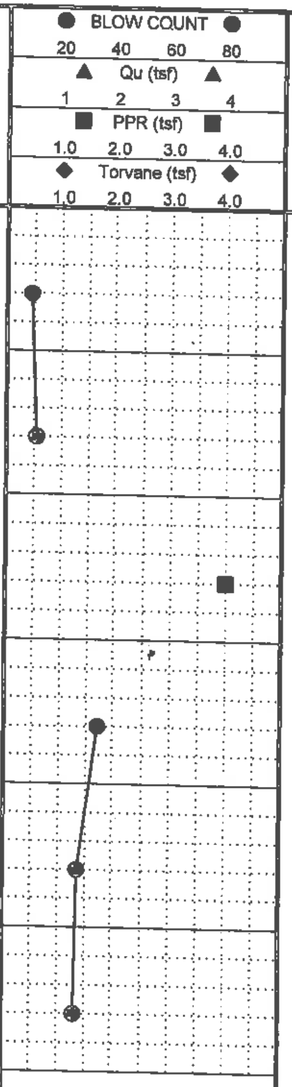
BORING TYPE: Flight Auger

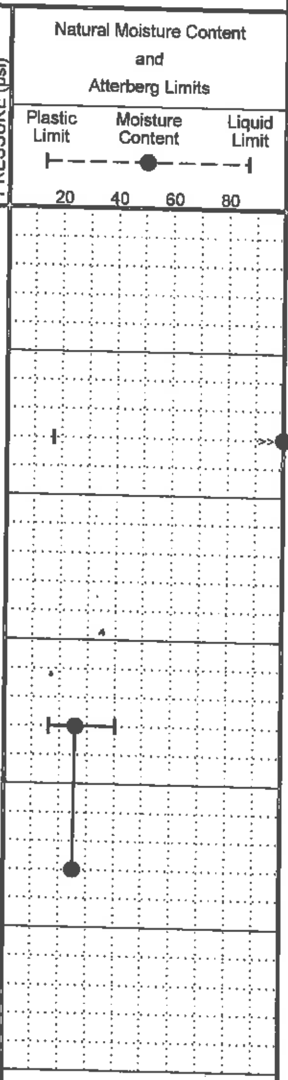
DATE 10/14/14

SURFACE ELEVATION 347.2

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) medium stiff; yellowish brown with reddish brown; dry; with clay seams	N=9										
8	ML	SANDY SILT(ML) medium dense; grayish brown; moist; with clay seams	N=11					108	17	17	NP	68	+40 Sieve=1% +4 Sieve=1%
13	CL	SANDY LEAN CLAY(CL) very stiff; light gray and gray; moist	P=4.0										
		–light gray and grayish brown; moist; layered with silt	N=34					26	40	16	24	67	+40 Sieve=1% +4 Sieve=0%
23	SP SM	POORLY GRADED SAND WITH SILT(SP-SM) medium dense; yellowish brown, light gray and reddish brown; wet	N=27					25				10	+40 Sieve=0% +4 Sieve=0%
28	CL	LEAN CLAY(CL) very stiff; dark brown; moist; with silt partings	N=26										
30		Bottom of Boring @ 30'											

GEOLOGIC UNIT: Eqc @ 0-28' & Er @ 28-30'





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 17' and caved to 23' upon completion.

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

Notes:

GPS Coordinates: N33.04774°, W94.84290°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-15

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-15

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

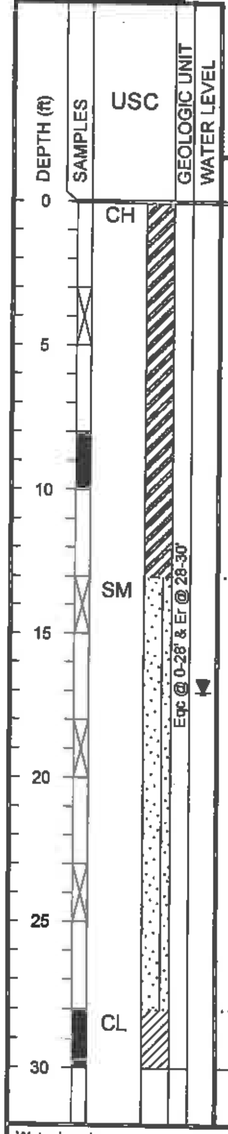
DRILL RIG:

PROJECT NO.: G4207-146

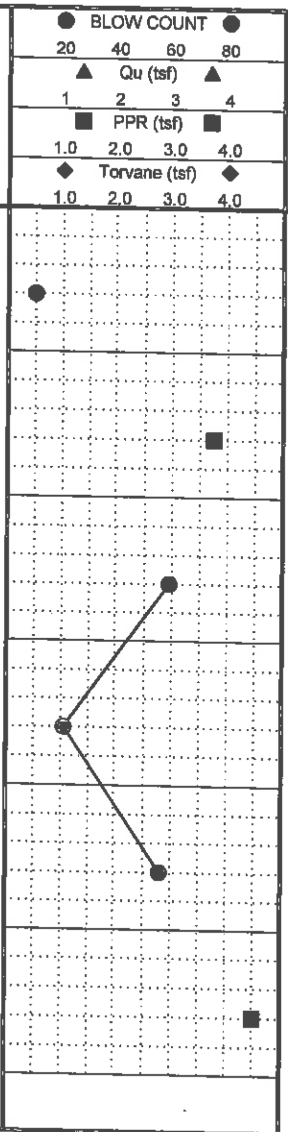
BORING TYPE: Flight Auger

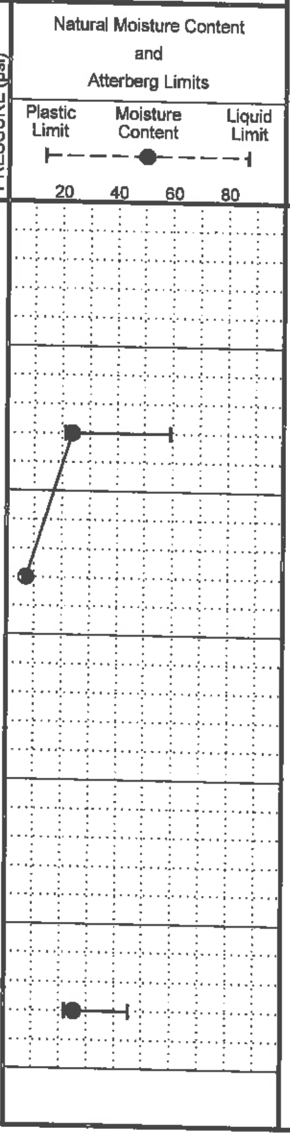
DATE 10/14/14

SURFACE ELEVATION 348.2



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY(CH) stiff; reddish brown and light gray; moist; mottled	N=10										
	--very stiff; light gray, grayish brown and reddish brown; moist; layered	P=3.75					24	59	21	38	85	+40 Sieve=0% +4 Sieve=0%
SM	SILTY SAND(SM) very dense; light brown; dry	N=59					7				12	+40 Sieve=0% +4 Sieve=0%
	--medium dense; wet	N=21										
	--very dense	N=56										
CL	LEAN CLAY(CL) hard; dark brown; moist; with silt partings	P=4.5					25	45	22	23	92	+40 Sieve=0% +4 Sieve=0%
	Bottom of Boring @ 30'											





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

Water Observations: Water level @ 17' and caved to 19' upon completion.

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

Notes:

GPS Coordinates: N33.04857°, W94.84286°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No.
1

Date:
8/20/2015

Direction Photo Taken:

North

Description:
Staging area west of landfill.

P8200493

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No.
2

Date:
8/20/2015

Direction Photo Taken:

South Southeast

Description:

Potential wetland on the top (west) end of the Primary Ash Pond.

P8200495

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 3

Date: 8/20/2015

Direction Photo Taken:

West Northwest

Description:

Ditch between road and railway west of landfill, this ditch would be non-jurisdictional.

P8200497

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 4

Date: 8/20/2015

Direction Photo Taken:

Northeast

Description:

Ground Water Monitoring Well AD-12 near northwest end of landfill.

P8200501

ARCADIS

PHOTOGRAPHIC LOG

Project Name:

AEP – J. ROBERT WELSH POWER PLANT

Location:

PITTSBURG, TITUS COUNTY, TEXAS

Project No.

OK001625.0001

Photo No.

5

Date:

8/20/2015

Direction Photo Taken:

East Northeast

Description:

View of plant from top of landfill. Primary ash pond is within the wooded area on left.

P8200506

ARCADIS

PHOTOGRAPHIC LOG

Project Name:

AEP – J. ROBERT WELSH POWER PLANT

Location:

PITTSBURG, TITUS COUNTY, TEXAS

Project No.

OK001625.0001

Photo No.

6

Date:

8/20/2015

Direction Photo Taken:

East Northeast

Description:

Drainage canal that drains from primary ash pond to clear water pond.

P8200510

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. **7**	**Date:** 8/20/2015

Direction Photo Taken:

West Northwest

Description:

Vegetated strip between landfill and road. This would be isolated due to lack of connectivity.

P8200521

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. **8**	**Date:** 8/20/2015

Direction Photo Taken:

North

Description:

Dike between landfill and primary ash pond. Facility in the background.

P8200522

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No.
9

Date:
8/20/2015

Direction Photo Taken:

West

Description:

Vegetated strip between landfill and road. This area would be isolated due to lack of connectivity.

P8200527

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No.
10

Date:
8/20/2015

Direction Photo Taken:

North Northeast

Description:

Road east of landfill running toward facility and clear water pond.

P8200530

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. **11**	**Date:** 8/20/2015

Direction Photo Taken:

South

Description:

Top of landfill.

P8200534

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. **12**	**Date:** 8/20/2015

Direction Photo Taken:

Southeast

Description:

View of lined bottom ash storage pond.

P8200538

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 13

Date: 8/20/2015

Direction Photo Taken:

Southeast

Description:

Lined bottom ash storage pond.

P8200545

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 14

Date: 8/20/2015

Direction Photo Taken:

South

Description:

Southside of lined bottom ash storage pond.

P8200547

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 15

Date: 8/20/2015

Direction Photo Taken:

West

Description:

East side of lined bottom ash storage pond.

P8200560

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 16

Date: 8/20/2015

Direction Photo Taken:

North

Description:

Upland with pine and ground water monitoring well AD-2 south of lined bottom ash storage pond.

P8200563

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 17

Date: 8/20/2015

Direction Photo Taken:

Description:

Outflow of water from plant into the northeast portion of the Primary Ash Pond.

P8200577

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 18

Date: 8/20/2015

Direction Photo Taken:

South Southwest

Description:

Northeast portion of primary ash pond, view facing south-southwest.

P8200578

American Electric Power Service Corporation

Landfill - CCR Groundwater Monitoring Well Network Evaluation

J. Robert Welsh Power Plant
1187 County Road 4865
Titus County
Pittsburg, Texas

February 5, 2018

ARCADIS

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

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Project Manager

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John Holm, P.E.
Professional Engineer

Landfill - CCR Groundwater Monitoring Well Network Evaluation

J. Robert Welsh Power Plant
1187County Road 4865
Titus County
Pittsburg, Texas

Prepared for:
AEP

Prepared by:
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Our Ref.:
OH015976.0011

Date:
February 5, 2018

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 existing landfill (CCR Unit) at the AEP J. Robert Welsh Generating Plant (Plant) located at 1187 County Road 4865 in Pittsburg, Titus 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.

Three regulated CCR units associated with the Plant were identified for review, which include the primary bottom ash pond, existing landfill, and bottom ash storage pond (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the existing landfill (landfill). The evaluation of 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 landfill CCR unit, as well as publicly-available geologic and hydrogeologic data. This 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

This section provides background information for the AEP Welsh Generating Plant landfill.

2.1 Facility Location Description

The AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The landfill CCR unit is located approximately 2,000 feet southwest of the Plant generating units, directly south of the primary bottom ash pond CCR unit, and approximately 800 feet west of the Welsh Reservoir (**Figures 1** and **2**).

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 placed into operation in approximately 1977, and is located in a topographically high area south of the primary bottom ash pond. The landfill is approximately 40 acres in size, and is located directly above native clayey soils. The base of the landfill ranges in elevation from approximately 355 feet amsl on the west side to 345 feet amsl on the east side. These landfill base elevations were confirmed by soil borings installed through the landfill in 2014 (ETTL, 2015).

The western two thirds of the landfill is used as a temporary storage and processing area for marketable CCR that is sold for beneficial reuse including road base material. The eastern third of the landfill is an approximate 13-acre active ash disposal area where ash is placed above the base of the landfill to a top surface elevation that currently ranges from approximately 364 to 380 feet amsl.

Ash material had previously been placed into the landfill against an earthen embankment with 2:1 side slopes (2 feet horizontal, 1 foot vertical). However, to reduce the potential for slope failure, the side slopes of the landfill embankment were re-graded to 3:1 (3 feet horizontal, 1 foot vertical) in 2010.

2.2.2 Area/Volume

The landfill occupies an area of approximately 40 acres. A capacity analysis of the landfill was conducted by AEP in 2008 (AEP, 2008). The capacity analysis concluded the landfill has a maximum ash storage capacity of approximately 1,770,000 cubic yards beyond April 2008. Based on soil borings installed through the landfill (ETTL, 2015), the maximum ash thickness is approximately 33 feet, and the average ash thickness within the 40-acre landfill is approximately 20 feet. This corresponds to a current ash volume of approximately 800 acre-feet (1,290,000 cubic yards).

2.2.3 Construction and Operational History

The AEP J. Robert Welsh Plant began operations in 1977 with three coal-fired generating units (Units 1, 2, and 3). Throughout the life of the generating plant, CCR materials (fly ash, bottom ash, economizer ash) have been generated. All of these byproducts were stored in the primary bottom ash pond and in the landfill that was constructed in the late 1970's. In 2000, the 22-acre bottom ash storage pond was installed south of the landfill (**Figure 3**).

The landfill received fly ash, bottom ash, and economizer ash from the generating plant. The ash was sluiced to the landfill between approximately 1982 and 2000. Currently, dry ash is trucked to the landfill. The landfill is also utilized for disposal of ash dredged from the bottom ash storage pond that was constructed in 2000. The ash is currently stored in the eastern third of the landfill, and the western two thirds of the landfill is currently used as a temporary storage and processing area for marketable ash material that is sold for beneficial reuse, loaded into trucks, and transported offsite for reuse (highway road base, etc.).

2.2.4 Surface Water Control

Surface water flow within the landfill is controlled by drainage ditches at the north and east toes of the landfill. Surface water in the drainage ditches flows to a culvert at the northeast corner of the landfill, then discharges into the primary ash pond directly north of the landfill.

2.3 Previous Investigations

The initial soils investigation for the site was provided in a 1973 report prepared by McClelland Engineers, Inc. entitled "*Soils Investigation, Welsh Power Plant, Cason,* *Texas*". This investigation included advancement of soil borings in the primary bottom ash pond area, and geotechnical soil testing to characterize the area encompassed by the primary bottom ash pond.

In 2001, five monitoring wells (AD-1 through AD-5) were installed in the area of the primary bottom ash pond and bottom ash storage pond to obtain hydrologic data for the uppermost water-bearing unit. Twelve additional monitoring wells (AD-4a, AD-4b, AD-4c, AD-6 through AD-14) were installed in the area of the primary bottom ash pond, bottom ash storage pond, and landfill by Eagle Environmental Services in 2009 to obtain more detailed hydrologic data for the uppermost water-bearing unit. Monitoring well completion diagrams are provided in **Appendix A.**

In 2015, ETTL conducted a *Geotechnical Investigation* of the Landfill (ETTL, 2015). The report concluded the risk of slope failure due to liquefaction is very low, and recommended regrading of the top surface of the existing ash at the southeast corner of the landfill to eliminate ponding of surface water. The report also recommended dredged ash be spread out to drain water prior to placement in the landfill, emplacement of a 3-foot-thick clay cap on the existing side slopes in the eastern third of the landfill on a 3:1 slope (3 feet horizontal, 1 foot vertical), and improve drainage along the toe of the eastern third of the landfill using either horizontal drains at the toe of the slope or trenches containing perforated pipe with a geotextile cover.

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant by installation of monitoring wells AD-15 through AD-18 (Auckland Consulting, 2016). Monitoring well completion diagrams are provided in **Appendix A.**

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 Site is located on the outcrop of the Eocene-age Recklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966).

These features are further illustrated on five lines of cross section that were prepared through the 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').

2.4.1 Climate and Water Budget

The climate of Titus County, Texas is moist subhumid. The average January temperature is 45˚ Fahrenheit (F), and the average July temperature is 82.9˚F. The mean annual growing season is 228 days (Broom, 1965). Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches according to weatherdb.com.

2.4.2 Regional and Local Geologic Setting

The Site is located on the outcrop of the Eocene-age Recklaw Formation, which consists of very fine to fine grained sand and clay (Flawn, 1966). The Recklaw Formation attains a thickness of approximately 110 feet in Titus County, and is underlain by the Eocene-age Carrizo Sand which consists of fine to coarse sand, silt, and clay (Broom, 1965). In the topographically low areas underling the Welsh Reservoir to the east of the landfill, Quarternary alluvial sediments associated with Swauano Creek are present (Flawn, 1966).

Detailed regional geologic characterization can be found in several published reports including Texas Water Commission Bulletin 6517 "*Ground-Water Resources of Camp, Franklin, Morris and Titus Counties, Texas*" (Broom, 1965), and The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Texarkana Sheet*" (Flawn, 1966).

Detailed regional and site geologic characterization can be found in the 2015 ETTL report entitled "*Geotechnical Investigation, Phase 1 Landfill Seepage Evaluation and Vertical Expansion, Pittsburg, Texas"* (ETTL, 2015).

2.4.3 Surface Water and Surface Water Groundwater Interactions

The Site is generally less than one-half mile from Swauano Creek, which was dammed near the southern end of the site during plant development to form the Welsh Reservoir. Groundwater flow direction at the Site is generally from west to east, following surface topography towards the Welsh Reservoir. The Welsh Reservoir is likely a gaining surface water feature, and groundwater elevations on site are higher than the normal stage elevation of the Welsh Reservoir (approximately 320 feet amsl).

Figure 9 and **Figure 10** are potentiometric surface maps for the uppermost aquifer at the Site based on March 2016 and February 2017 water level data, respectively. Water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figures 9** and **10**, a hydraulic ridge is present in the uppermost aquifer in the area of monitoring well AD-12 at the west end of the landfill. Shallow groundwater flow often follows surface topography, and the hydraulic ridge location corresponds to a topographically high area of the Site. Shallow groundwater flow direction at the landfill is northeasterly to easterly toward the Welsh Reservoir at an average hydraulic gradient of approximately 0.01 foot per foot. Shallow groundwater flow directly west of the landfill in the area of monitoring well AD-17 is westerly toward a topographically low-lying area west of monitoring well AD-17.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed one water well within a ½-mile radius of the Site (Banks, 2013). The water well is located on-site to the northwest (up gradient) of the landfill, and was installed for Southwestern Electric Company in 1974 with screens from 515 to 535 feet below ground surface, and plugged at a later date.

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 upgradient and down gradient of the Site. The upgradient 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 and monitoring wells installed at the site show the uppermost aquifer in the area of the landfill is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 10 feet that is located between an average elevation of approximately 325 and 335 feet amsl (**Appendix A**). The base of the landfill is at an elevation of approximately 345 to 355 feet amsl. This separation distance is further illustrated on cross section B-B’ (**Figure 5)** and cross section D-D’ (**Figure 7)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration and locally from ash pond use. 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 10 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 2017. The most recent comprehensive groundwater data set from February 2017 is depicted on **Figure 10**. A hydraulic ridge is present in the uppermost aquifer in the area of monitoring well AD-12 at the west end of the landfill. The hydraulic ridge extends northerly from AD-12 toward monitoring well AD-18, which is located hydraulically sidegradient of the landfill. Shallow groundwater flow direction at the landfill is easterly toward the Welsh Reservoir at an average hydraulic gradient of approximately 0.01 foot per foot. Shallow groundwater flow directly west of the landfill in the area of monitoring well AD-17 is westerly toward a topographically low-lying area west of monitoring well AD-17.

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 below the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified on-Site hydrostratigraphic unit in the area of the landfill is the very fine to fine grained clayey and silty sand stratum that is located between an elevation of approximately 325 and 335 feet amsl. This unit is not used locally for groundwater supply or industrial water use, but meets the TCEQ definition of a useable aquifer.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 20, 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 20, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-11 through AD-14 were previously installed at the Site to monitor the uppermost aquifer (very fine to fine grained clayey and silty sand stratum) associated with the landfill. As discussed above in Section 3.1.1, the uppermost aquifer below the landfill is approximately 10 feet thick and is located between an elevation of approximately 325 and 335 feet amsl. In addition to these four monitoring wells, several soil borings were installed through the landfill as part of the ETTL geotechnical investigation of the landfill embankments (ETTL, 2015). These soil borings confirmed the presence of the uppermost aquifer beneath the landfill between an average elevation of approximately 325 and 335 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on the monitoring well completion diagrams in **Appendix A** and Geologic Cross Sections B-B’ (**Figure 5**) and E-E’ (**Figure 8**), existing monitoring wells AD-11, AD-13, and AD-14 are screened in the uppermost aquifer down gradient (east) of the landfill. These three monitoring wells will be utilized as down gradient monitoring wells for the landfill groundwater monitoring system. Existing monitoring wells AD-1 and AD-5 are screened in the uppermost aquifer south and north, respectively, of the landfill. As shown on **Figures 9** and **10**, the groundwater flow path at the landfill is easterly toward the Welsh Reservoir, and monitoring wells AD-1 and AD-5 are not within this groundwater flow path. Therefore, monitoring wells AD-1 and AD-5 will be utilized as background (upgradient) monitoring wells to collect background water quality data for the landfill.

As shown on **Figure 3** and Geologic Cross Section B-B’ (**Figure 5**), existing monitoring well AD-12 is located in the upgradient (west) portion of the landfill, but is located within the landfill boundaries as confirmed by the presence of ash material in the uppermost 10 feet of the boring. Therefore, due to the presence of ash material at the AD-12 location, this monitoring well will not be utilized as an upgradient monitoring well. This data gap was addressed by installation of new monitoring wells AD-17 and AD-18 outside of the landfill boundary approximately 500 feet west and 700 feet northwest, respectively, of monitoring well AD-12. As shown on **Figures 9** and **10**, monitoring well AD-17 is located west of the hydraulic ridge along the western boundary of the landfill that extends north toward monitoring well AD-18. Therefore, monitoring well AD-17 will be utilized as a background (upgradient) monitoring well for the landfill groundwater monitoring system. Monitoring well AD-18 is located along the hydraulic ridge in uppermost aquifer in the western portion of the Site, and is therefore side gradient of the landfill. Therefore, monitoring well MW-18 may be utilized as a piezometer to obtain water level data for the uppermost aquifer. With the addition of monitoring wells AD-17 and AD-18 during December 2015, there are no data gaps remaining in the groundwater monitoring system for the landfill.

4. Recommended Monitoring Network and PE Certification

The recommended modifications to the existing groundwater monitoring well network are intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the landfill (upgradient 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

A total of three down gradient well locations (existing monitoring wells AD-11, AD-13 and AD-14) and three upgradient well locations (existing monitoring wells AD-1, AD-5 and AD-17) are recommended to establish a groundwater quality monitoring well network for the landfill. In addition, existing monitoring wells AD-12 and AD-18 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 3** and illustrated on **Figure 11.**

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 beneath the landfill between an average elevation of approximately 325 and 335 feet amsl. 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 beneath the landfill was addressed by installation of monitoring wells AD-17 and AD-18 during December 2015. Monitoring wells AD-17 and AD-18 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**.

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

Signature

KENNETH J. BRANDNER
69586

69586	TX	2-5-18
Registration No.	Registration State	Date

5. References

AEP. 2015. Soil Boring Logs AD-1 through AD-14.

Auckland Consulting LLC, “Monitoring Well Installation – 2015, Welsh Generating Station, Pittsburg, Texas”, January 26, 2016.

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Tables

Table 1
Water Level Data
AEP J. Robert Welsh Power Plant - CCR Storage Areas
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Top of Casing Elevation	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen		Bottom of Screen		6/7/2011	12/6/2011	5/2/2012	11/1/2012	5/14/2013	11/19/2013	5/12/2014	11/16/2014	5/12/2015	3/4/2016	5/26/2016	7/27/2016	10/19/2016	12/12/2016	1/17/2017	2/23/2017
									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	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																												
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	357.57	25.0	1/11/01	Sch. 40 PVC	2	15.0	340.57	25.0	330.57	338.46	334.92	337.88	337.18	337.43	336.73	338.03	337.64	340.82	342.83	344.89	342.89	341.23	340.58	341.18	339.74
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	346.16	25.0	4/26/01	Sch. 40 PVC	2	15.0	329.16	25.0	319.16	330.16	329.07	330.00	329.26	329.83	329.70	330.09	329.69	332.56	332.32	---	---	---	---	---	---
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	333.10	17.0	4/26/01	Sch. 40 PVC	2	7.0	324.10	17.0	314.10	323.81	323.19	323.99	323.29	323.77	323.98	324.12	323.28	325.58	325.12	324.59	323.70	323.47	323.78	325.04	324.92
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	342.61	30.0	4/26/01	Sch. 40 PVC	2	19.0	321.61	29.0	311.61	324.81	324.84	324.62	324.40	324.74	325.52	325.44	325.13	327.00	326.90	---	---	---	---	---	---
AD-4a (a)	33.04527	94.84258	340.19	342.85	30.0	9/22/09	Sch. 40 PVC	2	20.0	320.19	30.0	310.19	325.01	324.19	325.24	322.90	324.86	324.68	325.64	325.34	327.19	327.12	---	---	---	---	---	---
AD-4b (a)	33.04531	94.84230	329.55	333.23	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.55	15.0	314.55	324.35	324.32	324.50	324.30	324.30	325.21	325.22	324.90	326.58	326.67	---	---	---	---	---	---
AD-4c (a)	33.04507	94.84244	329.15	333.28	15.0	9/23/09	Sch. 40 PVC	2	5.0	324.15	15.0	314.15	324.18	324.50	324.64	324.37	324.11	325.06	325.01	324.71	326.50	326.19	325.89	324.01	323.76	325.07	326.39	324.89
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	351.00	30.0	1/11/01	Sch. 40 PVC	2	20.0	329.00	30.0	319.00	336.34	336.58	336.82	336.99	336.78	336.47	336.80	336.01	339.07	338.04	337.62	337.24	337.74	337.01	338.34	336.17
AD-6 (a)	33.05235	94.84757	343.31	346.33	33.0	9/23/09	Sch. 40 PVC	2	23.0	320.31	33.0	310.31	333.04	333.02	332.83	333.02	333.11	332.81	333.11	332.81	333.38	334.00	---	---	---	---	---	---
AD-7 (a)	33.05257	94.84219	347.86	350.82	38.0	9/24/09	Sch. 40 PVC	2	28.0	319.86	38.0	309.86	334.32	334.12	334.19	334.20	334.13	334.58	333.77	333.98	334.09	333.61	---	---	---	---	---	---
AD-8 (a)	33.05187	94.84026	337.53	340.01	29.0	9/21/09	Sch. 40 PVC	2	16.0	321.53	26.0	311.53	325.41	324.09	325.69	325.15	325.79	325.75	325.98	325.77	326.05	325.70	325.68	325.05	325.29	325.92	326.76	324.27
AD-9 (a)	33.04995	94.84196	340.32	343.09	35.0	9/21/09	Sch. 40 PVC	2	20.0	320.32	35.0	305.32	328.46	328.53	328.63	328.44	328.74	329.38	NM	330.18	329.98	329.74	329.28	329.53	328.92	329.31	330.50	328.05
AD-10 (a)	33.04881	94.84047	340.23	343.01	35.0	9/22/09	Sch. 40 PVC	2	20.0	320.23	35.0	305.23	323.44	322.55	323.27	323.35	323.51	323.76	323.57	323.88	323.95	323.55	---	---	---	---	---	---
AD-11 (a)	33.04824	94.84177	339.61	342.18	20.0	9/22/09	Sch. 40 PVC	2	10.0	329.61	20.0	319.61	327.99	328.37	327.82	327.93	327.94	328.13	328.20	327.97	328.96	328.13	328.39	328.14	327.87	328.20	328.90	328.25
AD-12 (a)	33.04901	94.84977	366.27	369.33	30.0	9/24/09	Sch. 40 PVC	2	20.0	346.27	30.0	336.27	348.30	348.29	349.86	349.56	349.99	349.65	349.89	350.01	350.65	350.39	---	---	---	---	---	---
AD-13 (a)	33.04918	94.84275	344.12	347.00	20.0	9/22/09	Sch. 40 PVC	2	6.0	338.12	16.0	328.12	332.36	332.24	333.09	332.26	332.68	333.25	333.35	332.01	337.58	334.76	334.54	332.93	332.39	332.84	334.54	331.83
AD-14 (a)	33.04715	94.84256	342.32	345.43	19.0	9/22/09	Sch. 40 PVC	2	8.0	334.32	18.0	324.32	330.40	329.80	331.67	330.34	330.94	331.69	332.12	330.17	336.63	334.83	334.51	331.71	330.94	330.79	332.63	330.87
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	343.29	46.0	12/12/15	Sch. 40 PVC	2	25.5	314.71	45.5	294.71	---	---	---	---	---	---	---	---	---	322.14	321.93	321.28	321.42	321.71	321.64	322.81
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	353.97	21.0	12/10/15	Sch. 40 PVC	2	11.0	339.86	21.0	329.86	---	---	---	---	---	---	---	---	---	337.09	335.84	332.14	331.52	331.43	330.96	330.71
AD-16R(e)	33° 02' 49"	94° 50' 28.9"	350.55	353.49	27.0	4/12/17	Sch. 40 PVC	2	12.0	338.55	27.0	323.55	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	357.10	40.0	12/10/15	Sch. 40 PVC	2	24.0	329.99	39.0	314.99	---	---	---	---	---	---	---	---	---	334.64	334.26	334.30	334.45	334.64	334.05	333.94
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	349.28	29.0	12/11/15	Sch. 40 PVC	2	14.0	332.17	29.0	317.17	---	---	---	---	---	---	---	---	---	343.66	343.26	340.81	339.92	339.38	338.97	340.38
Piezometers																												
B-2 (b)	33° 03.078'	94° 50.449'	339.7	339.7	50.0	10/28/09	Sch. 40 PVC	2	10.0	329.70	20.0	319.70	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-4 (b)	33° 03.011'	94° 50.462'	340.6	340.6	50.0	10/27/09	Sch. 40 PVC	2	8.0	332.60	18.0	322.60	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-5 (b)	33° 02.964'	94° 50.428'	340.0	340.0	50.0	10/27/09	Sch. 40 PVC	2	10.0	330.00	20.0	320.00	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
B-6 (b)	33° 02.912'	94° 50.462'	340.1	340.1	50.0	10/28/09	Sch. 40 PVC	2	12.0	328.10	22.0	318.10	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

NM - Not measured.
(a) Source: Eagle Environmental Services Well Logs (2009).
(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).
(c) Source: Southwest Electric Power, State of Texas Well Report (2001).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.
(e) Monitoring well installed by ARCADIS on April 12, 2017 as a replacement for monitoring well AD-16.
Groundwater Elevation Source: AEP, Shallow Groundwater Data Summary through February 2017.

Table 2
Well Construction Details
AEP J. Robert Welsh Power Plant - CCR Units
Pittsburg, Titus County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen		Bottom of Screen	
								Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
<u>Monitoring Wells</u>															
AD-1 (c)	33° 02' 48"	94° 50' 47"	355.57	25.0	1/11/2001	PVC	2	13	343	25	331	15.0	340.57	25.0	330.57
AD-2 (c)	33° 02' 37"	94° 50' 44"	344.16	25.0	4/26/2001	PVC	2	12	332	25	319	15.0	329.16	25.0	319.16
AD-3 (c)	33° 02' 38"	94° 50' 37"	331.10	17.0	4/26/2001	PVC	2	5	326	17	314	7.0	324.10	17.0	314.10
AD-4 (c)	33° 02' 43"	94° 50' 33"	340.61	30.0	4/26/2001	PVC	2	16	325	30	311	19.0	321.61	29.0	311.61
AD-4a (a)	33.04527	94.84258	340.19	30.0	9/22/2009	PVC	2	17	323	30	310	20.0	320.19	30.0	310.19
AD-4b (a)	33.04531	94.84230	329.55	15.0	9/23/2009	PVC	2	4	326	15	315	5.0	324.55	15.0	314.55
AD-4c (a)	33.04507	94.84244	329.15	15.0	9/23/2009	PVC	2	4	325	15	314	5.0	324.15	15.0	314.15
AD-5 (c)	33° 03' 13"	94° 51' 00"	349.00	30.0	1/11/2001	PVC	2	16	333	30	319	20.0	329.00	30.0	319.00
AD-6 (a)	33.05235	94.84757	343.31	33.0	9/23/2009	PVC	2	21	322	33	310	23.0	320.31	33.0	310.31
AD-7 (a)	33.05257	94.84219	347.86	38.0	9/24/2009	PVC	2	26	322	38	310	28.0	319.86	38.0	309.86
AD-8 (a)	33.05187	94.84026	337.53	29.0	9/21/2009	PVC	2	14	324	29	309	16.0	321.53	26.0	311.53
AD-9 (a)	33.04995	94.84196	340.32	35.0	9/21/2009	PVC	2	18	322	35	305	20.0	320.32	35.0	305.32
AD-10 (a)	33.04881	94.84047	340.23	35.0	9/22/2009	PVC	2	18	322	35	305	20.0	320.23	35.0	305.23
AD-11 (a)	33.04824	94.84177	339.61	20.0	9/22/2009	PVC	2	8	332	20	320	10.0	329.61	20.0	319.61
AD-12 (a)	33.04901	94.84977	366.27	30.0	9/24/2009	PVC	2	18	348	30	336	20.0	346.27	30.0	336.27
AD-13 (a)	33.04918	94.84275	344.12	20.0	9/22/2009	PVC	2	4	340	20	324	6.0	338.12	16.0	328.12
AD-14 (a)	33.04715	94.84256	342.32	19.0	9/22/2009	PVC	2	6	336	18	324	8.0	334.32	18.0	324.32
AD-15 (d)	33° 03' 04"	94° 50' 27"	340.21	46.0	12/12/15	PVC	2	22	318	45.5	295	25.5	314.71	45.5	294.71
AD-16R	33° 02' 49"	94° 50' 29"	350.55	27.0	4/12/17	PVC	2	10	341	27	324	12.0	338.55	27.0	323.55
AD-17 (d)	33° 02' 57"	94° 51' 06"	353.99	40.0	12/10/15	PVC	2	22	332	39	315	24.0	329.99	39.0	314.99
AD-18 (d)	33° 03' 03"	94° 51' 03"	346.17	29.0	12/11/15	PVC	2	12	334	29	317	14.0	332.17	29.0	317.17
<u>Piezometers</u>															
B-2 (b)	33° 03.078'	94° 50.449'	339.7	50.0	10/28/2009	PVC	2	8	332	20	320	10.0	329.70	20.0	319.70
B-4 (b)	33° 03.011'	94° 50.462'	340.6	50.0	10/27/2009	PVC	2	8	333	18	323	8.0	332.60	18.0	322.60
B-5 (b)	33° 02.964'	94° 50.428'	340.0	50.0	10/27/2009	PVC	2	5	335	20	320	10.0	330.00	20.0	320.00
B-6 (b)	33° 02.912'	94° 50.462'	340.1	50.0	10/28/2009	PVC	2	4	336	22	318	12.0	328.10	22.0	318.10
AD-16 (d)	33° 02' 49"	94° 50' 29"	350.86	21.0	12/10/15	PVC	2	9	342	21	330	11.0	339.86	21.0	329.86

General Notes:
Elevation in feet above mean sea level.

Footnotes:
(a) Source: Eagle Environmental Services Well Logs (2009).
(b) Source: ETTL Engineers & Consultants Inc. (June 21, 2010).
(c) Source: Southwest Electric Power, State of Texas Well Report (2001).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-15 through AD-18 installed during December 2015.
Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP J. Robert Welsh Power Plant - Landfill
Pittsburg, Titus 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-1	Existing	Uppermost Water-Bearing Unit	South of Landfill	Upgradient	340.6	330.6	10	Existing well installed in 2001; well will be utilitzed to establish backgroud water quality
AD-5	Existing	Uppermost Water-Bearing Unit	NW of Landfill	Upgradient	329.0	319.0	10	Existing well installed in 2001; well will be utilitzed to establish backgroud water quality
AD-17	Existing	Uppermost Water-Bearing Unit	West of Landfill	Upgradient	330.0	315.0	15	New monitoring well installed during December 2015 in uppermost shallow aquifer west of Landfill - upgradient; well will be utilized to establish background water quality
Downgradient								
AD-11	Existing	Uppermost Water-Bearing Unit	East of Landfill	Down gradient	329.6	319.6	10	Existing well installed in 2009; uppermost shallow aquifer adjacent to the landfill - downgradient
AD-13	Existing	Uppermost Water-Bearing Unit	East of Landfill	Down gradient	338.1	328.1	10	Existing well installed in 2009; uppermost shallow aquifer adjacent to the landfill - downgradient
AD-14	Existing	Uppermost Water-Bearing Unit	East of Landfill	Down gradient	334.3	324.3	10	Existing well installed in 2009; uppermost shallow aquifer adjacent to the landfill - downgradient
Piezometers								
AD-12	Existing	Uppermost Water-Bearing Unit	Within Landfill Boundary	Upgradient	346.3	336.3	10	Existing well installed in 2009; and utilitzed to obtain water level data for uppermost water-bearing unit
AD-18	Existing	Uppermost Water-Bearing Unit	NW of Landfill	Side gradient	332.2	317.2	15	New monitoring well installed during December 2015 in uppermost shallow aquifer sidegradient of Landfill: will be utilized to obtain water level data for uppermost water-bearing unit.

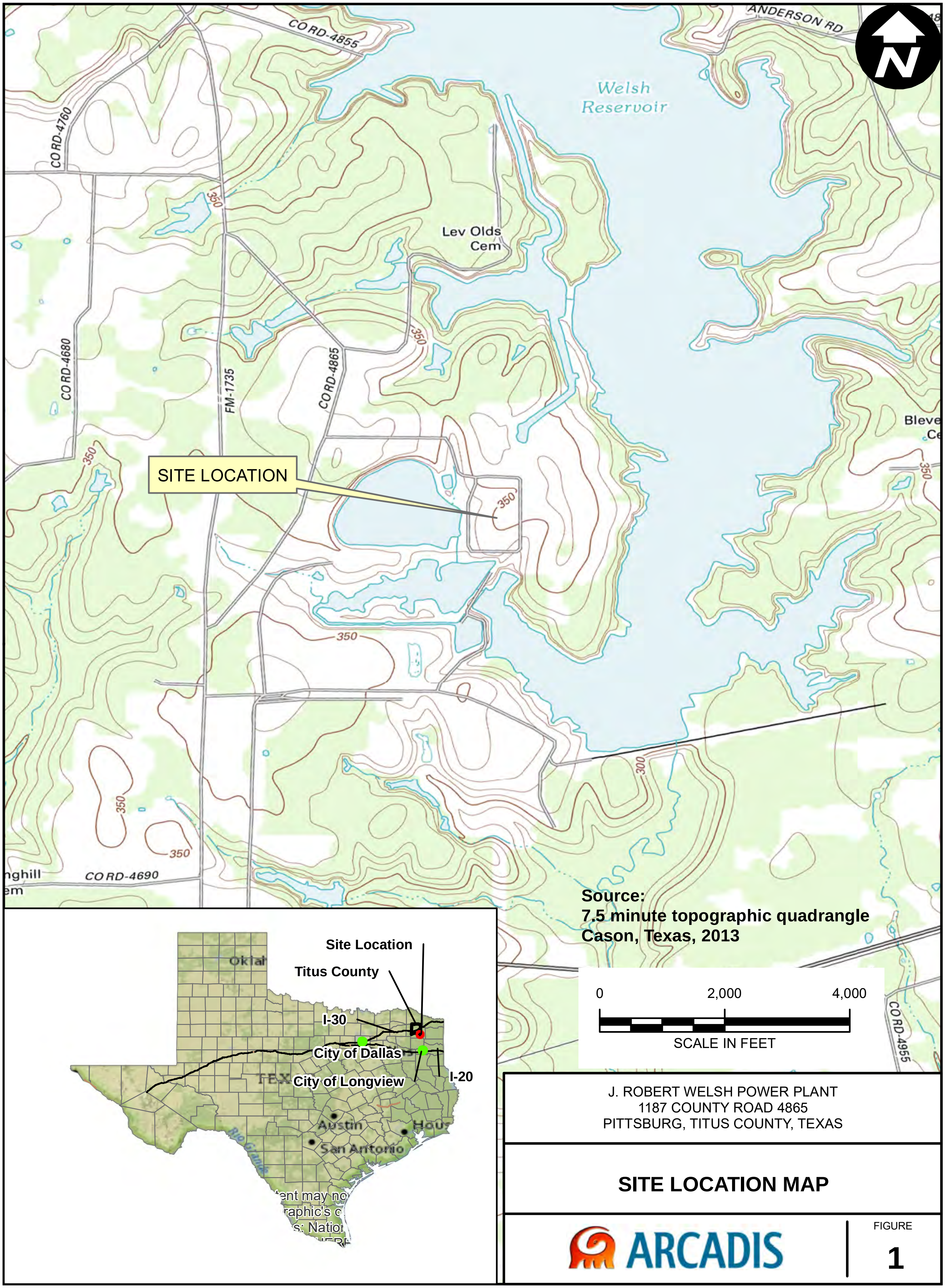
Footnotes:

a. Target elevations are an estimated range.

Acronyms and Abbreviations:

U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Cason, Texas, 2013

0 2,000 4,000
SCALE IN FEET

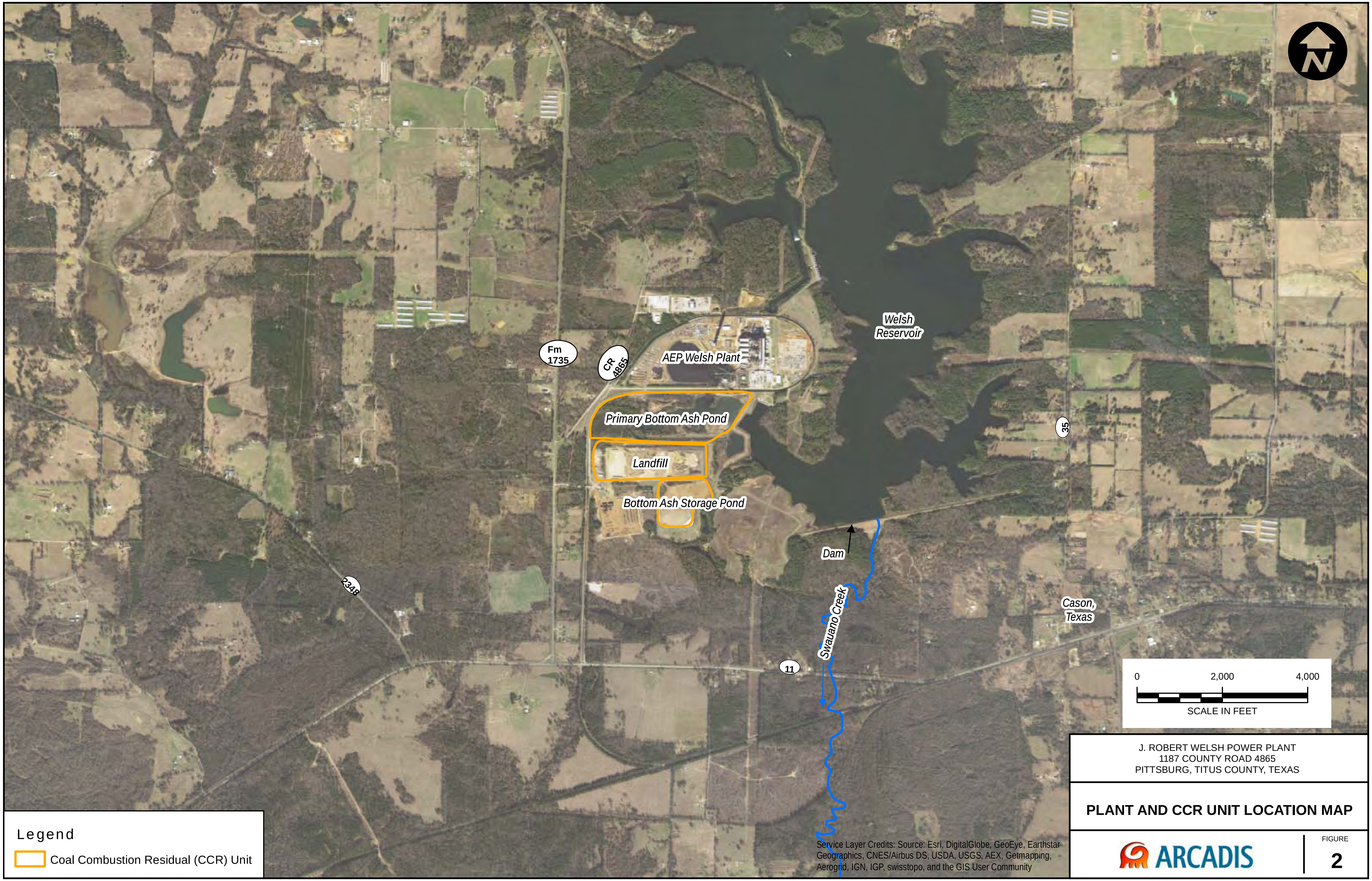
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 1 - site map.mxd



Legend

🟧 Coal Combustion Residual (CCR) Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

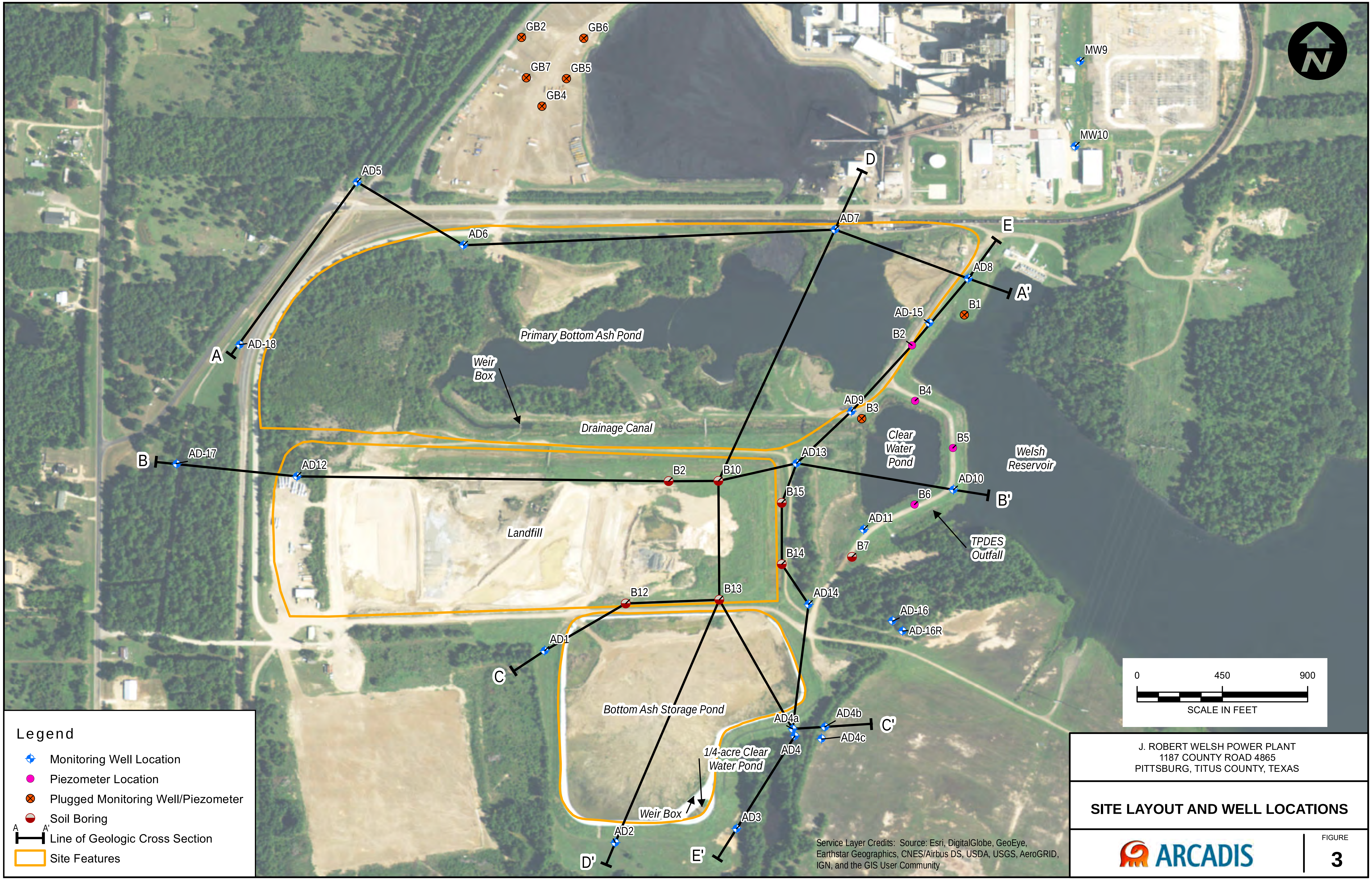
PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 2 - CCR location.mxd

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 3 - site layout.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

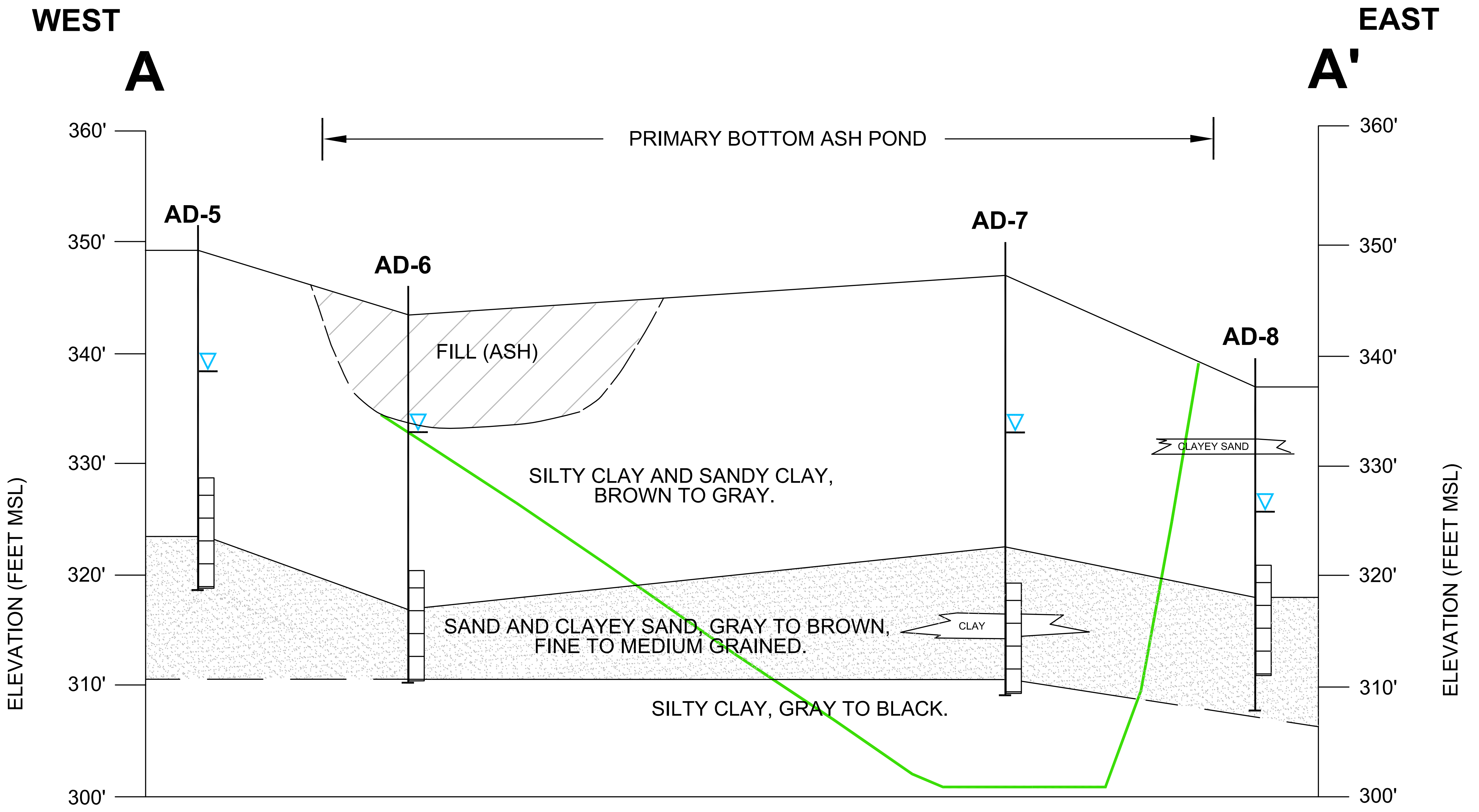
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond WELL Network Evaluation\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 8/26/2015 9:53 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
---- PLOTTED: 6/23/2016 10:35 AM BY: LEASE, DIANA



0 ▬ 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

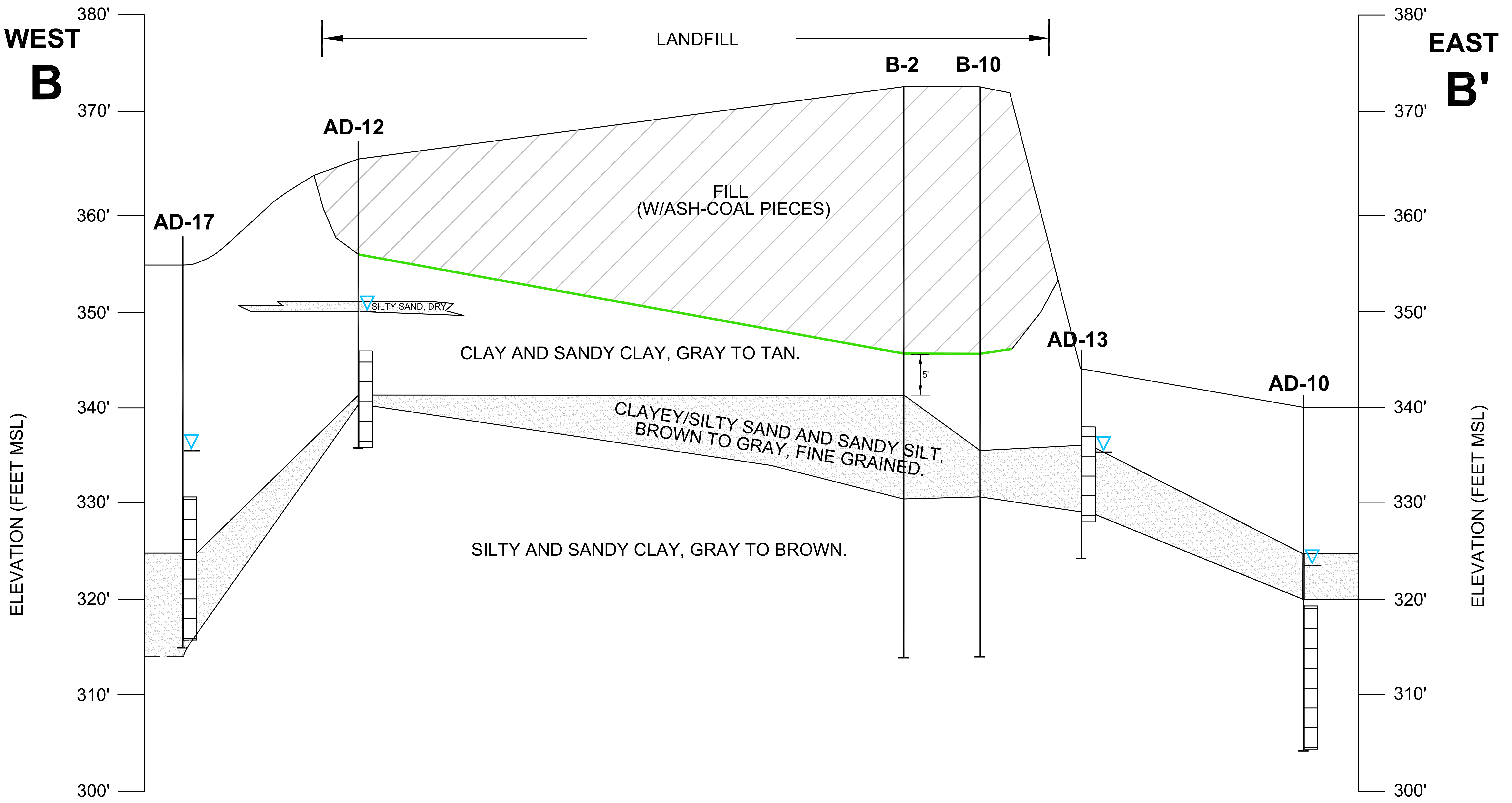
▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
▬	PROJECTED BASE OF ASH POND (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4



0 300'
HORIZONTAL SCALE

NOTE: BASE OF LANDFILL ELEVATION TAKEN FROM "WELSH POWER PLANT- UNIT 1 FLY ASH STORAGE AREA PHASE I" DRAWING ID WEPX-88, DATED 12/3/76.

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
🟩	BASE OF LANDFILL (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 3/11/2016 10:54 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ----
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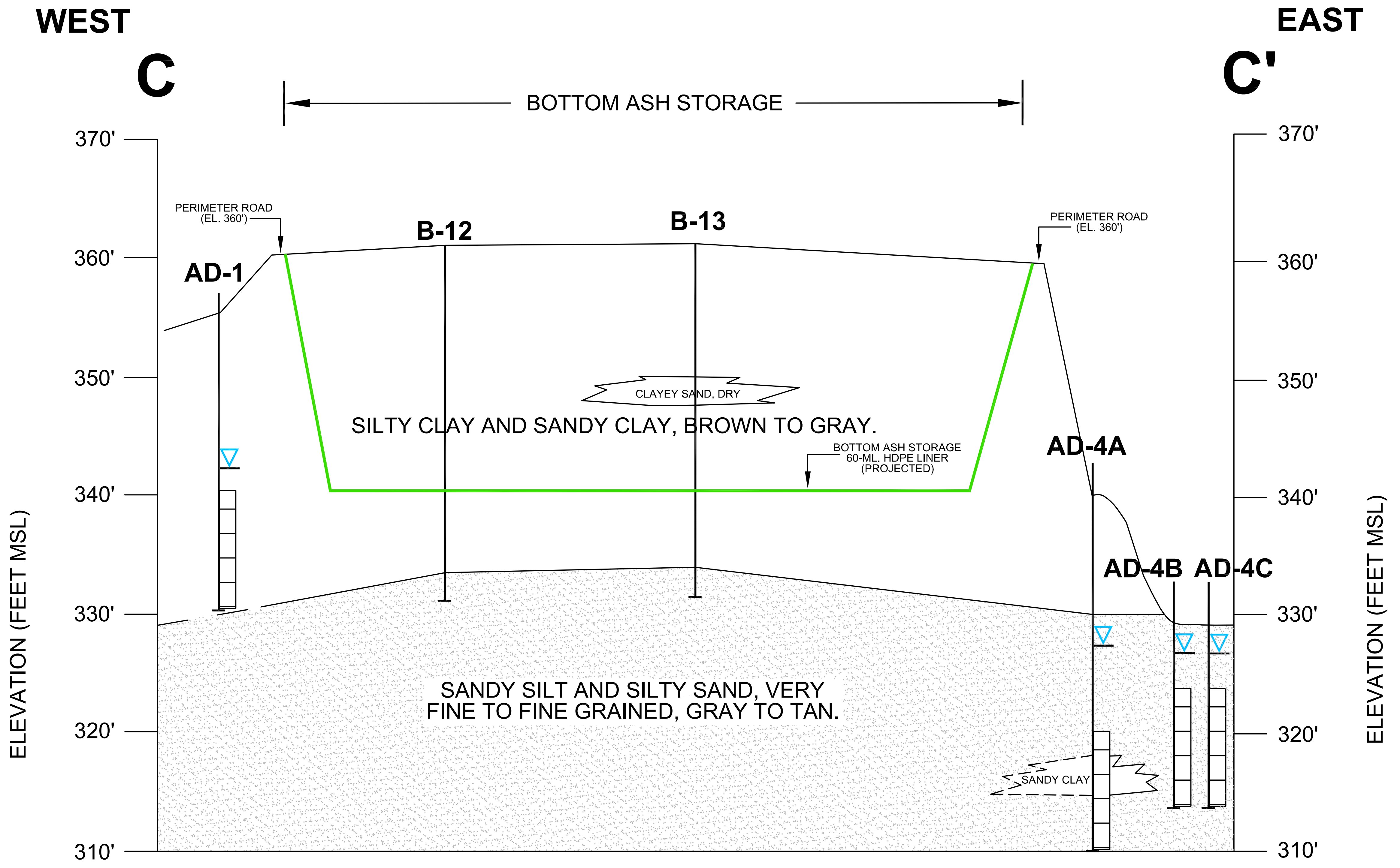


0 200'
HORIZONTAL SCALE

NOTE: BASE OF BOTTOM ASH STORAGE HAS A 60-ML. HDPE LINER AT ELEVATION 340.0', TAKEN FROM FREESE AND NICHOLS "HYDRAULIC ANALYSIS OF WELSH POWER PLANT ASH PONDS, AMERICAN ELECTRIC POWER COMPANY", DATED DECEMBER 2010.

LEGEND

☐	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
🟩	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

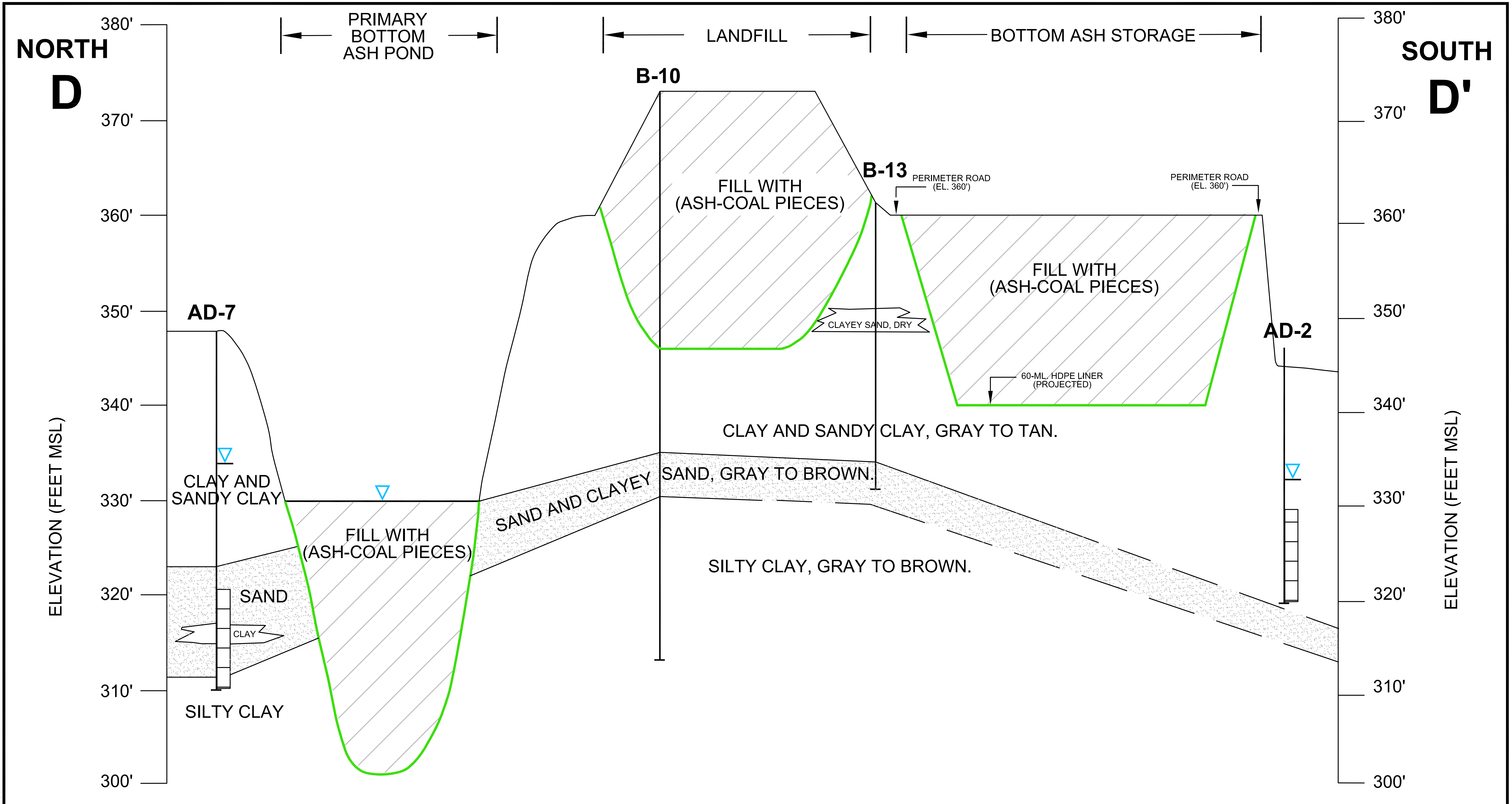
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

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\Welsh Power Plant\2016 Final Reports\Primary Ash Pond WELL Network Evaluation\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 8/26/2015 10:07 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 6/23/2016 10:39 AM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

NOTE: BASE OF PRIMARY BOTTOM ASH POND TAKEN FROM "WELSH POWER PLANT-UNIT 1 FLY ASH STORAGE AREA PHASE I " DRAWING ID WEPX-88, DATED 12-3-76; AND U.S. GEOLOGICAL SURVEY 7 1/2 MINUTE SERIES TOPOGRAPHIC MAP, CASON, TX QUADRANGLE, 1964 (PHOTO REVISED 1980).

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (5/12/15)
—	BASE OF CCR UNIT

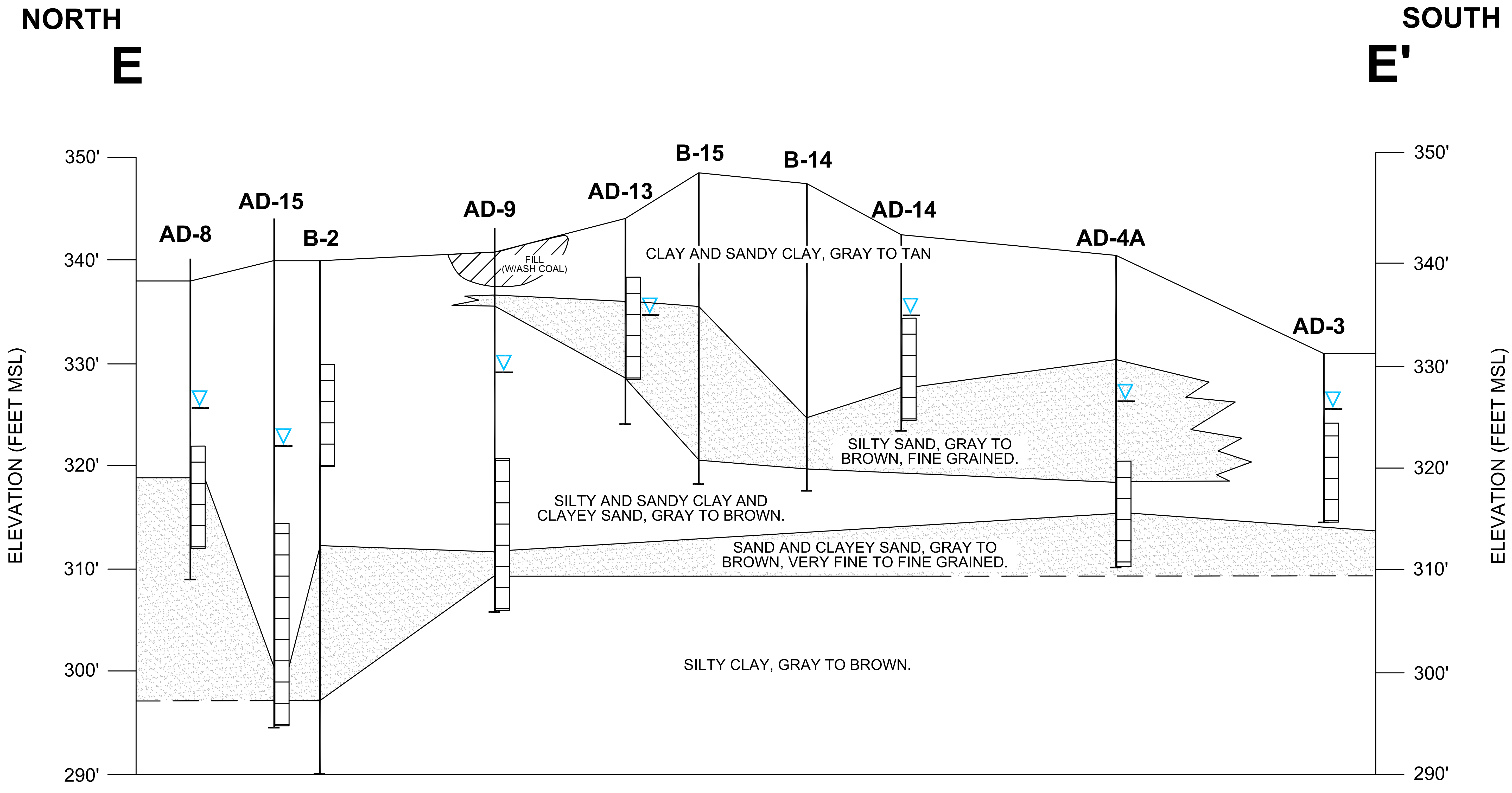
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Welsh Power Plant\2016 Final Reports\Primary Ash Pond Location Restriction Report\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 3/11/2016 12:06 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
---- PLOTTED: 3/11/2016 12:52 PM BY: LEASE, DIANA



LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (3/4/16)
—	PROJECTED BASE OF ASH STORAGE (SEE NOTE)

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8

Legend

⌖	Monitoring Well Location
●	Piezometer Location
⊗	Plugged Monitoring Well/Piezometer
◒	Soil Boring
▭	Site Features
340.82	Water Level Elevation (feet MSL)
—	Groundwater Contour
→	Groundwater Flow Direction

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

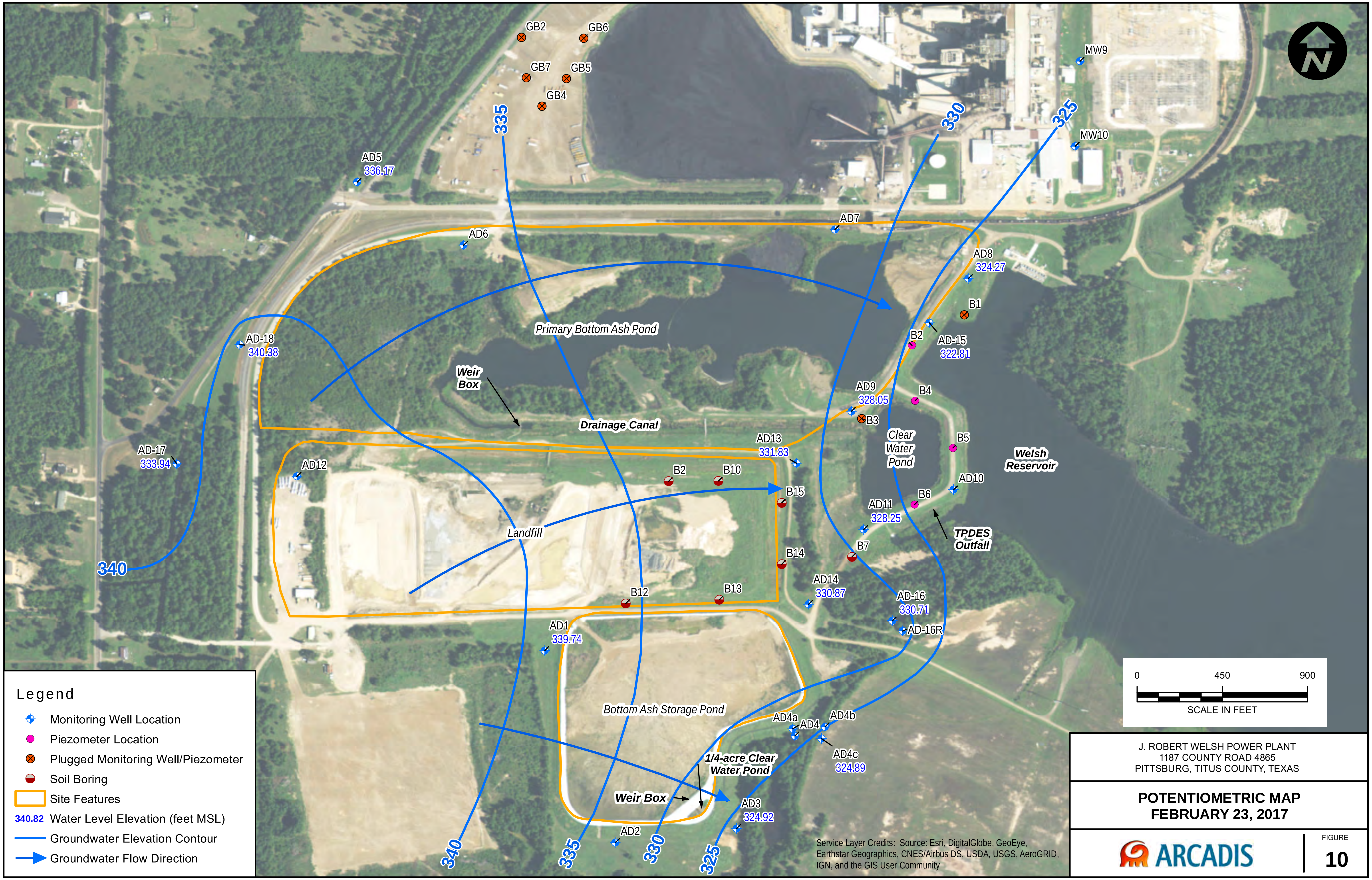
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP MARCH 4, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 9 - Mar2016_POT.mxd



Legend

- ⊕ Monitoring Well Location
- ● Piezometer Location
- ⊗ Plugged Monitoring Well/Piezometer
- ◒ Soil Boring
- ▭ Site Features
- **340.82** Water Level Elevation (feet MSL)
- — Groundwater Elevation Contour
- → Groundwater Flow Direction

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

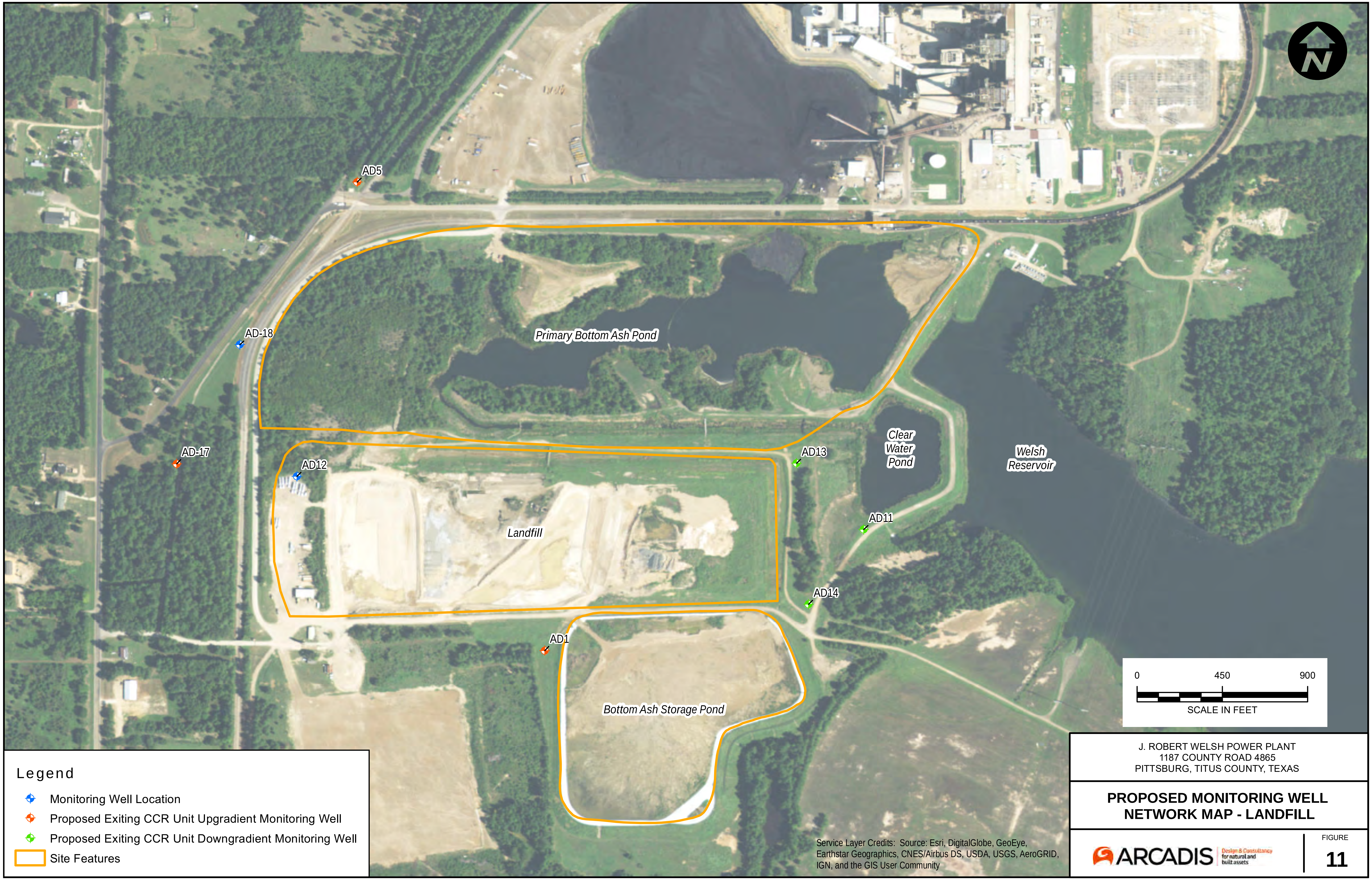
J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

POTENTIOMETRIC MAP
FEBRUARY 23, 2017

ARCADIS

FIGURE
10

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\fig 10 - Feb2017_POT.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

J. ROBERT WELSH POWER PLANT
1187 COUNTY ROAD 4865
PITTSBURG, TITUS COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP - LANDFILL

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11

Document Path: Z:\GISProjects_ENV\AEP\Welsh Plant\MXD\Landfill report\Dec2017Update\fig 11 - proposed wells_v2.mxd

ARCADIS

Boring/Well Construction Logs

AD-1

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) TX (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4, Box 221 (Street, RFD or other) Pittsburg (City) TX (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33° 02' 48" N
94° 50' 47" W
N↑

6) WELL LOG:
Date Drilling:
Started 1-11 19 2001
Completed 1-11 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	25

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

From (ft.)	To (ft.)	Description and color of formation material
0	25	gray silty clay with some hard red streaks
		AP-1

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______
If Gravel Packed give interval ... from 13 ft. to 25 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	15	sch 40
2	N	#10 slot screen	15	25	sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 13 ft. to 0 ft. No. of sacks used 6-50#
______ ft. to ______ ft. No. of sacks used ______
Method used bentonite
Cemented by ______
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level 12' 8" ft. below land surface Date 1-11-01
Artesian flow ______ gpm. Date ______

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ______ (Type or print) WELL DRILLER'S LICENSE NO. TX-52694-M

ADDRESS ______ (Street or RFD) (City) (State) (Zip)

(Signed) ______ (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-2

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'37"N
94°50'44"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 19 2001
Completed 4/26 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	25

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

From (ft.)	To (ft.)	Description and color of formation material
0	2	top soil
2	5	red & gray clay w/ silt
5	10	red & gray clay w/ silt
10	25	gray silty clay w/ tan streaks
		AP-2

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______
If Gravel Packed give interval ... from 12 ft. to 25 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	15	Sch. 40
2	N	#10 slot screen	15	25	Sch. 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 12 ft. to +2 ft. No. of sacks used 5-50#
______ ft. to ______ ft. No. of sacks used ______
Method used bentonite pellets
Cemented by ______
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ______ (Type or print) WELL DRILLER'S LICENSE NO. TX-52694-M

ADDRESS ______ (Street or RFD) (City) (State) (Zip)

(Signed) Gilbert M. R (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-3

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County Camp Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check):
☒ New Well ☐ Deepening
☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33°02'38"N
94°50'37"W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 19 2001
Completed 4/26 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	17

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

From (ft.)	To (ft.)	Description and color of formation material
0	12	gray silty clay w/tan streaks
12	15	very stiff gray/blood red clay
15	17	Very stiff gray clay w/ red nodules and tan streaks

AP-3

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______
If Gravel Packed give interval ... from 5 ft. to 17 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	7	Sch 40
2	N	#10 slot screen	7	17	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 2 ft. to 5 ft. No. of sacks used 2 1/2 - 50#
______ ft. to ______ ft. No. of sacks used ______
Method used bentonite pellets
Cemented by ______
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

12) PACKERS: NA Type Depth

13) TYPE PUMP: NA
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: NA
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME ______ (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS ______ (Street or RFD) (City) (State) (Zip)

(Signed) ______ (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

AD-4

Please use black ink.

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt. 4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt. 4 Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) GPS
33° 02' 43" N
94° 50' 33" W
N↑

6) WELL LOG:
Date Drilling:
Started 4/26 19 2001
Completed 4/26 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	30

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other
If Gravel Packed give interval ... from 16 ft. to 30 ft.

From (ft.)	To (ft.)	Description and color of formation material
0	5	red silty clay with gray streaks
5 -	30	gray silty clay with red streaks
		AD-4

(Use reverse side if necessary)

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	19	Sch 40
2	N	#10 Slot Screen	19	29	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 16 ft. to 2 ft. No. of sacks used 8-50#
ft. to ft. No. of sacks used
Method used bentonite pellets
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level ft. below land surface Date
Artesian flow gpm. Date

12) PACKERS: NA Type Depth

13) TYPE PUMP:
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other NA
Depth to pump bowls, cylinder, jet, etc., ft.

14) WELL TESTS: NA
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print) WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

E·A·G·L·E
ENVIRONMENTAL SERVICES OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-4A**
TOTAL DEPTH:	**30'**
TOP OF CASING ELEV.:	**342.85 ft. NGVD**
GROUND SURFACE ELEV.:	**340.19 ft. NGVD**

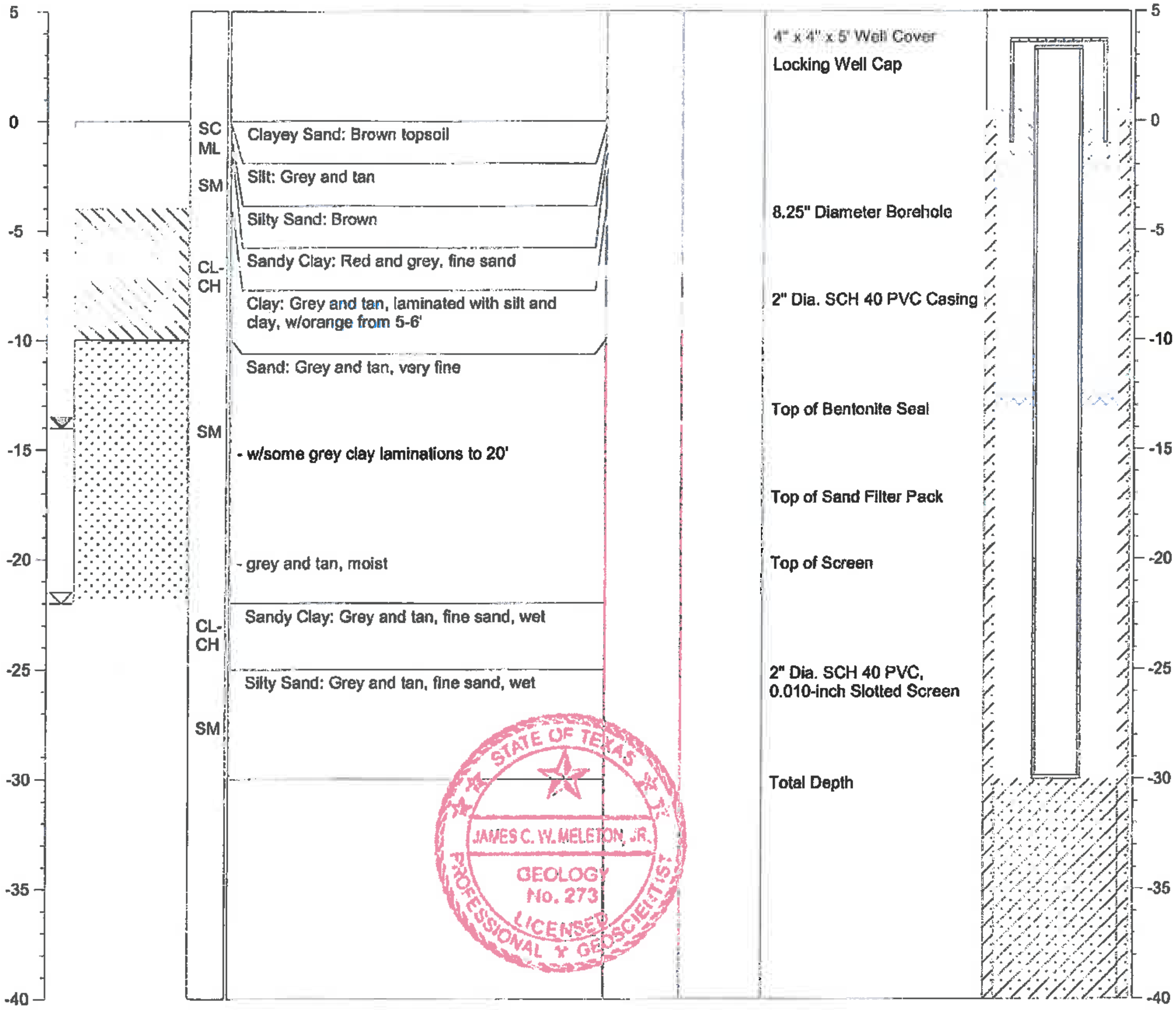
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04527**
Longitude: 94.84258

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Clayey Sand: Brown topsoil
Silt: Grey and tan
Silty Sand: Brown
Sandy Clay: Red and grey, fine sand
Clay: Grey and tan, laminated with silt and clay, w/orange from 5-6'
Sand: Grey and tan, very fine
- w/some grey clay laminations to 20'
- grey and tan, moist
Sandy Clay: Grey and tan, fine sand, wet
Silty Sand: Grey and tan, fine sand, wet

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED PROFESSIONAL GEOSCIENTIST

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.: **AD-4B**
TOTAL DEPTH: **15'**
TOP OF CASING ELEV.: **333.23 ft. NGVD**
GROUND SURFACE ELEV.: **329.55 ft. NGVD**

CLIENT: **AEP**
PROJECT: **Ash Disposal Area**
SITE LOCATION: **Welsh Power Plant**
PROJECT NO.: **S-08-0109**
LOGGED BY: **James Meleton, Jr.**

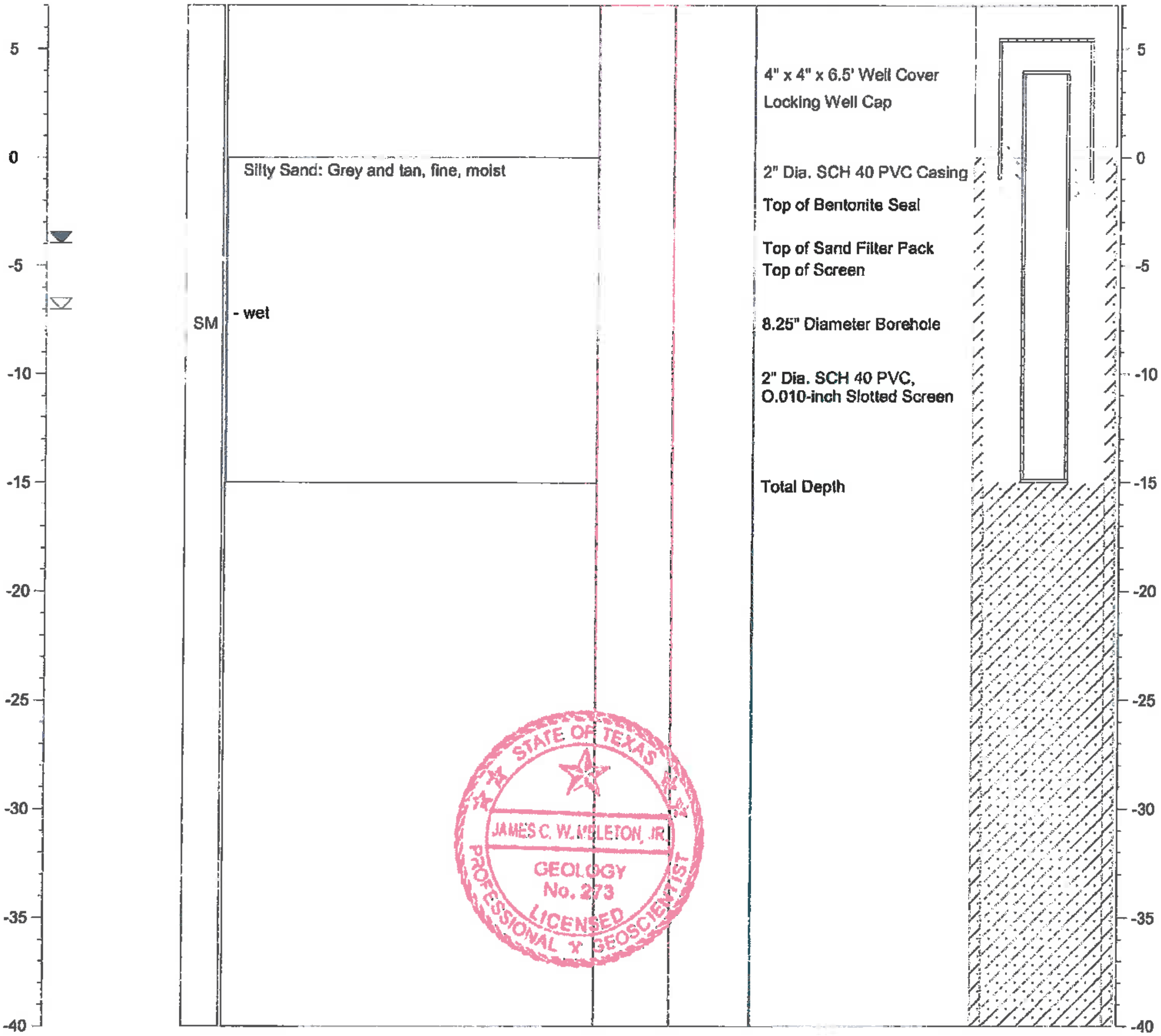
DRILLING CO.: **WEST Drilling**
DRILLER: **Tom McCullough**
METHOD OF DRILLING: **Hollow-stem Auger**
SAMPLING METHODS: **Split-spoon**
DATE DRILLED: **9/23/09**

NOTES: **Latitude: 33.04531**
Longitude: 94.84230

▼ Water level during drilling
▽ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED
PROFESSIONAL GEOSCIENTIST

E·A·G·L·E
ENVIRONMENTAL SERVICES OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-4C**
TOTAL DEPTH:	**15'**
TOP OF CASING ELEV.:	**333.28 ft. NGVD**
GROUND SURFACE ELEV.:	**329.15 ft. NGVD**

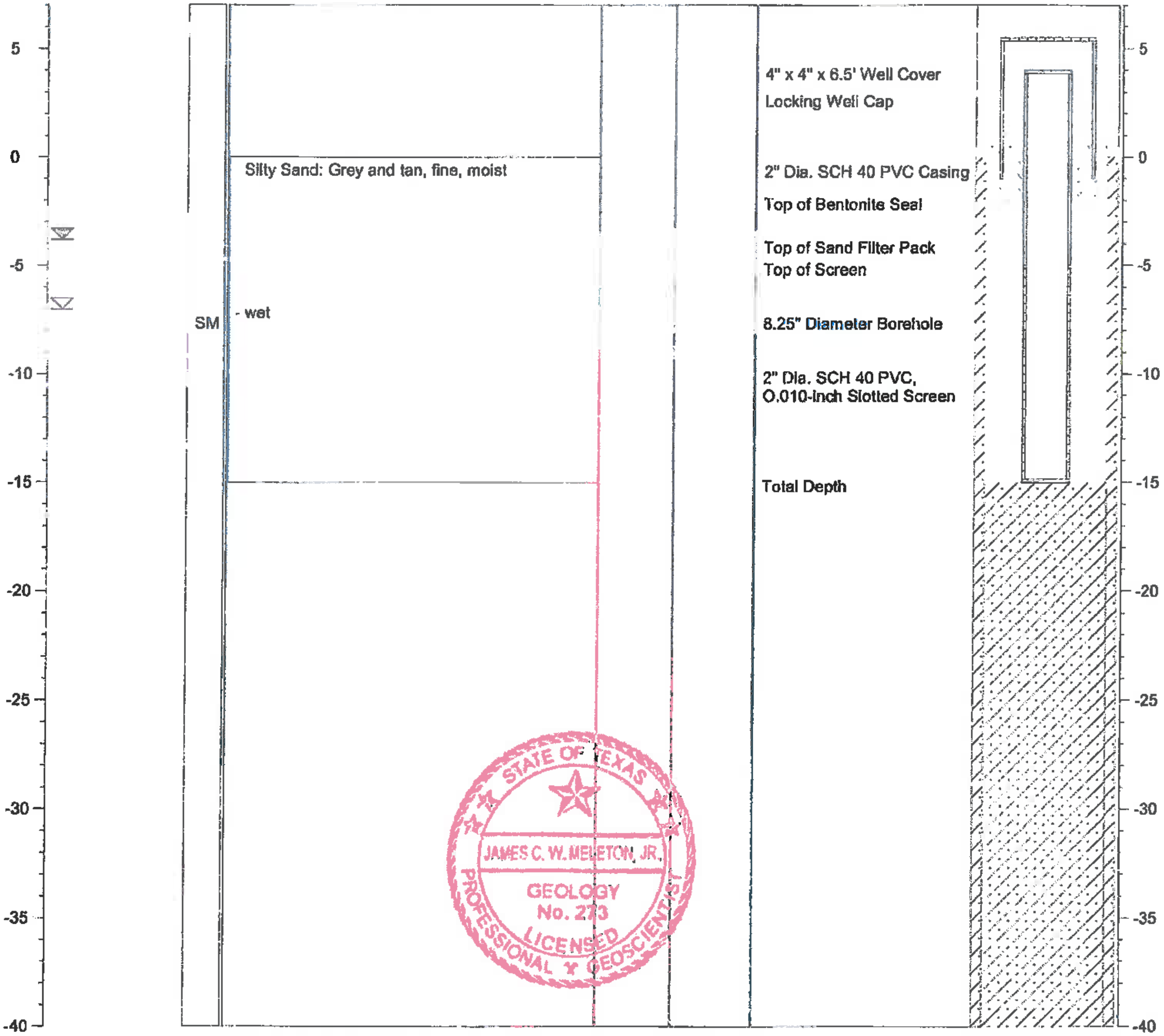
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/23/09**

NOTES: **Latitude: 33.04507**
Longitude: 94.84244

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED
PROFESSIONAL GEOSCIENTIST

AD-5

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Southwestern Electric Power (Name) ADDRESS Rt.4, Box 221 (Street or RFD) Pittsburg (City) Tx (State) 75686 (Zip)

2) ADDRESS OF WELL: County ~~Camp~~ Titus Rt.4, Box 221 (Street, RFD or other) Pittsburg (City) Tx (State) 75686 (Zip) GRID # 16-58-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) 33°03'13"N 94°51'00"W N

6) WELL LOG:
Date Drilling:
Started 1-11 19 2001
Completed 1-11 19 2001

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8 1/4	Surface	30

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

From (ft.)	To (ft.)	Description and color of formation material
0	10	red & gray clay with orange streaks
10	20	gray/black clay with tan clay
20	25	stiff clay with lignite streak
25	30	fine gray sand

AP-5

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other
If Gravel Packed give interval ... from 16 ft. to 30 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2	N	riser	+2	20	Sch 40
2	N	#10 slot screen	20	30	Sch 40

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 16 ft. to 0 ft. No. of sacks used
ft. to ft. No. of sacks used
Method used bentonite
Cemented by
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

✓10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☒ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:
Static level 11' 9" ft. below land surface Date 1-11-01
Artesian flow gpm. Date

12) PACKERS: NA Type Depth

13) TYPE PUMP:
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ft.

14) WELL TESTS:
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

✓15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME (Type or print)
WELL DRILLER'S LICENSE NO. TX 52694-M

ADDRESS (Street or RFD) (City) (State) (Zip)

(Signed) (Licensed Well Driller)
(Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94)

Send one (1) copy each to: TNRCC, DRILLER, WELL OWNER

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-6**
TOTAL DEPTH:	**33'**
TOP OF CASING ELEV.:	**346.33 ft. NGVD**
GROUND SURFACE ELEV.:	**343.31 ft. NGVD**

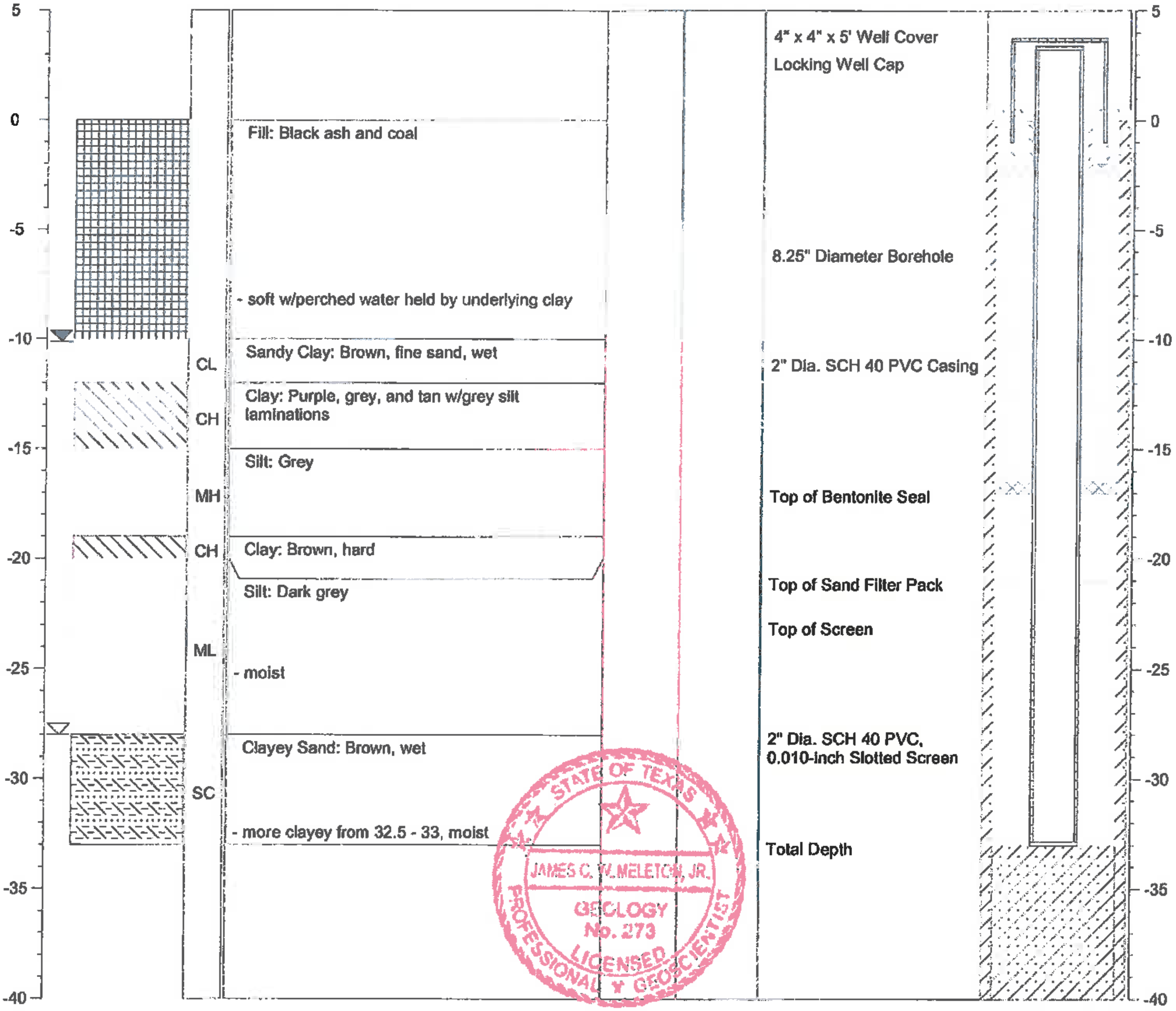
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/23/09**

NOTES: **Latitude: 33.05235**
Longitude: 94.84757

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



Fill: Black ash and coal
- soft w/perched water held by underlying clay

CL Sandy Clay: Brown, fine sand, wet

CH Clay: Purple, grey, and tan w/grey silt laminations

MH Silt: Grey

CH Clay: Brown, hard

ML Silt: Dark grey
- moist

SC Clayey Sand: Brown, wet
- more clayey from 32.5 - 33, moist

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
JAMES C. W. MELETON, JR.
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PROFESSIONAL GEOSCIENTIST

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OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-7**
TOTAL DEPTH:	**38'**
TOP OF CASING ELEV.:	**350.82 ft. NGVD**
GROUND SURFACE ELEV.:	**347.86 ft. NGVD**

CLIENT:	**AEP**
PROJECT:	**Ash Disposal Area**
SITE LOCATION:	**Welsh Power Plant**
PROJECT NO.:	**S-08-0109**
LOGGED BY:	**James Meleton, Jr.**

DRILLING CO.:	**WEST Drilling**
DRILLER:	**Tom McCullough**
METHOD OF DRILLING:	**Hollow-stem Auger**
SAMPLING METHODS:	**Split-spoon**
DATE DRILLED:	**9/24/09**

NOTES: **Latitude: 33.05257**
Longitude: 94.84219

▽ Water level during drilling
▼ Water level in completed well

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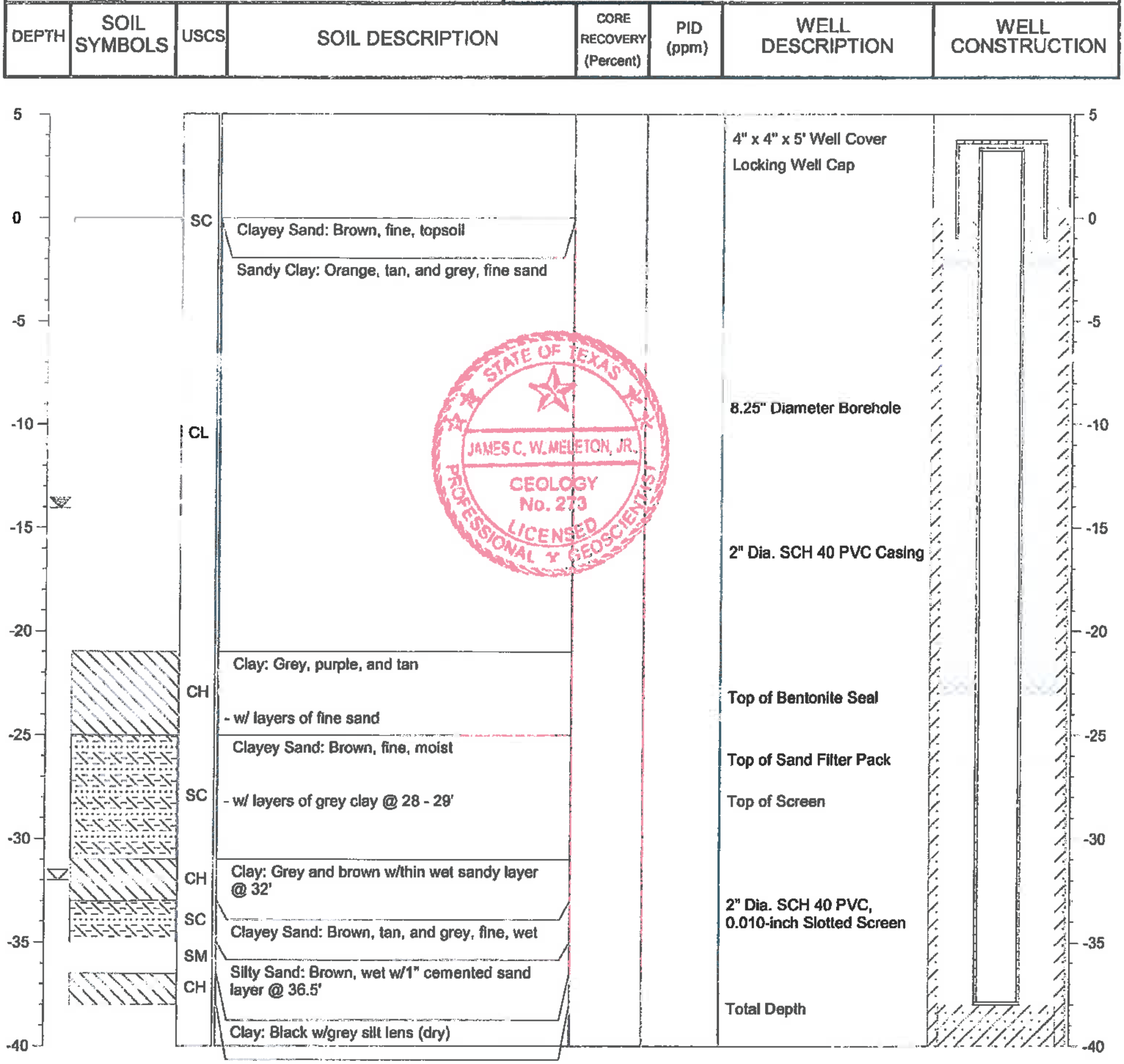

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ENVIRONMENTAL SERVICES OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-8**
TOTAL DEPTH:	**29'**
TOP OF CASING ELEV.:	**340.01 ft. NGVD**
GROUND SURFACE ELEV.:	**337.53 ft. NGVD**

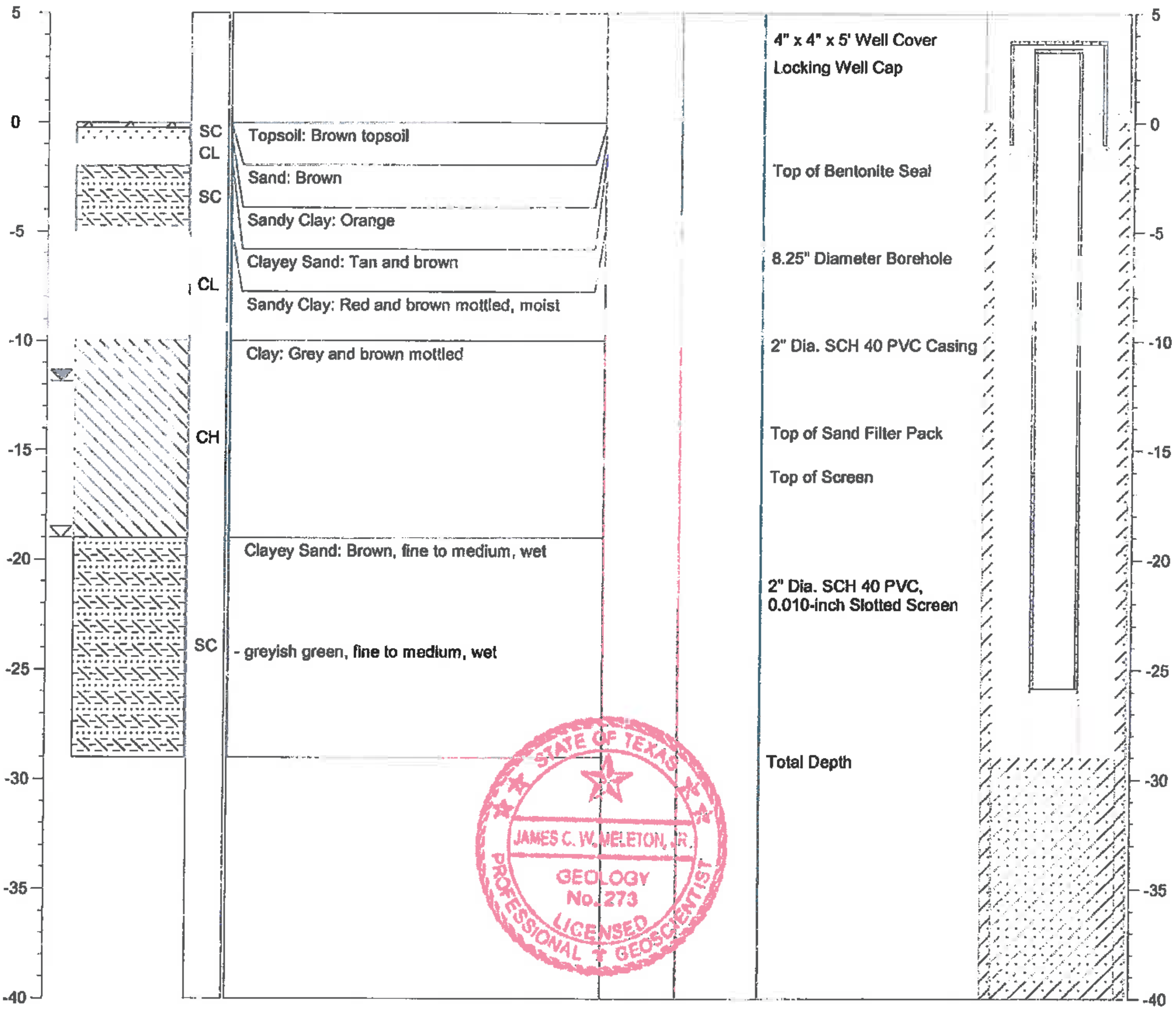
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/21/09**

NOTES: **Latitude: 33.05187**
Longitude: 94.84026

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Topsoil: Brown topsoil
CL	Sand: Brown
SC	Sandy Clay: Orange
	Clayey Sand: Tan and brown
CL	Sandy Clay: Red and brown mottled, moist
CH	Clay: Grey and brown mottled
SC	Clayey Sand: Brown, fine to medium, wet
	- greyish green, fine to medium, wet

WELL DESCRIPTION:
4" x 4" x 5' Well Cover
Locking Well Cap
Top of Bentonite Seal
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-9**
TOTAL DEPTH:	**35'**
TOP OF CASING ELEV.:	**343.09 ft. NGVD**
GROUND SURFACE ELEV.:	**340.32 ft. NGVD**

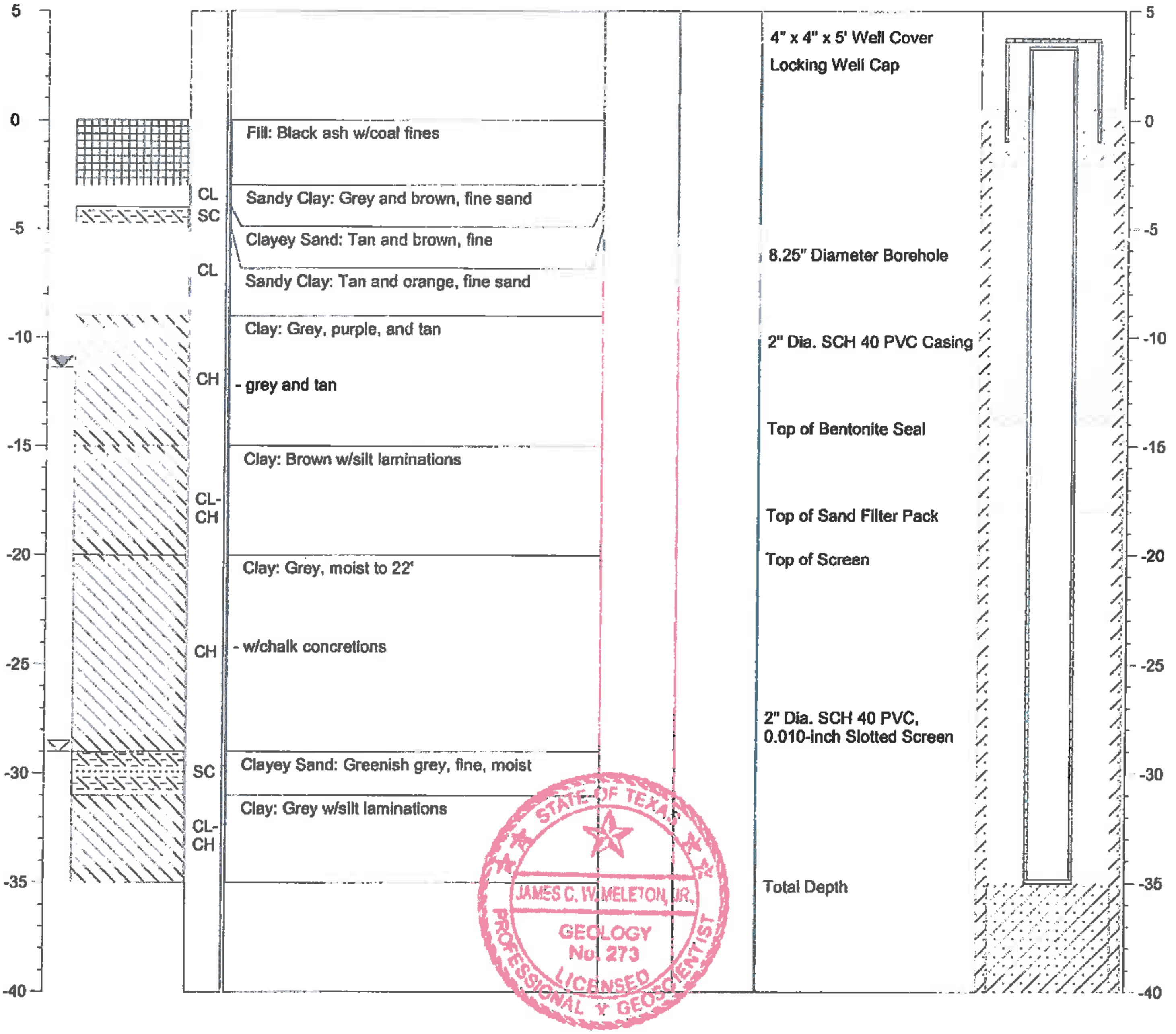
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/21/09**

NOTES: **Latitude: 33.04995**
Longitude: 94.84196

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
	Fill: Black ash w/coal fines
CL	Sandy Clay: Grey and brown, fine sand
SC	Clayey Sand: Tan and brown, fine
CL	Sandy Clay: Tan and orange, fine sand
CH	Clay: Grey, purple, and tan - grey and tan
CL-CH	Clay: Brown w/silt laminations
CH	Clay: Grey, moist to 22' - w/chalk concretions
SC	Clayey Sand: Greenish grey, fine, moist
CL-CH	Clay: Grey w/silt laminations

WELL DESCRIPTION:
4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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SOIL BORING LOG

BORING/WELL NO.:	**AD-10**
TOTAL DEPTH:	**35'**
TOP OF CASING ELEV.:	**343.01 ft. NGVD**
GROUND SURFACE ELEV.:	**340.23 ft. NGVD**

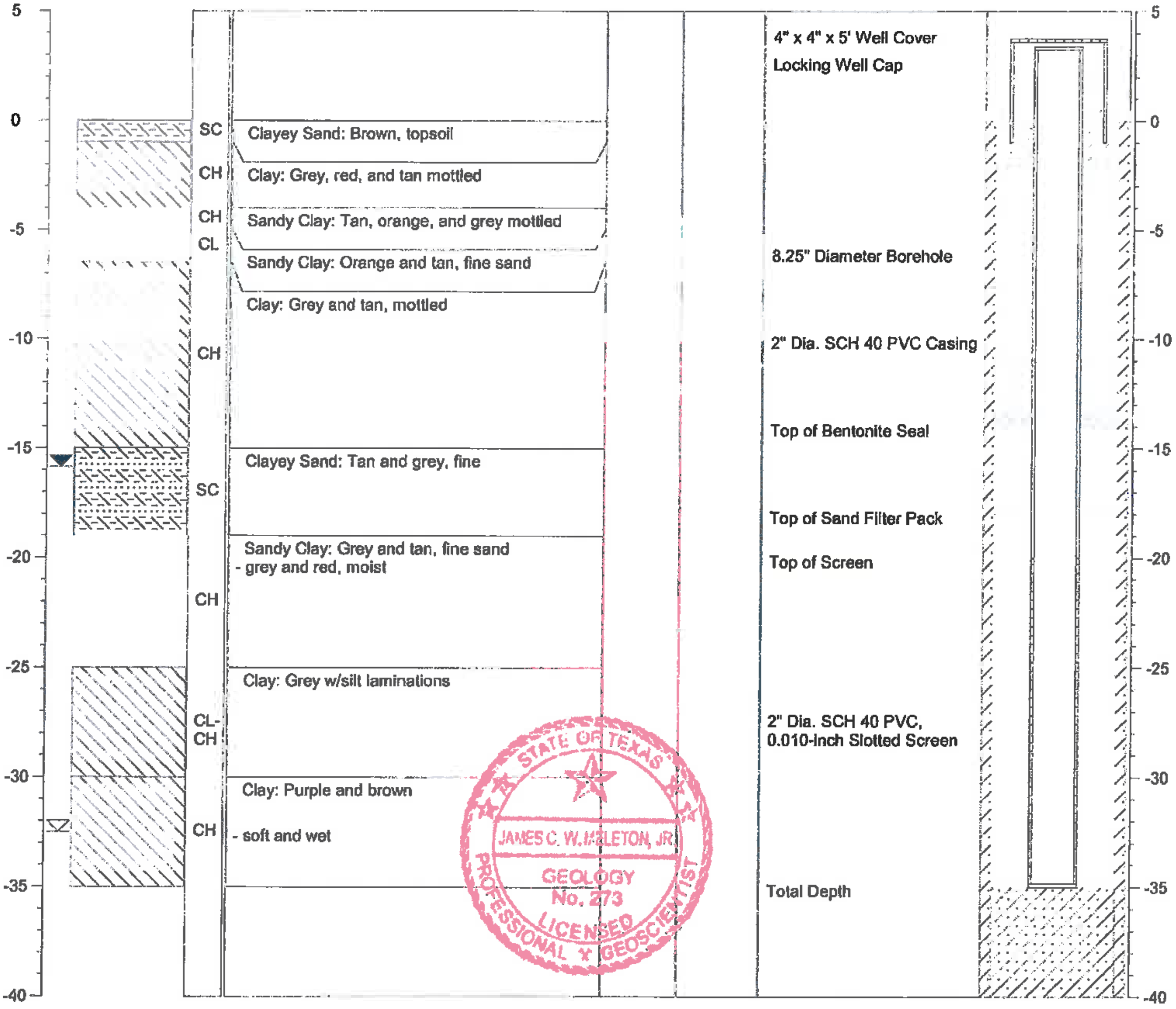
CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04881**
Longitude: 94.84047

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
CH	Clay: Grey, red, and tan mottled
CH	Sandy Clay: Tan, orange, and grey mottled
CL	Sandy Clay: Orange and tan, fine sand
CH	Clay: Grey and tan, mottled
SC	Clayey Sand: Tan and grey, fine
CH	Sandy Clay: Grey and tan, fine sand - grey and red, moist
CL-CH	Clay: Grey w/silt laminations
CH	Clay: Purple and brown - soft and wet

WELL DESCRIPTION:

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
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OF SHREVEPORT, INC

SOIL BORING LOG

BORING/WELL NO.: **AD-11**
TOTAL DEPTH: **20'**
TOP OF CASING ELEV.: **342.18 ft. NGVD**
GROUND SURFACE ELEV.: **339.61 ft. NGVD**

CLIENT: **AEP**
PROJECT: **Ash Disposal Area**
SITE LOCATION: **Welsh Power Plant**
PROJECT NO.: **S-08-0109**
LOGGED BY: **James Meleton, Jr.**

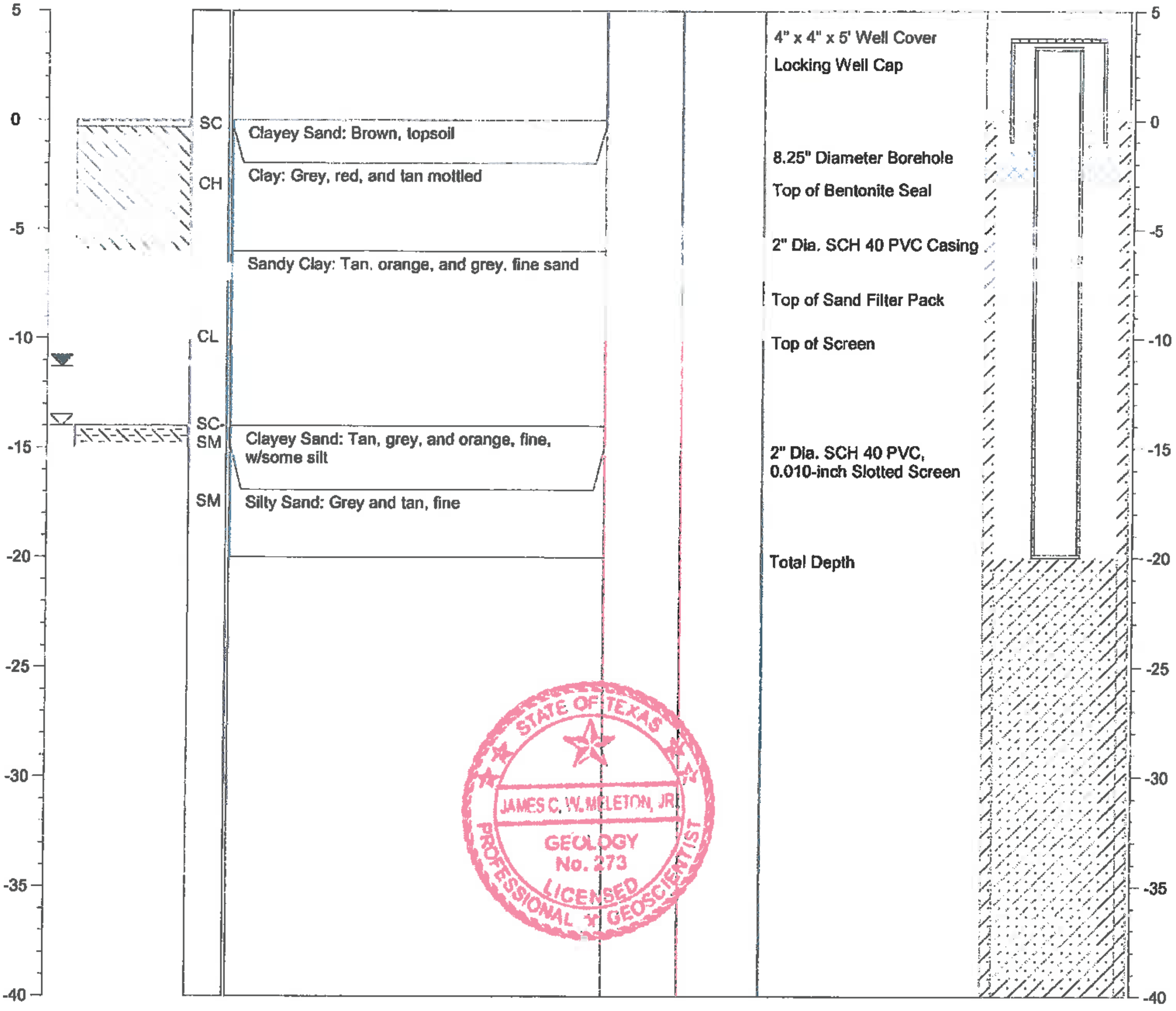
DRILLING CO.: **WEST Drilling**
DRILLER: **Tom McCullough**
METHOD OF DRILLING: **Hollow-stem Auger**
SAMPLING METHODS: **Split-spoon**
DATE DRILLED: **9/22/09**

NOTES: **Latitude: 33.04824**
Longitude: 94.84177

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1

DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
CH	Clay: Grey, red, and tan mottled
	Sandy Clay: Tan, orange, and grey, fine sand
CL	
SC-SM	Clayey Sand: Tan, grey, and orange, fine, w/some silt
SM	Silty Sand: Grey and tan, fine

4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
Top of Bentonite Seal
2" Dia. SCH 40 PVC Casing
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.: **AD-12**
TOTAL DEPTH: **30'**
TOP OF CASING ELEV.: **369.33 ft. NGVD**
GROUND SURFACE ELEV.: **366.27 ft. NGVD**

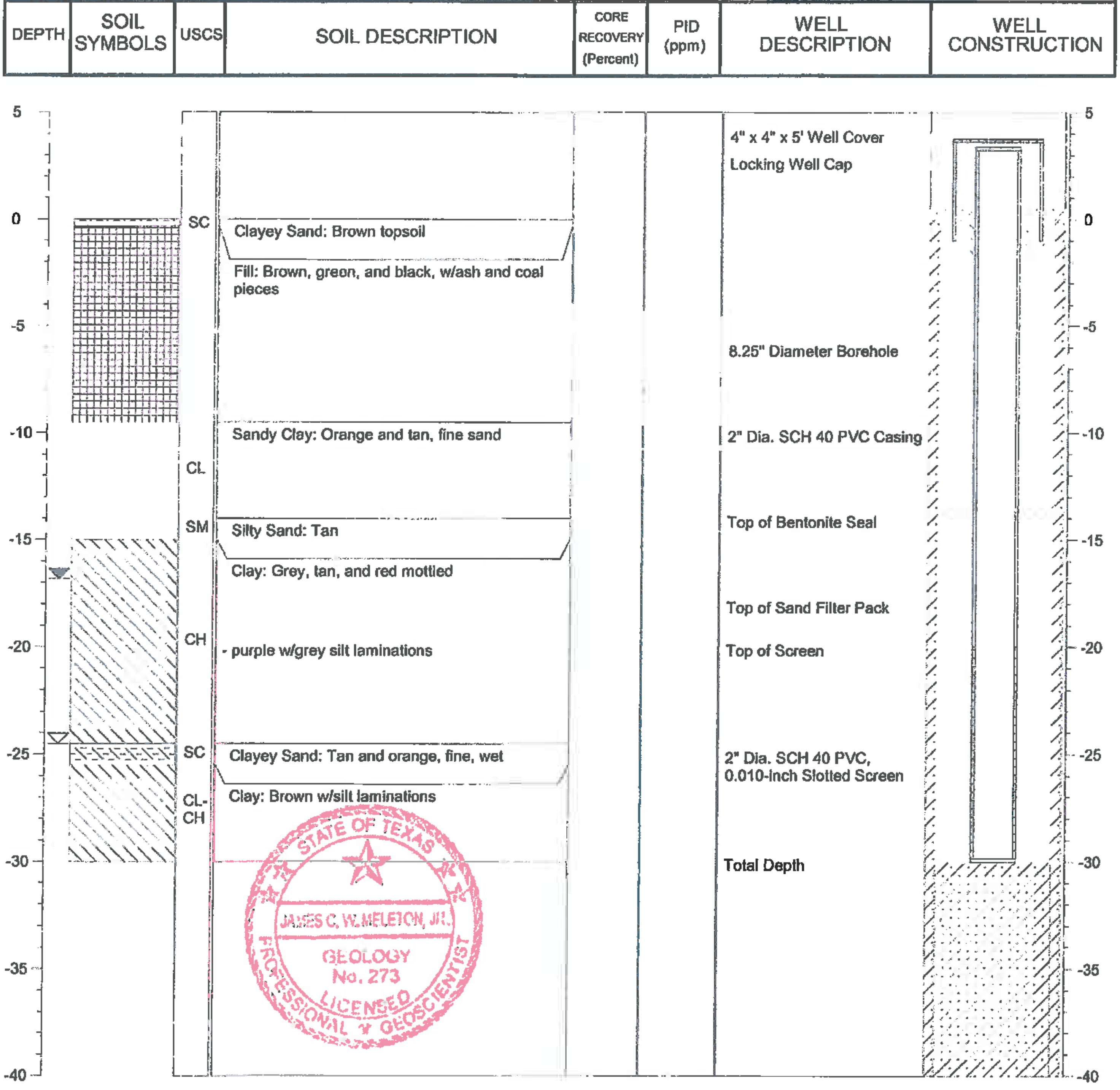
CLIENT: **AEP**
PROJECT: **Ash Disposal Area**
SITE LOCATION: **Welsh Power Plant**
PROJECT NO.: **S-08-0109**
LOGGED BY: **James Meleton, Jr.**

DRILLING CO.: **WEST Drilling**
DRILLER: **Tom McCullough**
METHOD OF DRILLING: **Hollow-stem Auger**
SAMPLING METHODS: **Split-spoon**
DATE DRILLED: **9/24/09**

NOTES: **Latitude: 33.04901**
Longitude: 94.84977

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



Clayey Sand: Brown topsoil

Fill: Brown, green, and black, w/ash and coal pieces

Sandy Clay: Orange and tan, fine sand

Silty Sand: Tan

Clay: Grey, tan, and red mottled

- purple w/grey silt laminations

Clayey Sand: Tan and orange, fine, wet

Clay: Brown w/silt laminations

4" x 4" x 5' Well Cover

Locking Well Cap

8.25" Diameter Borehole

2" Dia. SCH 40 PVC Casing

Top of Bentonite Seal

Top of Sand Filter Pack

Top of Screen

2" Dia. SCH 40 PVC,
0.010-inch Slotted Screen

Total Depth

STATE OF TEXAS
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ENVIRONMENTAL SERVICES
OF SHREVEPORT INC

SOIL BORING LOG

BORING/WELL NO.:	**AD-13**
TOTAL DEPTH:	**20'**
TOP OF CASING ELEV.:	**347.00 ft. NGVD**
GROUND SURFACE ELEV.:	**344.12 ft. NGVD**

CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04918**
Longitude: 94.84275

▽ Water level during drilling
▼ Water level in completed well

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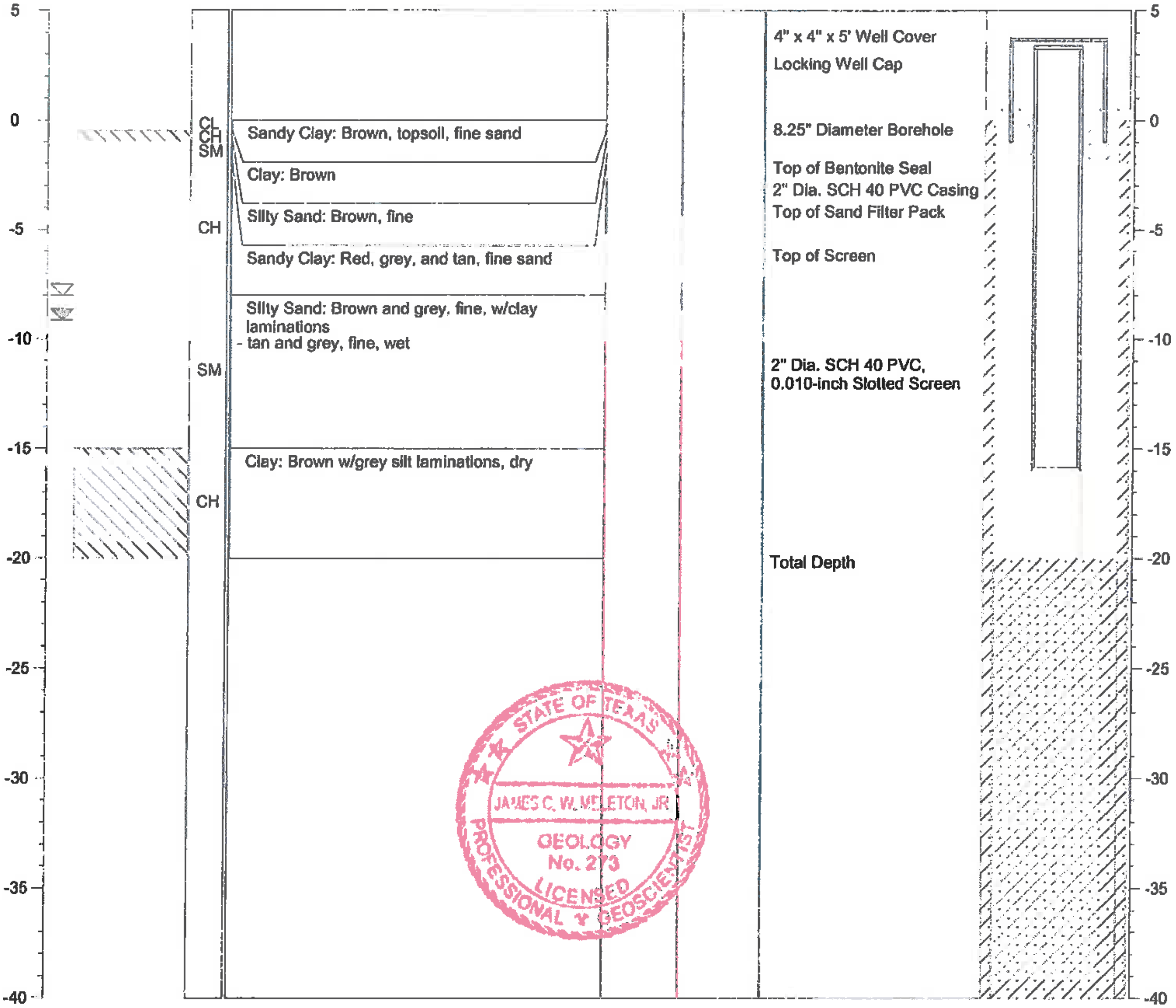
DEPTH	SOIL SYMBOLS	USCS	SOIL DESCRIPTION	CORE RECOVERY (Percent)	PID (ppm)	WELL DESCRIPTION	WELL CONSTRUCTION



USCS	SOIL DESCRIPTION
CL	Sandy Clay: Brown, topsoil, fine sand
CH	Clay: Brown
SM	Silty Sand: Brown, fine
CH	Sandy Clay: Red, grey, and tan, fine sand
SM	Silty Sand: Brown and grey, fine, w/clay laminations - tan and grey, fine, wet
CH	Clay: Brown w/grey silt laminations, dry

WELL DESCRIPTION:
4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
Top of Bentonite Seal
2" Dia. SCH 40 PVC Casing
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

STATE OF TEXAS
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OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**AD-14**
TOTAL DEPTH:	**18.5'**
TOP OF CASING ELEV.:	**345.43 ft. NGVD**
GROUND SURFACE ELEV.:	**342.32 ft. NGVD**

CLIENT:	**AEP**	DRILLING CO.:	**WEST Drilling**
PROJECT:	**Ash Disposal Area**	DRILLER:	**Tom McCullough**
SITE LOCATION:	**Welsh Power Plant**	METHOD OF DRILLING:	**Hollow-stem Auger**
PROJECT NO.:	**S-08-0109**	SAMPLING METHODS:	**Split-spoon**
LOGGED BY:	**James Meleton, Jr.**	DATE DRILLED:	**9/22/09**

NOTES: **Latitude: 33.04715**
Longitude: 94.84256

▽ Water level during drilling
▼ Water level in completed well

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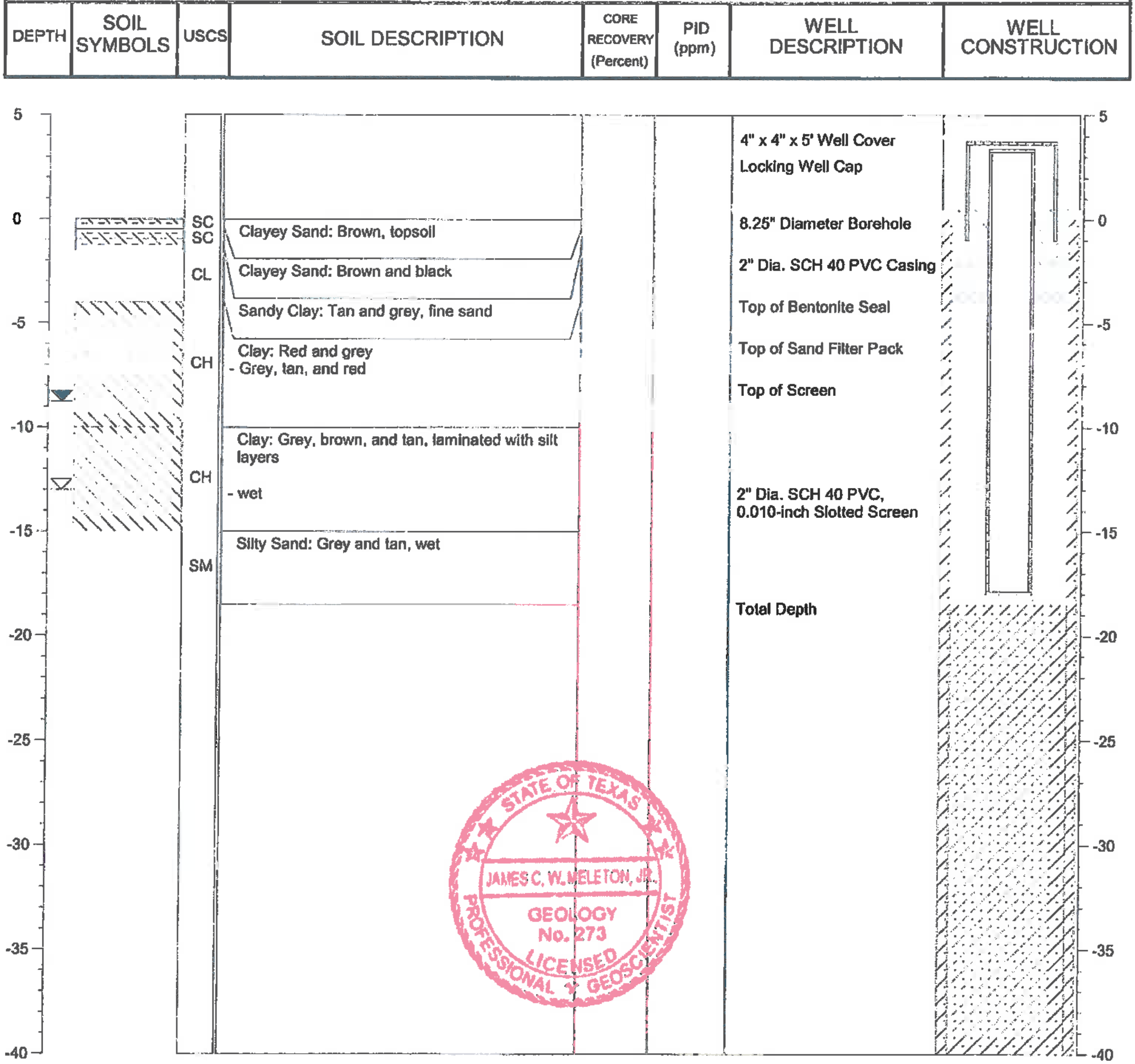

USCS	SOIL DESCRIPTION
SC	Clayey Sand: Brown, topsoil
SC	Clayey Sand: Brown and black
CL	Sandy Clay: Tan and grey, fine sand
CH	Clay: Red and grey - Grey, tan, and red
CH	Clay: Grey, brown, and tan, laminated with silt layers - wet
SM	Silty Sand: Grey and tan, wet

WELL DESCRIPTION:
4" x 4" x 5' Well Cover
Locking Well Cap
8.25" Diameter Borehole
2" Dia. SCH 40 PVC Casing
Top of Bentonite Seal
Top of Sand Filter Pack
Top of Screen
2" Dia. SCH 40 PVC, 0.010-inch Slotted Screen
Total Depth

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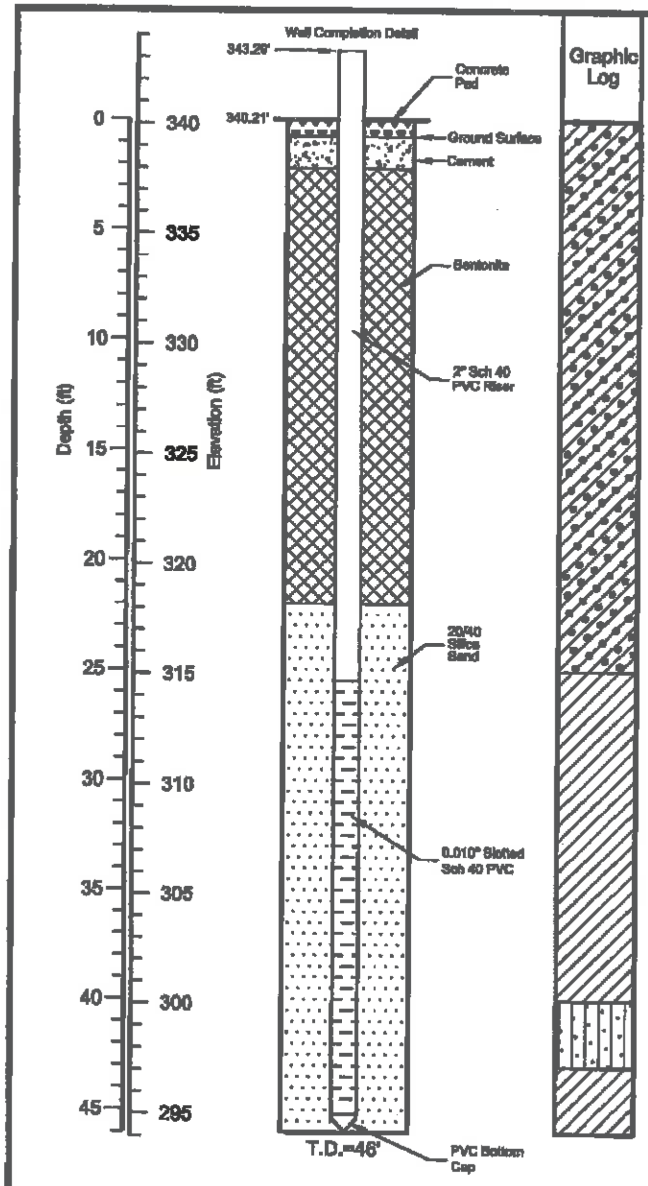


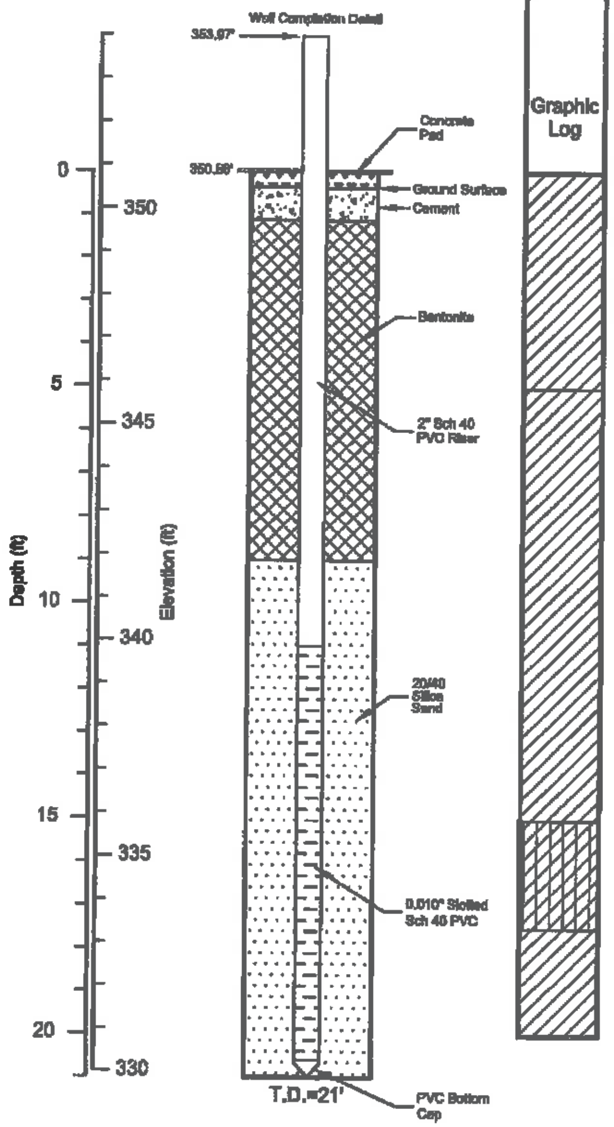
Depth (ft)	PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
0		Direct Push		SC	Clayey SAND: reddish brown					
10						16	48	37	18	19
15					- 2" lense of brown sand					
20					- 3" lense of brown sand					
25		Direct Push		CL	Sandy Lean CLAY: reddish brown, very moist					
30					- less moisture					
35						22	51	36	19	17
40				SM	Silty SAND: light brown & light gray, wet.	27	24	26	NP	-
45				CL	Lean CLAY: orangish brown & light gray, mottled, with sand	26	94	45	21	24

STEVEN R. WEMPLE
2176
1-22-16

west DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/12/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-15
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/12/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: —	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg



PID Reading (ppm)	Sampling Device	Sample Interval	Description Interva (feet bgs)	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		CL	Lean CLAY w/ Sand: light brown & light gray - orangish brown, with silt	16	82	26	16	10
			CL	Lean CLAY w/ Sand: orangish-brown & light gray	22	88	31	19	12
			CL-ML	Silty CLAY: orange w/ brown, wet	30	69	27	20	7
			CL	Sandy, Lean CLAY: brown w/ orange, stiff	26	66	46	26	20

STEVEN R. WEMPLE
2176
1-22-16

west DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/10/15
Drilling Method: H.S.A.
Bit Diameter: 7.25"
Depth to Water: --

Logged by: Robert Williams, PE
Driller: Robert Williams
Date Completed: 12/10/15
Depth to Product: NA

Welsh Power Station
Pittsburg, Texas

DRAWN BY: HDS
CHECKED BY: SRW

Log of Boring
AD-16

PROJECT NO.: --
SCALE: AS SHOWN
FILE NAME: JR Welsh Power Plant LOGS.dwg

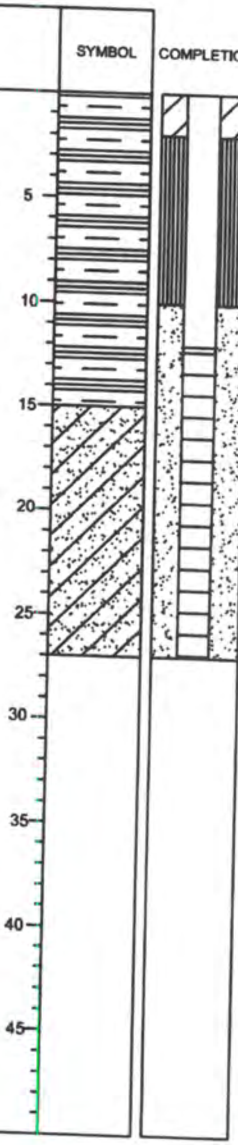
WELL LOG

DEPTH	SAMPLE	ANALYZED	TYPE	ORGANIC VAPOR (ppm)	SAMPLE DESCRIPTION
0-15'			SS SS SS SS SS SS SS		(0-15') SILTY CLAY (CL), BROWN TO ORANGE-BROWN, STIFF, DRY.
15-18'			SS		(15-18') SILTY CLAY AND SANDY CLAY, ORANGE-BROWN TO LIGHT GRAY, MOIST.
18-27'			SS SS SS SS SS		(18-27') SILTY CLAY AND SANDY CLAY, DARK BROWN TO GRAY, MOIST TO WET.

TOTAL DEPTH = 27' BGS

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

4-12-17



AD-16R
WELL

AEP
CLIENT

BOTTOM ASH STORAGE POND
PROJECT

WELSH POWER PLANT
LOCATION

4/12/17
DATE

HSA
DRILLING METHOD

2" PVC, 2' AGL-12' BGL
CASING

2" PVC, 12'-27' BGS
SCREEN

0-2' BGS
CEMENT

2-10' BGS
BENTONITE

10-27' BGS
SAND PACK

350.55' / 353.49'
GROUND ELEV. / TOP OF CASING ELEV.

CT - CUTTINGS
SB - SPLIT BARREL(5')
SS - SPLIT SPOON(2')

▽ HC LEVEL
▼ WATER LEVEL

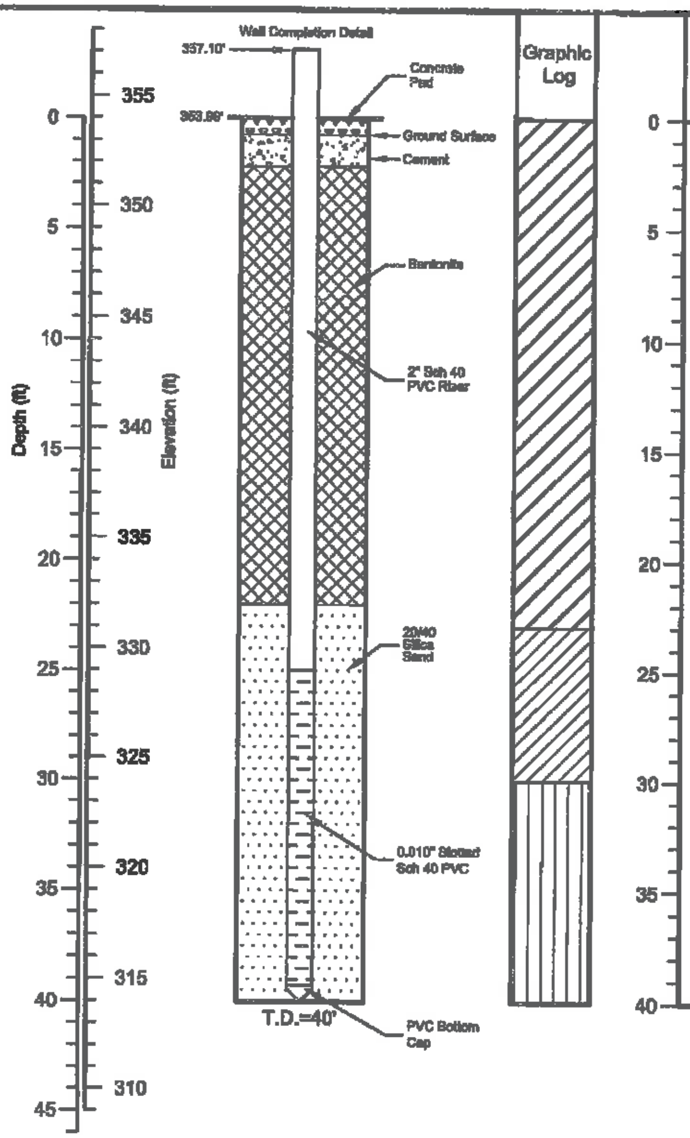
▨ SAND
▨ SILT
▨ CLAY
▨ FILL/CONCRETE
▨ BENTONITE
▨ GRAVEL

START:
FINISH:

PAGE 1 OF 1

ARCADIS Design & Consultancy for natural and built assets

711 N. CARANCAHUA, #1080
CORPUS CHRISTI, TEXAS 78401
TEL: (361) 883-1353 FAX: (361) 883-7565



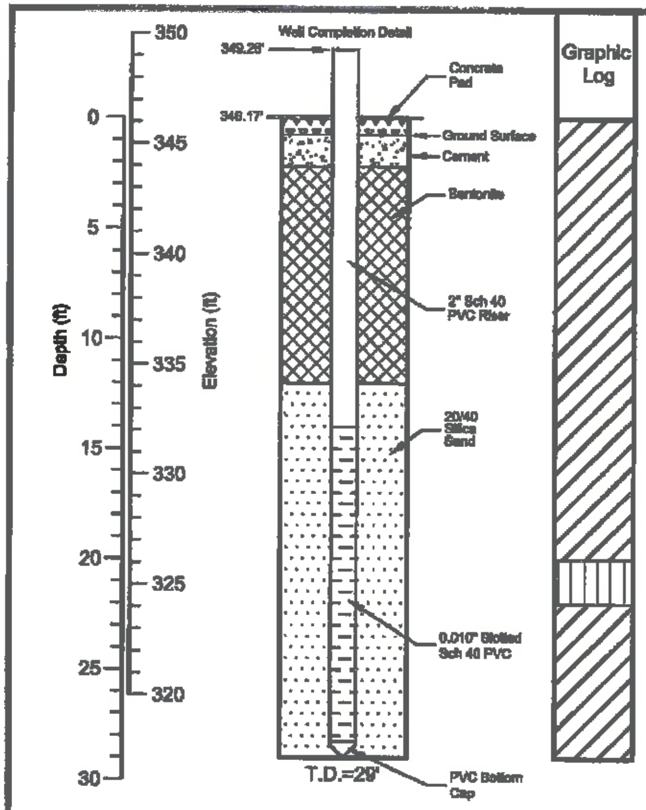
PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		CH	Fat CLAY: reddish-brown					
				- light gray to light brown, reddish brown w/ Sand and gravel lenses	24	97	83	30	53
				- light brown					
				- brown Sand lenses, wet					
				- gray, w/ some Silt	18	90	53	25	28
			CL	Lean CLAY with Sand: gray	22	81	43	22	21
	Direct Push		ML	Sandy SILT: gray	23	63	26	NP	-

STEVEN R. WEMPLE
2176
1/22/16

west DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/10/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-17
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/11/15	DRAWN BY: HDS	PROJECT NO.: —
			SCALE: AS SHOWN
Depth to Water: –	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg



PID Reading (ppm)	Sampling Device	Sample Interval	USCS	Comments and Lithology	Percent Moisture	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index
	Direct Push		CH	Fat CLAY: light brown & light gray, sandy - reddish brown and light gray, with Sand - gray with silt - gray, stiff	19	88	50	24	26
			ML	SILT: gray, with Clay and Sand, wet	29	86	26	NP	-
			CH	Fat CLAY: light gray, silty w/ Sand, very stiff	20	85	50	23	27

Depth (ft): 0, 5, 10, 15, 20, 25, 30

STEVEN R. WEMPLE
SOIL SCIENCE
LICENSE NUMBER
2175

1.22.16

west
DRILLING
environmental & geotechnical

WEST Drilling, Inc.
101 Industrial Drive
Waxahachie, Texas 75165

DATE: 12/11/15	Logged by: Robert Williams, PE	Welsh Power Station Pittsburg, Texas	Log of Boring AD-18
Drilling Method: H.S.A.	Driller: Robert Williams		
Bit Diameter: 7.25"	Date Completed: 12/11/15	DRAWN BY: HDS	PROJECT NO.: — / SCALE: AS SHOWN
Depth to Water: —	Depth to Product: NA	CHECKED BY: SRW	FILE NAME: JR Welsh Power Plant LOGS.dwg

Project: AEP Welsh Power Plant **Project Location: Cason, TX** **Project Number: TXL0064**	**Log of Boring GB-1** Sheet 1 of 2

Date(s) Drilled **July 23, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **37 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **367 feet MSL**
Groundwater Level and Date Measured	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Bentonite Chips**	Location **On the Northern edge of proposed chemical pond along the screening berm.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
367	0					Other		Black COAL, a few fine roots and organics.						
			ST											Shelby tube pulled black COAL
			SS	10										SPT 4, 5, 5, 5. 24" recovered
362	5		SS	11	Soft to Firm	SC		Reddish Brown fine SAND, little clay, trace silt, Dry. Natural Ground.						SPT 4, 5, 6, 7. 24" recovered
			SS	11	Soft	SM		Reddish brown fine SAND with silt, trace clay. Vertical sand seams in sample, Dry.						SPT 3, 5, 6, 6. 24" recovered.
357	10		ST						23.6	22	48.9	5.4E-07		Shelby tube sample, 18" recovered.
					Soft	SC		Reddish brown well graded fine SAND, trace silt and clay. Damp.						SPT 5, 6, 6, 9. 24" recovered
			SS	12	Firm	CL		Greyish red CLAY, little sand, horizontal sand seams, Dry.						
					Soft	SC		Brownish red fine SAND, little clay, Damp.						SPT 7, 6, 7, 9. 24" recovered.
			SS	13	Firm	SC-CL		〉 Four-inch CLAY seam, little fine sand.						
					Firm	CL		Reddish grey CLAY, little sand, oxidized iron ore. Dry						
352	15				Soft	SM		Brownish red fine SAND, trace clay, thin clay seams. Moist.						SPT 8, 9, 9, 9. 24" recovered.
			SS	18					17.74	14	40.1			
			ST						16.25	NP	28.9	3.6E-05		Shelby tube samples look like SC. 17" recovered.
347	20		SS	17	Soft	Other		〉 Iron oxidized material						SPT 9, 8, 9, 11. 24 Inches recovered.
					Soft	SC		Brownish red fine SAND, little clay. Moist.						
			SS	15										SPT 5, 7, 8, 50/2. 21" recovered
			SS	50	Soft	CL		Dark grey CLAY, little fine sand, Wet.						SPT 50/3".
					Very Hard	SP		Dark grey-black cemented SAND, little clay. Wet. Driller comments that cemented sand terminates at 25.5 feet.						
342	25		SS	27	Soft to Firm	SC		Dark grey fine SAND, little clay. Moist. Soft sand with lenses of firm clay.						SPT 11, 13, 14, 16. 24" recovered.
					Hard	CL		I Dark grey CLAY, little sand, Dry.						
			SS	46	Soft	SC		Dark grey-black fine SAND, little clay, Wet. Encountered water but water rose to 19 feet after 15 min break.						SPT 11, 16, 30, 14. 24" recovered.
			SS	37										SPT 11, 15, 22, 25. 24" recovered.
337	30				Hard	CL								

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, TX
Project Number: TXL0064

Log of Boring GB-1

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
337	30	▨	SS	37	Hard	CL	▨	Dark grey CLAY, little fine sand, occansional horizontal sand seams. Wet. (cont.)						SPT 11, 15, 22, 25. 24" recovered.
		▨	SS	29	Soft	ML	▥	Dark grey-black fine SAND, with clay, frequent hard clay lenses (1-3"), Wet.	26.37	NP	57.5			SPT 6, 11, 18, 24. 24 recovered.
332	35		SS	34	Hard	CL	▨	Black CLAY, trace to little fine sand, trace silt. Dry						SPT 9, 16, 18, 23. 24" recovered.
								Bottom of Boring at 37 feet bgs						
327	40													
322	45													
317	50													
312	55													
307	60													
302	65													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-02

Sheet 1 of 1

Date(s) Drilled **August 14, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **30 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **364.56 feet MSL**
Groundwater Level and Date Measured **21.53 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Well Completion**	Location **Western edge of proposed chemical pond near perimeter fence.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
364.6	0				Soft	Other		Coal						
					Soft	CL		Greyish brown CLAY, with little silt, little sand, damp.						SPT 2, 2, 2. 12" recovered.
			SS	4										
														SPT 4, 7, 6, 12.
			SS	13										
														Shelby Tube Sample
359.6	5		ST											
					Firm	CH		Brownish tan CLAY with silt, little sand, Damp. Occasional sand and iron ore.						SPT 8, 12, 17, 21
			SS	29					23.71	36	77.3			
														SPT 20, 30, 50/5. 17" recovered
			SS	80										
354.6	10				Soft	SC		Red-orange fine SAND, little clay, damp. Occasional iron ore.						
					Soft	CL		Brownish tan CLAY, little silt, little sand, Damp.						SPT 15, 20, 24, 31. 18" recovered.
			SS	44	Soft	SM		Red-orange fine SAND, little clay, Damp.						
														SPT 11, 12, 9, 32.
			SS	21					20.35	NP	33.5			
														SPT 6, 6, 12, 6.
349.6	15		SS	18										
					Soft	SM-SC		Light brown fine SAND, with little silt, little sand, Damp.						
														SPT 12, 25, 50/5.
					Firm	CL		Black CLAY, with fine sand, Wet.						
			SS	75	Soft	SM-SC		Dark red fine SAND, little clay, little silt, Wet.						
														SPT 9, 16, 12, 15.
					Soft-Firm	SC		Dark grey fine SAND, little clay, Wet. Occasional clay seams.						
			SS	28										
344.6	20													SPT 9, 17, 21, 27.
			SS	38	Firm	SC		↓ Frequent clay lenses.	22.55	13	36.6			
								8/11/09 ▼						
														SPT 22, 35, 50/4".
			SS	65										
														SPT 10, 15, 18, 28.
339.6	25		SS	33										
					Soft	SC		↓ Less clay lenses, Wet.						SPT 12, 27, 37, 50/5".
			SS	64										
														SPT 19, 24, 21, 50/5".
			SS	44										
					Hard	CL		Dark grey CLAY, little sand, trace silt, Wet.						
334.6	30													

Figure

WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

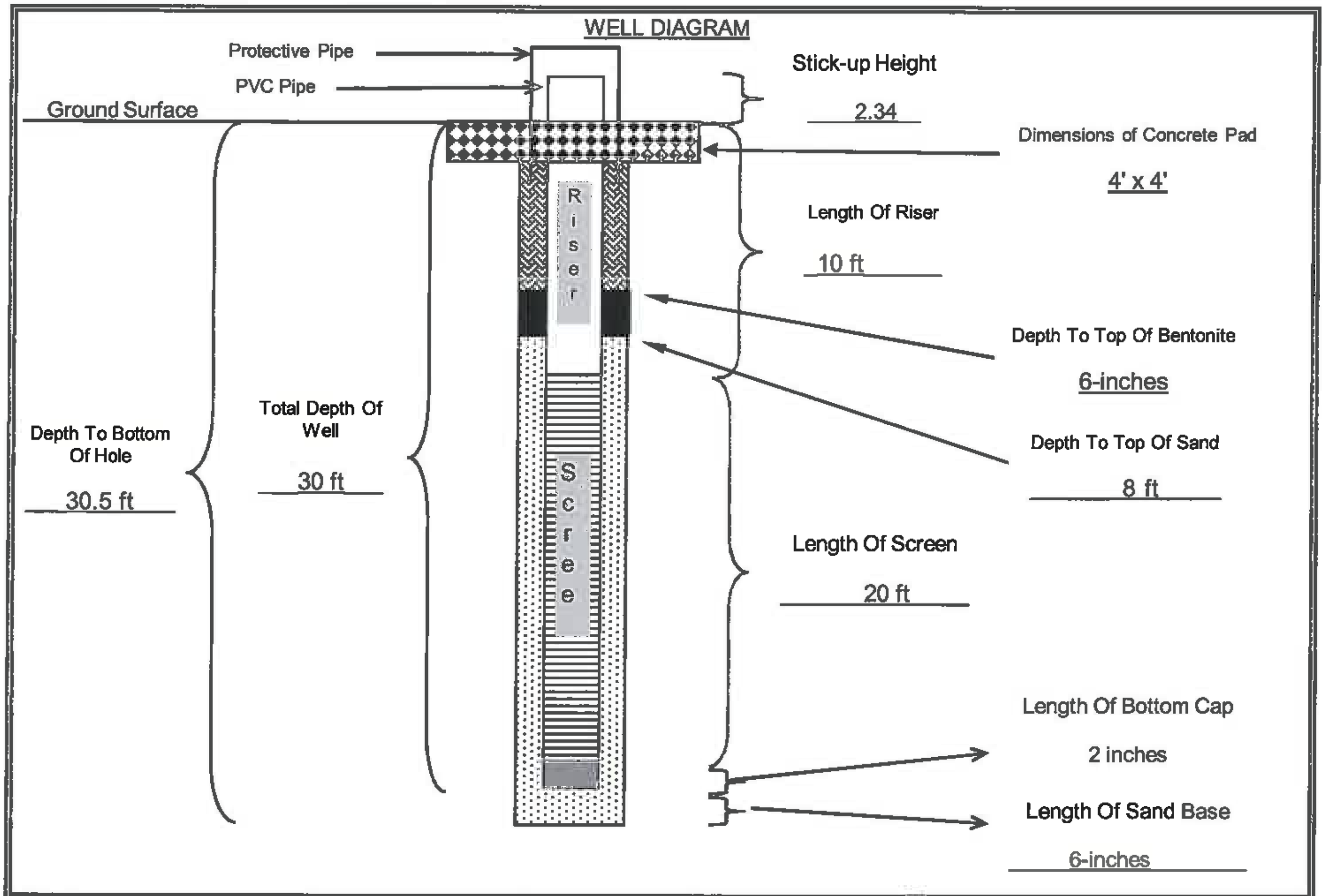
Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: 8/7/2009
WELL NO.: GB-02
WELL LOCATION:
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION: 364.56 (ft, msl)
TOP OF SCREEN ELEVATION: 354.56 (ft, msl)
BOTTOM OF WELL ELEVATION: 334.06 (ft, msl)
NORTHING: 747.0223 EASTING: -2442.888
SCREEN MATERIAL: PVC
SCREEN MANUFACTURER:
RISER MATERIAL: PVC
RISER MANUFACTURER:
RISER DIAMETER: 2 (in) Length: 10 (ft)
SCREEN DIAMETER: 2 (in) Length: 20 (ft)
BOREHOLE DIAMETER: 8 (in)
DRILLING TECHNIQUE: Hollow stem Size: (in)

BENTONITE TYPE: Western Bentonite
MANUFACTURER: PDS
CEMENT TYPE: Not used-sealed with bentonite chips
CEMENT MANUFACTURER:
SAND PACK TYPE AND SIZE: Silica 20/40
SAND MANUFACTURER: Uninum
DRILLING CONTRACTOR: Total Support Services
AMOUNT BENTONITE USED: 4 bags lbs
AMOUNT CEMENT USED: bags lbs
AMOUNT SAND USED: 13 bags lbs
STATIC WATER: 21.53 depth from TOC
ENCOUNTERED WATER: depth from ground

WELL DIAGRAM



Stick-up Height 2.34
Dimensions of Concrete Pad 4' x 4'
Length Of Riser 10 ft
Depth To Top Of Bentonite 6-inches
Depth To Top Of Sand 8 ft
Depth To Bottom Of Hole 30.5 ft
Total Depth Of Well 30 ft
Length Of Screen 20 ft
Length Of Bottom Cap 2 inches
Length Of Sand Base 6-inches

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

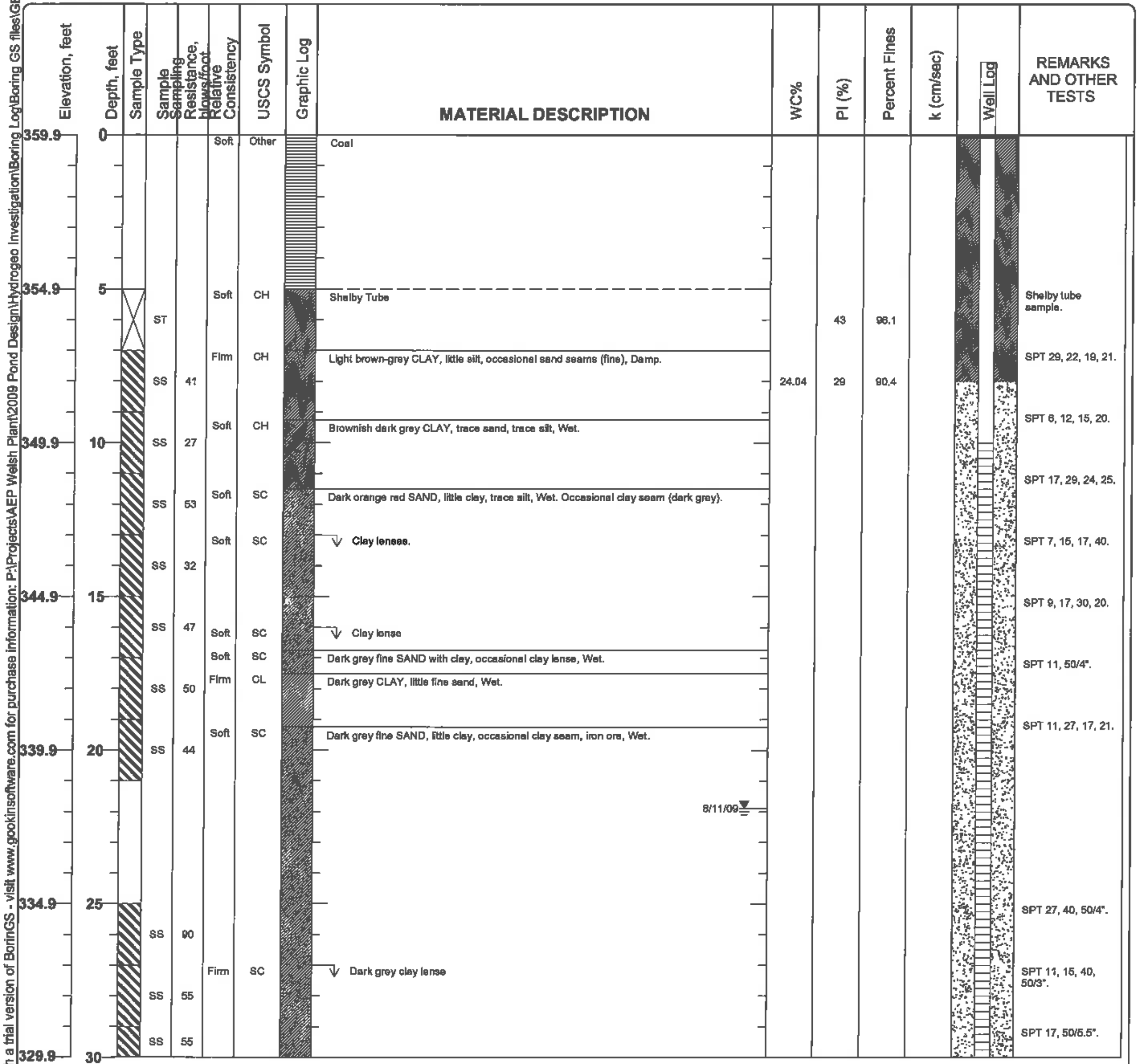
QA/QC
INSTALLED BY: Total Support Services
OBSERVED BY: Kush Chohan
DATE: August 7th, 2009
CHECKED BY:
DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-03

Sheet 1 of 2

Date(s) Drilled **August 7, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **31 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **359.91 feet MSL**
Groundwater Level and Date Measured **21.89 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Well Completion**	Location **Southwest corner of proposed chemical pond near screening pile.**	



Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
359.9	0				Soft	Other		Coal						
354.9	5				Soft	CH		Shelby Tube						Shelby tube sample.
			ST							43	96.1			
					Firm	CH		Light brown-grey CLAY, little silt, occasional sand seams (fine), Damp.						SPT 29, 22, 19, 21.
			SS	41					24.04	29	90.4			
					Soft	CH		Brownish dark grey CLAY, trace sand, trace silt, Wet.						SPT 6, 12, 15, 20.
349.9	10		SS	27										
					Soft	SC		Dark orange red SAND, little clay, trace silt, Wet. Occasional clay seam (dark grey).						SPT 17, 29, 24, 25.
			SS	53										
					Soft	SC		Clay lenses.						SPT 7, 15, 17, 40.
			SS	32										
344.9	15													SPT 9, 17, 30, 20.
			SS	47	Soft	SC		Clay lense						
					Soft	SC		Dark grey fine SAND with clay, occasional clay lense, Wet.						SPT 11, 50/4".
					Firm	CL		Dark grey CLAY, little fine sand, Wet.						
			SS	50										
					Soft	SC		Dark grey fine SAND, little clay, occasional clay seam, iron ore, Wet.						SPT 11, 27, 17, 21.
339.9	20		SS	44										
								8/11/09 ▼						
334.9	25													SPT 27, 40, 50/4".
			SS	90										
					Firm	SC		Dark grey clay lense						SPT 11, 15, 40, 50/3".
			SS	55										
			SS	55										SPT 17, 50/5.5".
329.9	30													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-03

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
329.9	30	SS	55	Hard	CL	▨	Dark grey CLAY, trace silt, trace fine sand.						SPT 17, 50/5.5".
							Bottom of Boring at 31 feet bgs						
324.9	35												
319.9	40												
314.9	45												
309.9	50												
304.9	55												
299.9	60												
294.9	65												

Figure

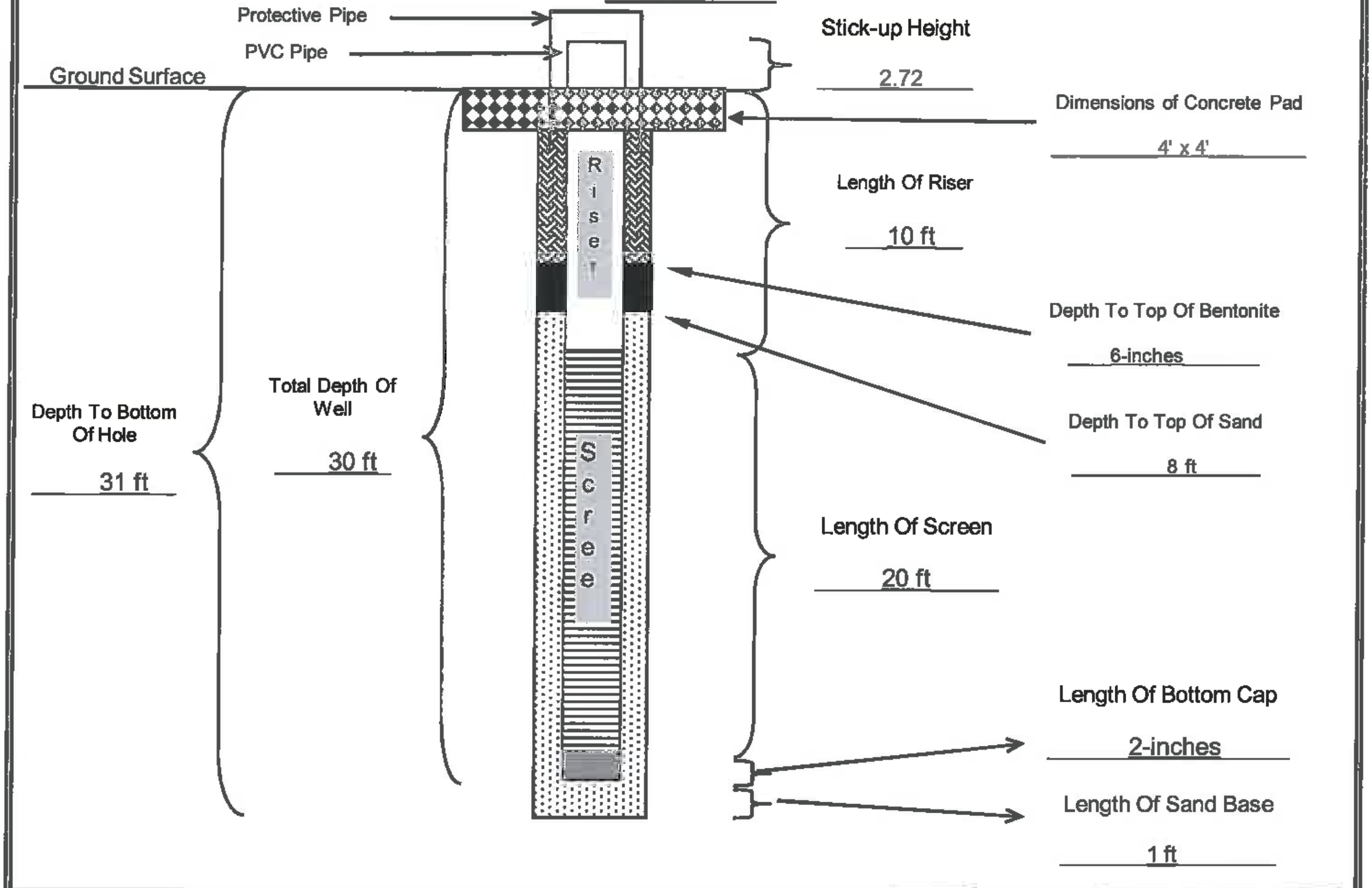
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		
JOB NO.:	TXL0064		
DATE/TIME:	8/7/2009	WELL NO.:	GB-03
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	359.57 (ft, msl)		BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	349.57 (ft, msl)		MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	328.57 (ft, msl)		CEMENT TYPE:	None used-sealed with bentonite chips
NORTHING:	460.5803	EASTING: -2507.6332	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC		SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:			SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC		DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:			AMOUNT BENTONITE USED:	4 bags lbs
RISER DIAMETER:	2 (in)	Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in)	Length: 20 (ft)	AMOUNT SAND USED:	12 bags lbs
BOREHOLE DIAMETER:	8 (in)		STATIC WATER:	21.89 depth from TOC
DRILLING TECHNIQUE:	Hollow Stem	Size: 8 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.72

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Depth To Bottom Of Hole: 31 ft

Total Depth Of Well: 30 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 1 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC	INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush S. Chohan
	DATE:	7-Aug-09	CHECKED BY:	DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-04

Sheet 1 of 2

Date(s) Drilled **July 24, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **34 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **357.22 feet MSL**
Groundwater Level and Date Measured **20.54 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Well Completion**	Location **Southeast corner of proposed chemical evaportation pond. Located in a grassy field.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.2	0				Soft	SM-SC		Reddish brown fine SAND, little silt, trace clay, damp.						SPT 1, 3, 6, 6. 24" recovered.
			SS	9	Soft	Other		COAL						
					Firm	SC		Brownish red SAND, little clay, trace silt. Damp.						
					Firm	CL		Reddish pink CLAY, some fine sand, Dry.						SPT 4, 4, 4, 4. 24" recovered.
			SS	8					24.49	47	90.2			
					Soft	Other		Oxidized SAND and clay with iron ore.						SPT 5, 6, 8, 4. 18" recovered.
352.2	5		SS	14	Soft	CH		Light reddish brown CLAY and sand mixture, Dry.						
					Soft	SC		Reddish brown SAND, little clay, Dry.						12" Shelby tube. 9" recovered.
			ST						28.4	38	61.1	7.7E-09		
														SPT 3, 4, 13, 15. 27" recovered.
			SS	17	Firm	CH		Light brownish tan CLAY, little sand, occasional sand seams, Dry.						
347.2	10													
342.2	15				Soft	SC		Red/yellowish brown SAND, some clay, Wet.						SPT 3, 7, 3, 15. 24" recovered.
			SS	10	Firm	SC		Occasional clay lenses.	6.95	14	47			
337.2	20		ST					8/11/09 ▼						Shelby tube. 12" driven 0" pulled. Gravel material encountered.
					Soft to Firm	SM		Black to dark grey fine/med SAND, little clay, occasional clay lenses, Wet.						SPT 7, 10, 9, 13. 24" recovered.
			SS	19										
332.2	25				Soft	SM		Well graded light grey fine/med SAND, trace silt, Wet.						SPT 17, 24, 50/5.5". 19" recovered.
			SS	74					22.29	NP	13.5			
					Firm	CL		Dark grey clay lense, Wet.						
					Firm	SM-SC		Well graded light grey fine/med SAND, trace silt, Wet.						
327.2	30													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-04

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
327.2	30	☒	ST		Hard	ML		Dark grey CLAY, little sand, Wet.						12" Shelby tube. Bent shelby tube.
		☒	ST						21.3	NP	84.2	2.0E-08		12" Shelby tube.
		▨			Hard	CL		Dark grey CLAY, trace sand, Wet.						SPT 15, 19, 19, 25. 24" recovered.
			SS	38					25.44	18	92.5			
								Bottom of Boring at 34 feet bgs						
322.2	35													
317.2	40													
312.2	45													
307.2	50													
302.2	55													
297.2	60													
292.2	65													

WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

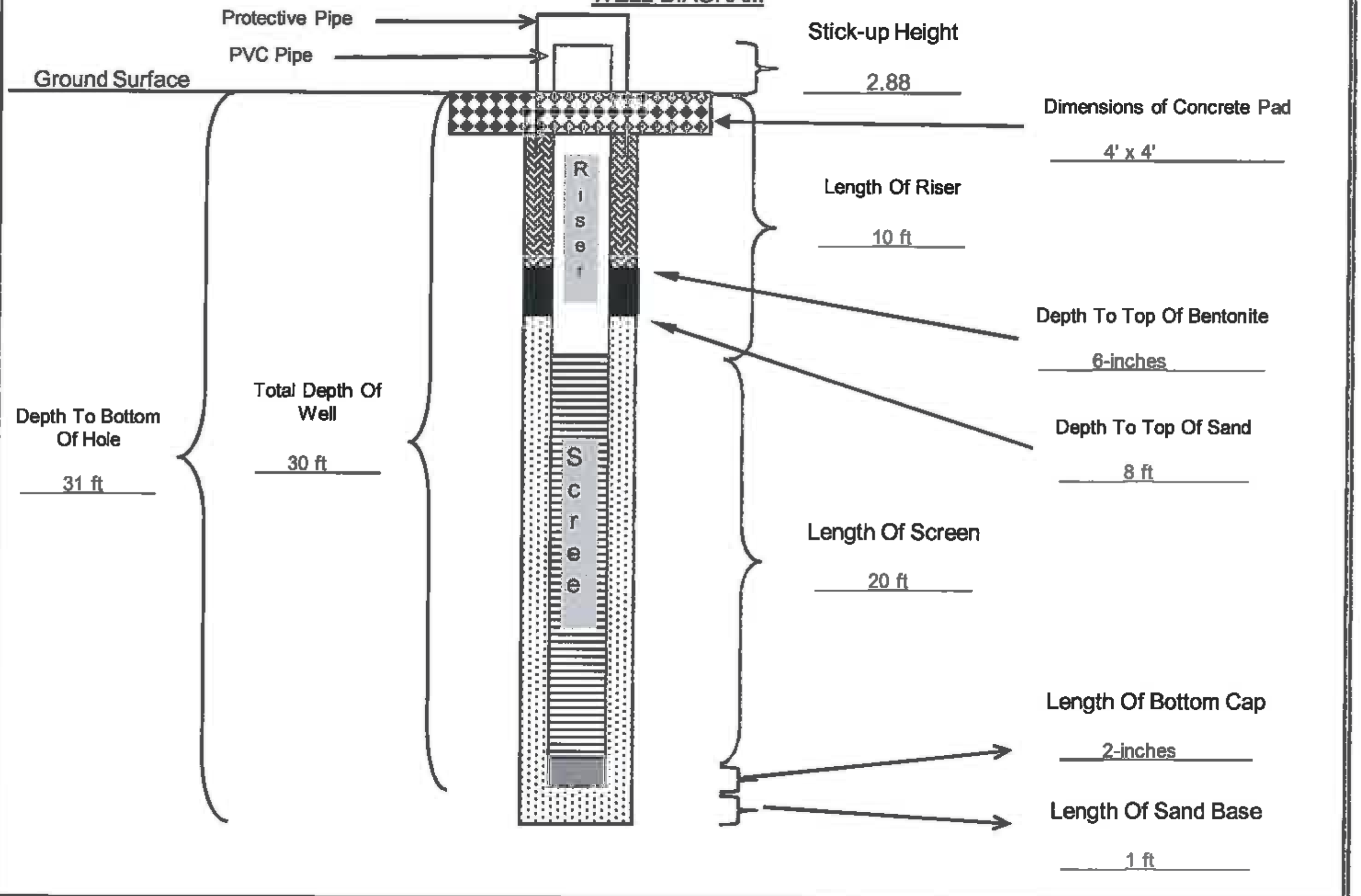
Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: 24-Jul-09
WELL LOCATION:
WELL NO.: GB-04
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION: 357.22 (ft, msl)
TOP OF SCREEN ELEVATION: 347.22 (ft, msl)
BOTTOM OF WELL ELEVATION: 326.22 (ft, msl)
NORTHING: -384.9666 EASTING: -2353.7375
SCREEN MATERIAL: PVC
SCREEN MANUFACTURER:
RISER MATERIAL: PVC
RISER MANUFACTURER:
RISER DIAMETER: 2 (in) Length: 10 (ft)
SCREEN DIAMETER: 2 (in) Length: 20 (ft)
BOREHOLE DIAMETER: 6.75 (in)
DRILLING TECHNIQUE: Hollow Stem Size: 6.75 (in)

BENTONITE TYPE: Western Bentonite
MANUFACTURER: PDS
CEMENT TYPE:
CEMENT MANUFACTURER:
SAND PACK TYPE AND SIZE: Silica 20/40
SAND MANUFACTURER: Uninum
DRILLING CONTRACTOR: Total Support Services
AMOUNT BENTONITE USED: 3 bags lbs
AMOUNT CEMENT USED: bags lbs
AMOUNT SAND USED: 7 bags lbs
STATIC WATER: 20.54 depth from TOC
ENCOUNTERED WATER: depth from ground

WELL DIAGRAM



Stick-up Height: 2.88
Dimensions of Concrete Pad: 4' x 4'
Length Of Riser: 10 ft
Depth To Top Of Bentonite: 6-inches
Depth To Top Of Sand: 8 ft
Length Of Screen: 20 ft
Length Of Bottom Cap: 2-inches
Length Of Sand Base: 1 ft
Total Depth Of Well: 30 ft
Depth To Bottom Of Hole: 31 ft

▨ Cement/Bentonite Grout ░ Sand Pack ▦ Neat Concrete ■ Bentonite ▒ Bottom Cap

QA/QC
INSTALLED BY: Total Support Services
DATE: 24-Jul-09
OBSERVED BY: Kush S. Chohan
CHECKED BY:
DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-05

Sheet 1 of 2

Date(s) Drilled **July 24, 2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **30.5 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **357.49 feet MSL**
Groundwater Level and Date Measured **15.3 feet measured on 8-11-09**	Sampling Method(s) **SPT, Tube**	Hammer Data **140 lb, 30 in drop, Auto-hammer**
Borehole Backfill **Well Completion**	Location **Eastern edge of proposed chemical evaporation pond.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.5	0				Soft	SW-SM		Dark fine SAND with brown organic material and roots.						SPT 2, 2, 5, 5. 24" recovered
			SS	7	Firm	CH		Dark red/grey CLAY, trace silt. Dry.	23.37	44	68.6			
														SPT 4, 4, 7, 9. 24" recovered.
			SS	11								7E-07		
														SPT 5, 6, 8, 13. 24 recovered
352.5	5		SS	14										
						CH		Trace of sand						
			ST		Soft	CH		Dark red fine SAND, trace clay, Damp.	16.5	41	73.8	3.2E-08		Shelby tube. Pushed 12 recovered 9".
														SPT 5, 7, 11, 11. 24" recovered.
			SS	18	Firm	CH		Light tan CLAY, trace sand, Dry.						
					Soft	SC		Dark red SAND, trace of CLAY, Damp.						
					Firm	CL		Light tan CLAY, trace fine sand, Dry.						
					Soft	SC		Dark red SAND, little clay, frequent clay seams, Damp						SPT 6, 7, 11, 14. 24" recovered.
347.5	10		SS	16										
						SC		Frequent clay seams						SPT 11, 22, 13, 14. 24" recovered.
			SS	35	Soft	SC		Red/orange fine SAND, trace clay, trace coarse sand, poorly sorted, Moist.						
														SPT 17, 27, 50/5". 17" recovered.
			SS	77	Firm	CL		Brownish grey CLAY, trace sand, Moist.						
					Soft	SC		Tanish grey fine SAND, some clay, Wet.						
342.5	15													
			ST					8-11-09 ▼	19.9	13	35.7	6.6E-07		Shelby tube. Pushed 12" recovered 9".
														SPT 11, 13, 10, 14. 24" recovered.
			SS	23					27.98	NP	32.3			
					Soft	SM		Dark grey coarse SAND/GRAVEL mix, some fine sand, trace clay, Wet.						
					Soft	SM-SC		Red fine SAND, trace clay, Moist. cemented. Moist.						SPT 7, 8, 11, 13. 24" recovered.
			SS	19										
					Firm	SC		Black fine SAND, occasional clay, Wet.						
337.5	20													
					Firm	CL		Dark grey CLAY, little sand, Wet.						SPT 8, 10, 12, 15. 24" recovered.
			SS	22	Firm	SM		Black fine SAND, some medium sand, some clay, Wet.	32.23	NP	35.5			
					Firm	CL		Dark grey CLAY, little sand, Wet.						
					Firm	SM		Black fine SAND, some medium sand, some clay, Wet.						
														SPT 6, 11, 17, 21. 24" recovered.
			SS	28	Firm	SM		Frequent clay seams						
					Firm	SM		Frequent clay seams.						
			ST											Shelby tube. 12" driven 0 recovered.
332.5	25													SPT 15, 19, 21, 27. 24" recovered.
			SS	40	Hard	CL		Dark grey CLAY, trace of sand, Dry.						
														SPT 10, 11, 11, 50/5". 23" recovered.
			SS	22										
					Very Hard	CL		Dark grey CLAY, frequent iron stone/ore. Rig chatter driller comments						
			ST						24.9	15	75.0	1.0E-07		Shelby tube. 12" driven 9" recovered.
327.5	30													

Figure

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-05

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
327.5	30	⊠	ST		Hard	CL	▨	Dark grey CLAY, trace of sand, Dry. (cont.)	24.9	15	75.0	1.0E-07		Shelby tube. 12" driven 9" recovered.
								Bottom of Boring at 30.5 feet bgs						
322.5	35													
317.5	40													
312.5	45													
307.5	50													
302.5	55													
297.5	60													
292.5	65													

Figure

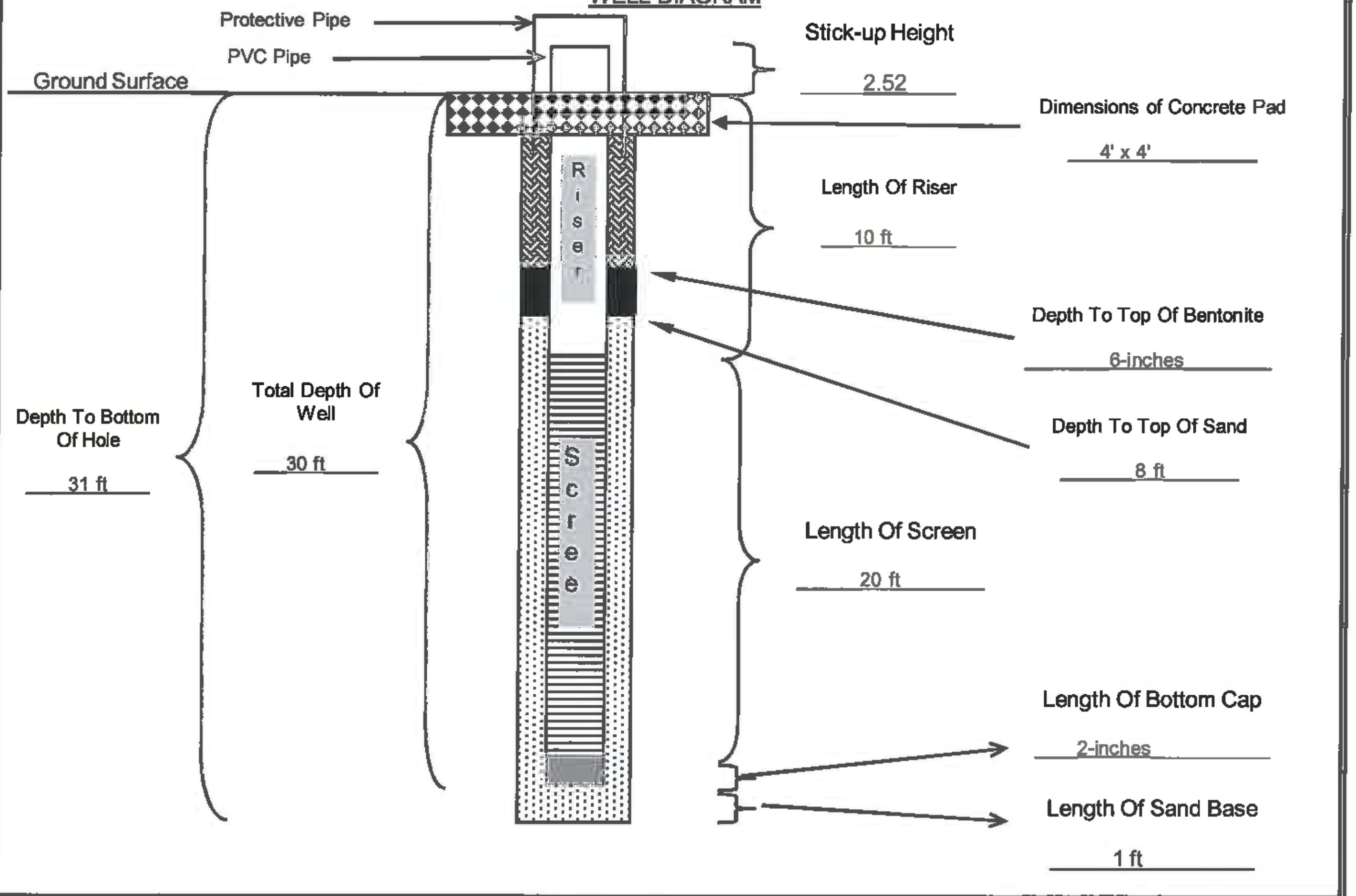
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME: AEP Welsh Power Plant
JOB NO.: TXL0064
DATE/TIME: August 6 2009
WELL LOCATION:
WELL NO.: GB-05
FIELD REP: Kush Chohan

GROUND SURFACE ELEVATION:	357.49 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	347.49 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	326.49 (ft, msl)	CEMENT TYPE:	
NORTHING: 529.1865	EASTING: -2243.9973	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	3 bags lbs
RISER DIAMETER:	2 (in) Length: 10 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in) Length: 20 (ft)	AMOUNT SAND USED:	7 bags lbs
BOREHOLE DIAMETER:	8 (in)	STATIC WATER:	17.33 depth from TOC
DRILLING TECHNIQUE:	Hollow Stem Size: 8 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.52

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 10 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 8 ft

Length Of Screen: 20 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 1 ft

Total Depth Of Well: 30 ft

Depth To Bottom Of Hole: 31 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC
INSTALLED BY: Total Support Services
OBSERVED BY: Kush Chohan
DATE: 6-Aug-09
CHECKED BY:
DATE:

Project: AEP Welsh Power Plant
Project Location: Cason, Texas
Project Number: TXL0064

Log of Boring GB-06

Sheet 1 of 1

Date(s) Drilled **7/23/2009**	Logged By **Kush S. Chohan**	Checked By
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type	Total Depth of Borehole **30 feet bgs**
Drill Rig Type **Mobil B61**	Drilling Contractor **Total Support Services**	Approximate Surface Elevation **357.41 feet MSL**
Groundwater Level and Date Measured **15.3 feet measured on 8/11/09**	Sampling Method(s) **SPT, Tube, Other**	Hammer Data **140 lb, 30 in drop, auto hammer**
Borehole Backfill **Well Completion**	Location **Northeast corner of proposed chemical pond in the middle of open grass field.**	

Elevation, feet	Depth, feet	Sample Type	Sample	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	WC%	PI (%)	Percent Fines	k (cm/sec)	Well Log	REMARKS AND OTHER TESTS
357.4	0				Soft	SP		Greyish brown fine SAND with trace fines. Organic material (roots).						Hand Auger
			HA		Soft	SP-SM		Greyish red fine SAND, little silt. Poorly sorted, less organic material.						
					Soft	SM		Greyish red fine SAND, with little silt and clay. Dry.						
					Soft			Tanish grey fine SAND, trace silt and clay, frequent iron oxide, frequent discoloration.						SPT 4, 7, 7. 18" recovered
			SS	14					12.74	34	67.9			
					Firm	CL		Red light brown CLAY, little sand, trace silt, Dry.						
352.4	5													SPT 3, 5, 6, 8. 20" recovered
			SS	11	Soft	SC		Dark reddish brown fine SAND, little clay.						
					Soft	CL		Light grey CLAY, little sand, trace silt. Dry.						SPT 3, 5, 7, 7. 24" recovered
					Soft	SC		Reddish brown fine SAND, trace clay, trace silt. Occasional clay seams. Damp.						
			SS	12					17.65	NP	43.2			
					Soft	CL		Light grey CLAY, little fine sand						
			SS		Soft to Firm	SC		Brownish red fine SAND, little to some clay, some cementation, Damp.						24" driven, 15" recovered.
347.4	10													
														SPT 8, 9, 10, 10. 24" recovered.
			SS	19										
					Soft to Firm	CL		Brown CLAY, little fine sand, frequent brown sand-clay mixture with iron ore oxide.						Shelby Tube. 24" driven/16" recovered
			ST						22.9	21	43.2	6.0e-07		
342.4	15				Firm	CL		Dark redish brown CLAY, little fine sand, Damp. 8/11/09 ▼						SPT 15, 10, 22, 30. 24" recovered
			SS	40	Firm	SC		Dark reddish brown SAND, little to some clay, Moist.						
					Firm	CL		Black CLAY, little fine sand, Wet.						SPT 2, 8, 14, 10. 24" recovered
			SS	22	Firm	SW		Black fine SAND, trace clay, trace med sand, Wet.						
					Firm	CL		Black CLAY, trace fine sand, trace silt, Wet.						SPT 5, 8, 22, 50/4". 22 recovered.
						SC		Black fine SAND, little clay, Wet.						
337.4	20		SS	30	Firm	CL		Black CLAY, trace sand, trace silt. Wet.						
					Firm	SC		Black fine SAND, trace to little clay, Wet. Occasional black clay seams.						SPT 10, 11, 23, 33. 24" recovered
			SS	34	Firm	SP-SC		Black fine SAND, with little clay, trace med sand, Wet.						
						SW-SC		Grading to med SAND, Wet.						SPT 11, 18, 18, 24. 24" recovered.
			SS	36										
332.4	25													SPT 9, 11, 12, 22. 24" recovered.
			SS	23	Firm	SW-SC		Occasional CLAY lenses, Wet.						
					Firm	SC		Black fine SAND, little med sand and clay, Wet.						SPT 7, 15, 25, 50/3". 21 recovered.
			SS	40	Hard	CL		Dark grey CLAY, little sand, little silt, Dry.						
			ST							19	45.1			Shelby tube. 12" driven-8" recovered.
327.4	30							Bottom of Boring at 30 feet bgs						

Figure

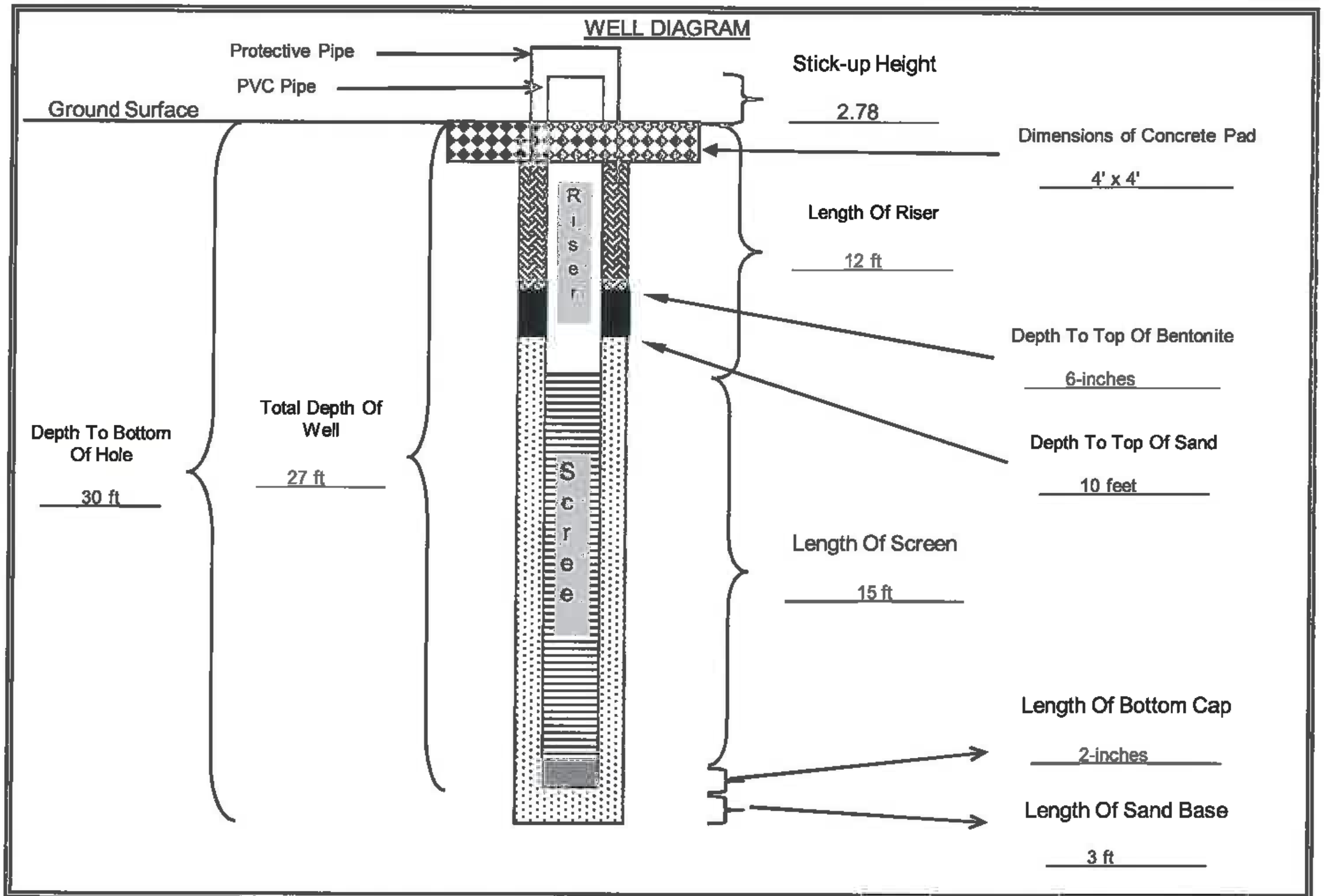
WELL CONSTRUCTION DIAGRAM - EPA TYPE II WELL (STICK-UP)

Geosyntec consultants

JOB NAME:	AEP Welsh Power Plant		
JOB NO.:	TXL0064		
DATE/TIME:	23-Jul-09	WELL NO.:	GB-06
WELL LOCATION:		FIELD REP:	Kush Chohan

GROUND SURFACE ELEVATION:	357.41 (ft, msl)	BENTONITE TYPE:	Western Bentonite
TOP OF SCREEN ELEVATION:	345.41 (ft, msl)	MANUFACTURER:	PDS
BOTTOM OF WELL ELEVATION:	327.41 (ft, msl)	CEMENT TYPE:	
NORTHING: 740.4893	EASTING: -2166.134	CEMENT MANUFACTURER:	
SCREEN MATERIAL:	PVC	SAND PACK TYPE AND SIZE:	Silica 20/40
SCREEN MANUFACTURER:		SAND MANUFACTURER:	Uninum
RISER MATERIAL:	PVC	DRILLING CONTRACTOR:	Total Support Services
RISER MANUFACTURER:		AMOUNT BENTONITE USED:	2.5 bags lbs
RISER DIAMETER:	2 (in) Length: 12 (ft)	AMOUNT CEMENT USED:	bags lbs
SCREEN DIAMETER:	2 (in) Length: 15 (ft)	AMOUNT SAND USED:	7 bags lbs
BOREHOLE DIAMETER:	6.75 (in)	STATIC WATER:	15.3 depth from TOC
DRILLING TECHNIQUE:	Hollow Stem Size: 6.75 (in)	ENCOUNTERED WATER:	depth from ground

WELL DIAGRAM



Stick-up Height: 2.78

Dimensions of Concrete Pad: 4' x 4'

Length Of Riser: 12 ft

Depth To Top Of Bentonite: 6-inches

Depth To Top Of Sand: 10 feet

Length Of Screen: 15 ft

Total Depth Of Well: 27 ft

Depth To Bottom Of Hole: 30 ft

Length Of Bottom Cap: 2-inches

Length Of Sand Base: 3 ft

▨	Cement/Bentonite Grout	░	Sand Pack	▦	Neat Concrete	■	Bentonite	▩	Bottom Cap

QA/QC INSTALLED BY:	Total Support Services	OBSERVED BY:	Kush Chohan
DATE:	23-Jul-09	CHECKED BY:	DATE:

E·A·G·L·E
ENVIRONMENTAL SERVICES
OF SHREVEPORT, INC.

SOIL BORING LOG

BORING/WELL NO.:	**GB-07/MW-7**
TOTAL DEPTH:	**34'**
TOP OF CASING ELEV.:	**362.75 ft. NGVD**
GROUND SURFACE ELEV.:	**360.20 ft. NGVD**

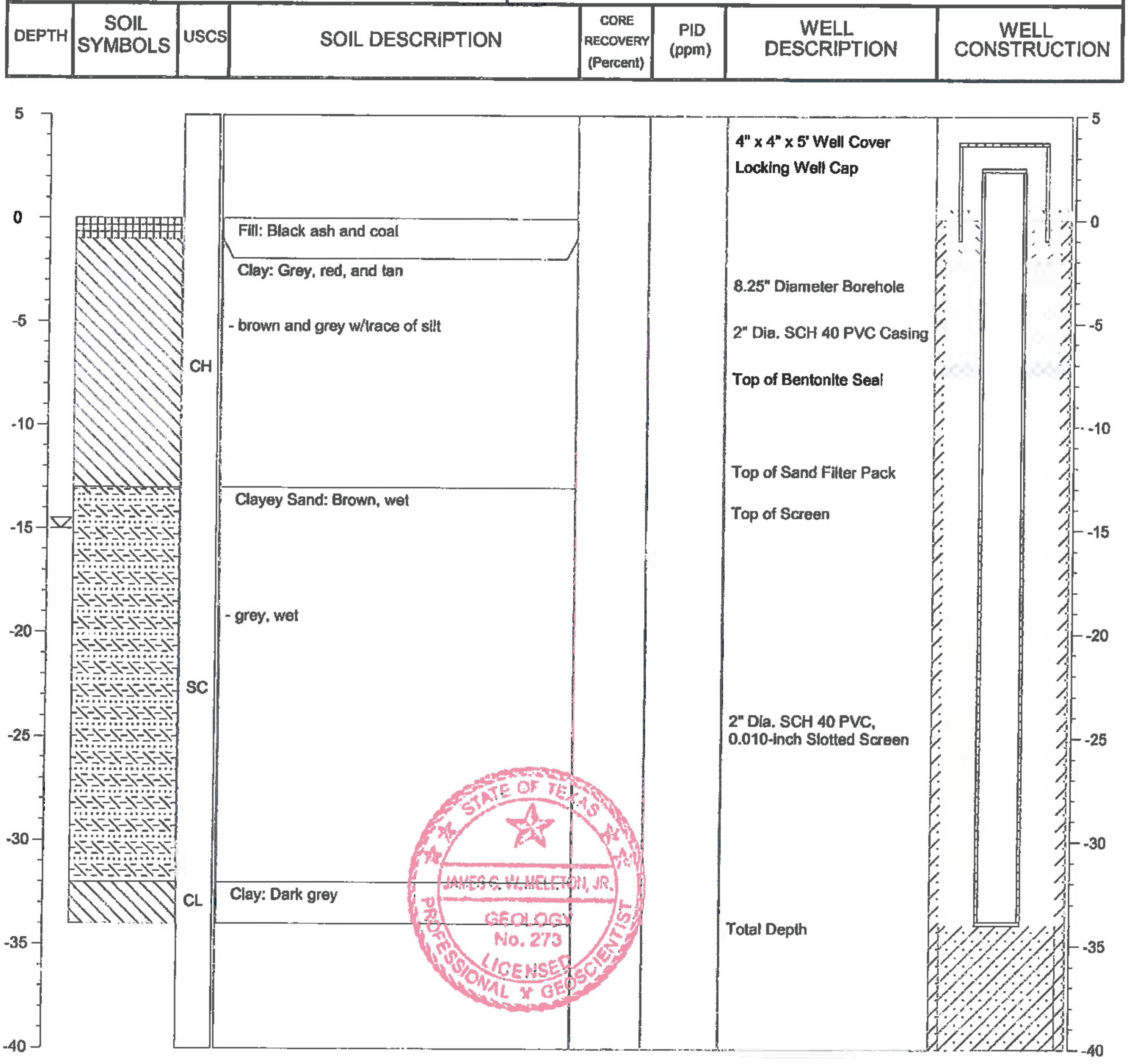
CLIENT:	**AEP**
PROJECT:	**Metal Cleaning Waste Pond**
SITE LOCATION:	**Welsh Power Plant**
PROJECT NO.:	**S-08-0120**
LOGGED BY:	**James Meleton, Jr.**

DRILLING CO.:	**WEST Drilling**
DRILLER:	**Tom McCullough**
METHOD OF DRILLING:	**Hollow-stem Auger**
SAMPLING METHODS:	**Split-spoon**
DATE DRILLED:	**12/1/09**

NOTES: **Latitude: 33.05455**
Longitude: 94.84674

▽ Water level during drilling
▼ Water level in completed well

Page 1 of 1



STATE OF TEXAS
JAMES C. W. MELETON, JR.
GEOLOGY
No. 273
LICENSED PROFESSIONAL GEOSCIENTIST

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-1

PROJECT: Welsh Power Plant
Pittsburgh, Texas

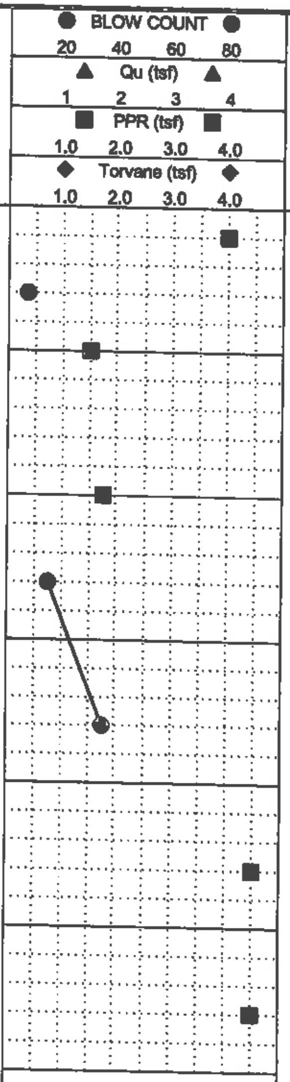
PROJECT NO.: G3242-09

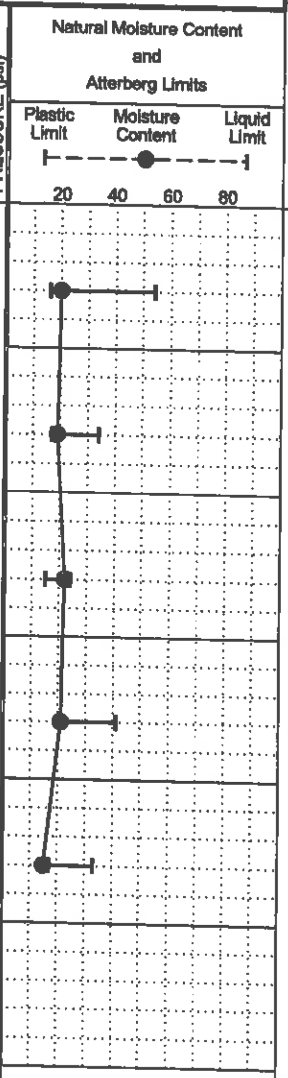
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 324.1

USC	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. #)
CL	SANDY LEAN CLAY(CL) very stiff; brownish orange	P=4.0 SF										
SM	SILTY SAND(SM) tannish orange	N=7										
CH	SANDY FAT CLAY(CH) medium stiff; tannish orange						20	54	16	38	63	+40Sieve=10%, +4 Sieve=1%
	–stiff	P=1.5										
SC	CLAYEY SAND(SC) medium dense; tannish orange; with clay seams	P=1.75					19	34	17	17	32	+40 Sieve=7%, +4 Sieve=3%
CL	SANDY LEAN CLAY(CL) stiff; orange											
SC	CLAYEY SAND(SC) medium dense; orange; saturated; with iron oxide cemented sandstone rock	N=15					22	24	15	9	19	+40Sieve=35%, +4 Sieve=22%
CL	LEAN CLAY WITH SAND(CL) hard; dark gray; with clay seams	N=35					21	41	21	20	75	+40 Sieve=2%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) hard; dark brown	P=4.5+					15	33	17	16	52	+40 Sieve=1%, +4 Sieve=0%
	–grayish brown; laminated with silt	P=4.5+										
	Bottom of Boring @ 30'											





DEPTH (ft) 0 5 10 15 20 25 30

SAMPLES

GEOLOGIC UNIT

WATER LEVEL

Water Level Est.: ∇ Measured: ▼ Perched: ∇

Water Observations: Seepage @ 5' while drilling. Water level @ 4' and open to 30' upon completion.

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

Notes:
GPS Coordinates: N 33°03.090', W 94°50.417'

Piezometer B-2

LOG OF BORING B-2

ETTL
ENGINEERS &
CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

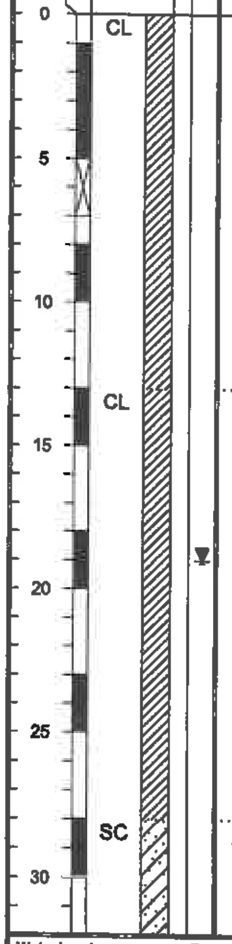
PROJECT NO.: G3242-09

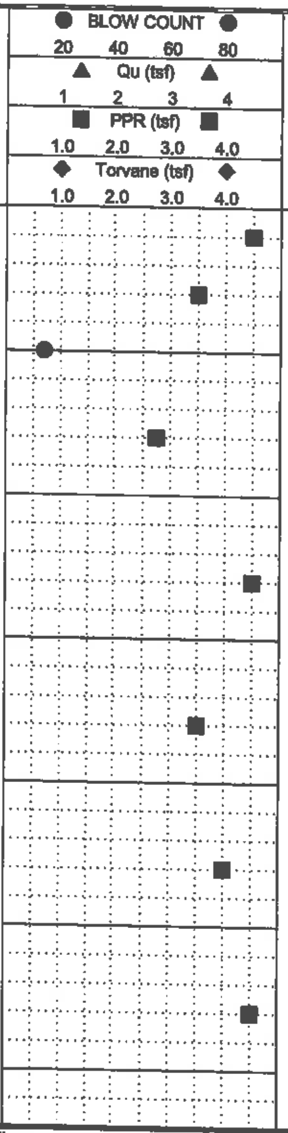
BORING TYPE: Flight Auger

DATE 10/28/09

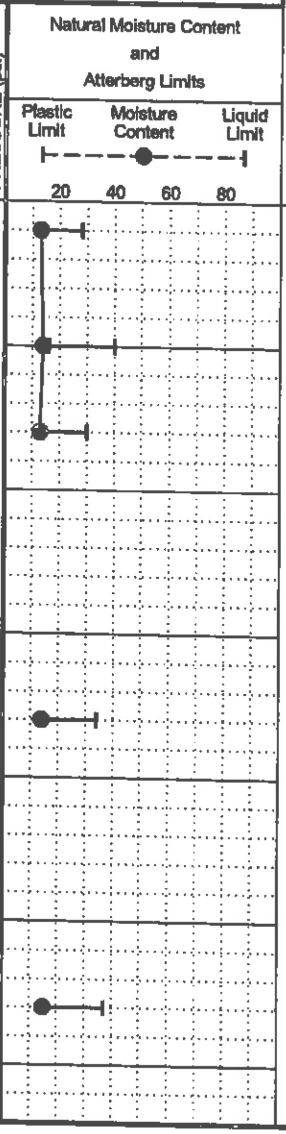
SURFACE ELEVATION 339.7

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	13	28	14	14	61	+40 Sieve=3%, +4 Sieve=0%
	–very stiff	P=3.5						
	–stiff	N=14	14	40	16	24	65	+40 Sieve=0%, +4 Sieve=0%
	–very stiff; reddish brown	P=2.75	13	30	14	16	58	+40 Sieve=0%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+						
	–very stiff	P=3.5	14	34	15	19	54	+40 Sieve=0%, +4 Sieve=0%
		P=4.0						
SC	CLAYEY SAND(SC) medium dense; tan, red, and gray	P=4.5	15	37	16	21	47	+40 Sieve=5%, +4 Sieve=3%





DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



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

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-2

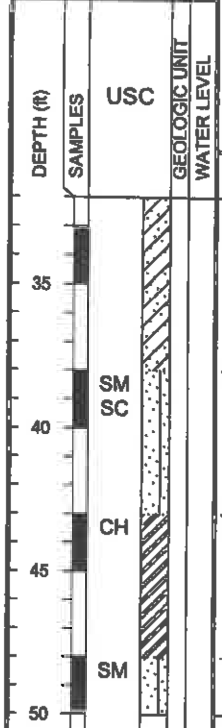
PROJECT: Welsh Power Plant
Pittsburgh, Texas

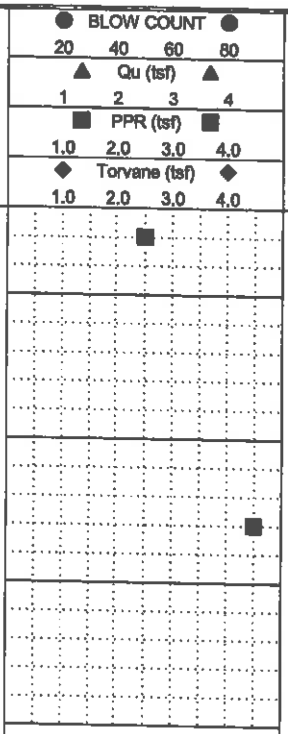
PROJECT NO.: G3242-09

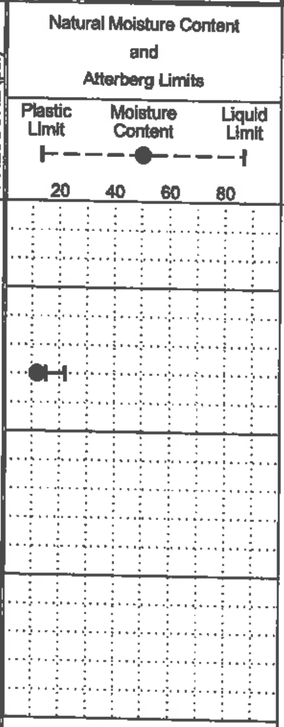
BORING TYPE: Flight Auger

DATE 10/28/09

SURFACE ELEVATION 339.7







DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		--red and tan	P=2.5										
	SM SC	SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated	SF					12	22	15	7	48	+40 Sieve=0%, +4 Sieve=0%
	CH	FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams	P=4.5+										
	SM	SILTY SAND(SM) black and gray	SF										
50		Bottom of Boring @ 50'											

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

Piezometer B-2

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

Well No. B-2

Location Pittsburg, Texas

Surface Elev.

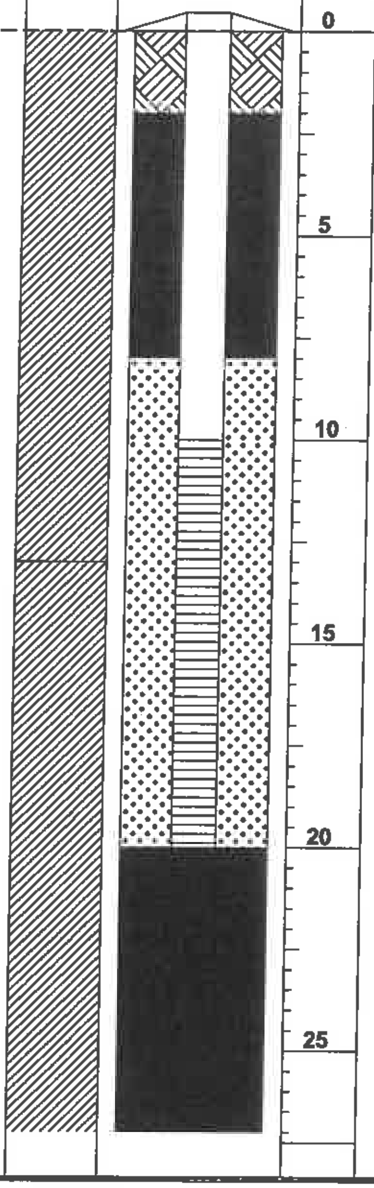
Page 1 **of** 2

Depth Feet Sampler	Overburden/Lithologic Description
0	Ground Surface
	SANDY LEAN CLAY(CL) hard; red and tan
	--very stiff
5	--stiff
	--very stiff; reddish brown
10	
	SANDY LEAN CLAY(CL) hard; red and tan
15	
	--very stiff
20	
25	

Continued Next Page

Field Strength Data | **Graphic Log** | **Well Construction Graphics** | **Depth Feet** | **Well Construction Details**

T.O.C. Elev.



Driller Doug Hinds

Logged By James Griffith

Drilling Started 10/28/09

Drilling Completed 10/28/09

Construction Completed

Development Completed

Type of Well

Drilling Method Soild Stem Auger

Borehole Diameter 6.5"

Well Casing 2.0" **Dia.** 0.0' **to** 10.0'

Casing Type PVC

Well Screen 2.0" **Dia.** 10.0' **to** 20.0'

Screen Type Slotted

Slot Size 0.010"

Grout Type Bentonite

Bentonite Seal 2-8' & 20-50'

Filter Pack Qty. 8-20'

Filter Pack Type 20/40 Sand

Static Water Level

Notes:

ETTL Engineers & Consultants Inc.

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

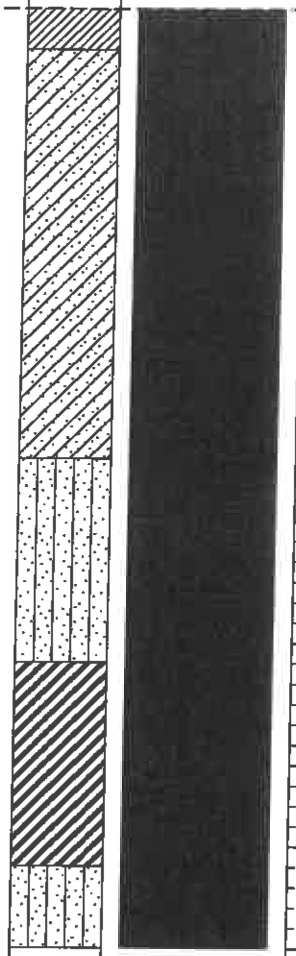
Well No. B-2

Location Pittsburg, Texas

Surface Elev.

Page 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
		Continued from previous page					
		CLAYEY SAND(SC) medium dense; tan, red, and gray					
30						30	
		--red and tan					
35						35	
		SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated					
40						40	
		FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams					
45						45	
		SILTY SAND(SM) black and gray					
50						50	
		Bottom of Boring @ 50'					
55							
60							



ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-3

PROJECT: Welsh Power Plant
Pittsburgh, Texas

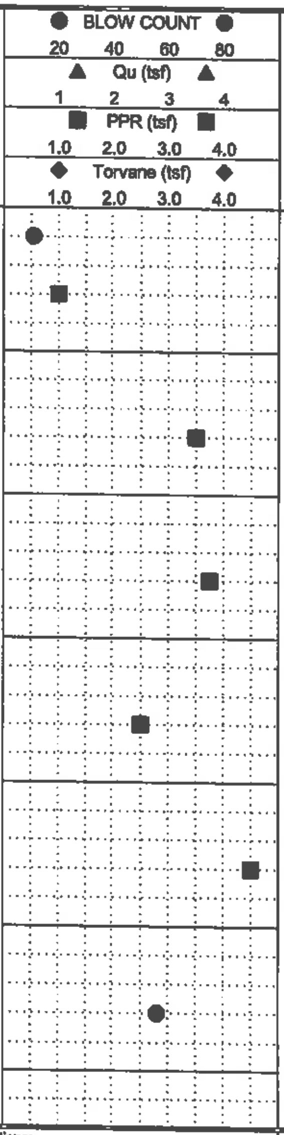
PROJECT NO.: G3242-09

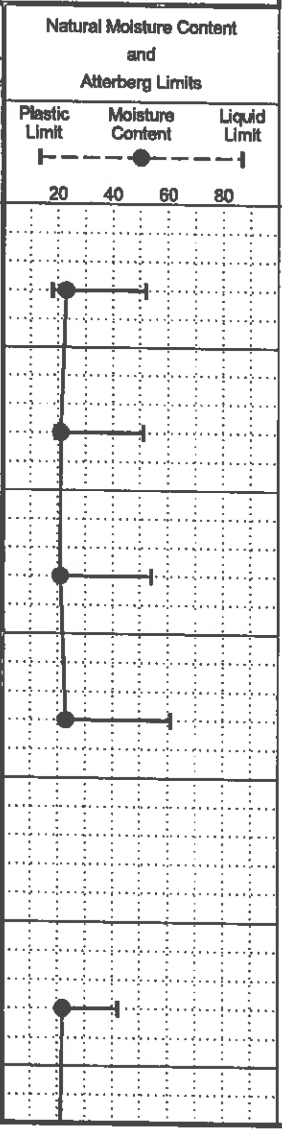
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	CLAYEY SAND(SC) medium dense; gray and red	N=11										
	CH	FAT CLAY(CH) stiff; red and tan; with sand seams	P=1.0					23	52	18	34	87	+40 Sieve=3%, +4 Sieve=0%
5													
		--very stiff	P=3.5					21	51	19	32	86	+40 Sieve=3%, +4 Sieve=0%
10													
	CH	FAT CLAY WITH SAND(CH) very stiff; brown; with ferric joints	P=3.75					21	54	20	34	85	+40Sieve=10%, +4 Sieve=1%
15													
		--red and tan; layered; with ferric seams	P=2.5					23	61	24	37	81	+40Sieve=11%, +4 Sieve=0%
20													
	CH	FAT CLAY(CH) hard; gray; with sand seams	P=4.5+										
25													
	SC	CLAYEY SAND(SC) very dense; gray; with sand seams	N=56					22	42	22	20	35	+40 Sieve=1%, +4 Sieve=0%
30													





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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

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

LOG OF BORING B-3

PROJECT: Welsh Power Plant
Pittsburgh, Texas

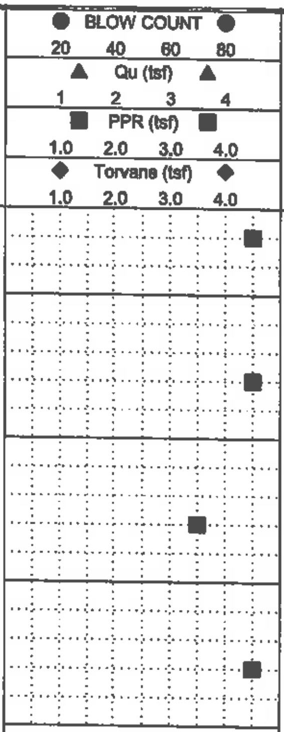
PROJECT NO.: G3242-09

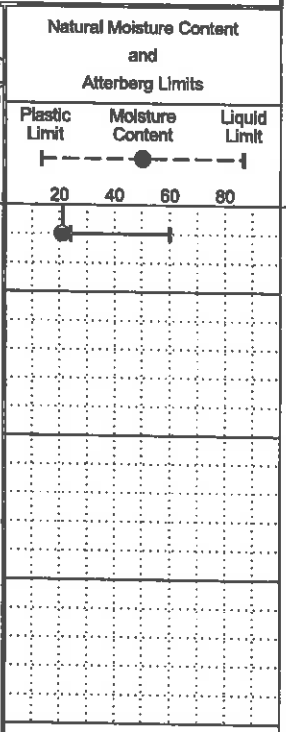
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

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. #)
35	■	CH	▨		FAT CLAY(CH) hard; brown; layered and with sand seams	P=4.5+					21	60	24	36	95	+40 Sieve=1%, +4 Sieve=0%
40	■		▨		--gray and green	P=4.5+										
45	■	CL	▨		SANDY LEAN CLAY(CL) very stiff; gray and dark green; layered; with sand seams	P=3.5										
50	■	CH	▨		FAT CLAY(CH) hard; gray and dark green; layered; with silt seams	P=4.5+										
					Bottom of Boring @ 50'											





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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' 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 33°02.998', W 94°50.514'

Piezometer B-4

ETTL
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CONSULTANTS

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

LOG OF BORING B-4

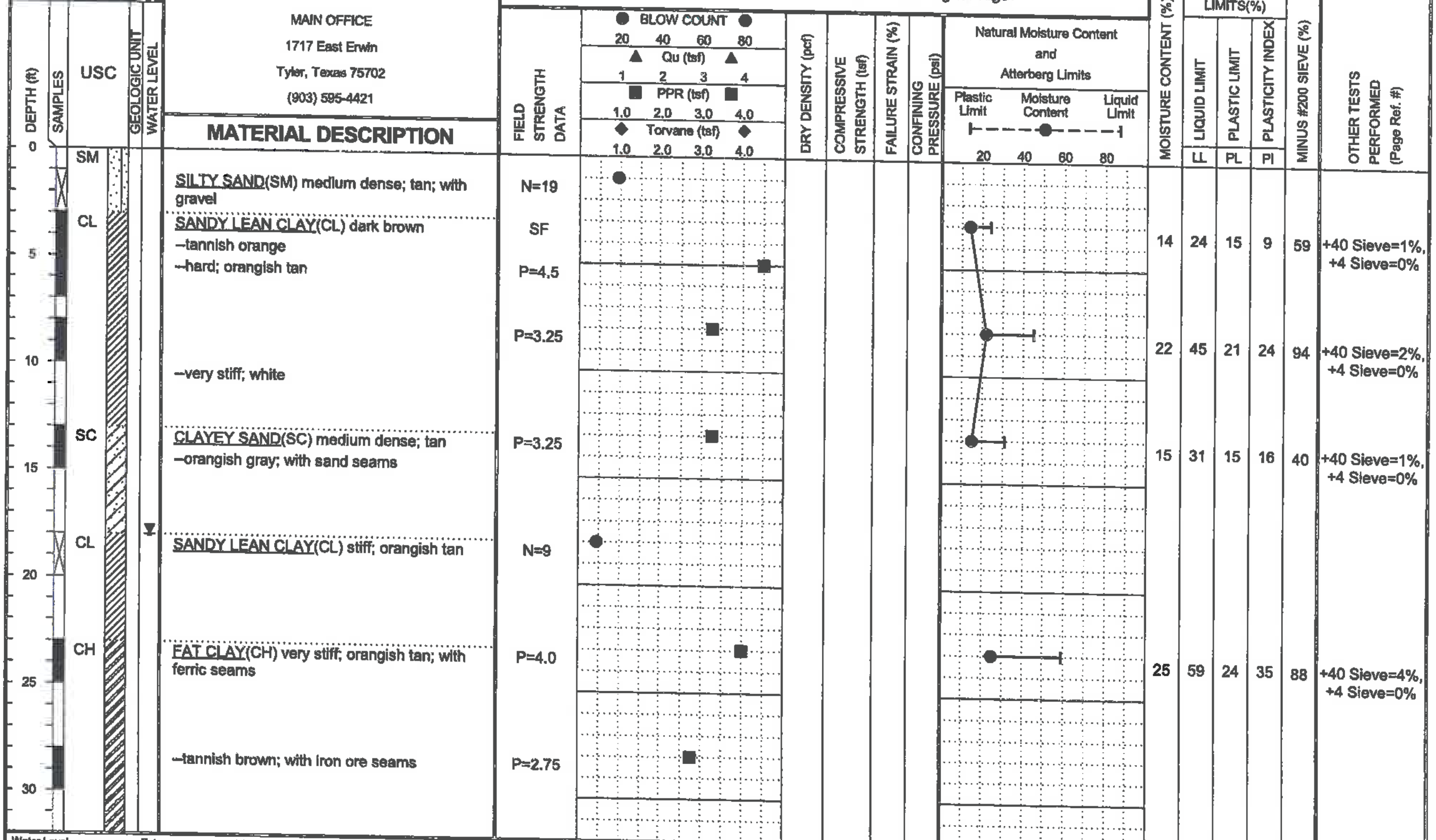
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6



USC	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. #)
SM	SILTY SAND(SM) medium dense; tan; with gravel	N=19						
CL	SANDY LEAN CLAY(CL) dark brown	SF						
	--tannish orange		14	24	15	9	59	+40 Sieve=1%, +4 Sieve=0%
	--hard; orangish tan	P=4.5						
		P=3.25	22	45	21	24	94	+40 Sieve=2%, +4 Sieve=0%
	--very stiff; white							
SC	CLAYEY SAND(SC) medium dense; tan	P=3.25						
	--orangish gray; with sand seams		15	31	15	16	40	+40 Sieve=1%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) stiff; orangish tan	N=9						
CH	FAT CLAY(CH) very stiff; orangish tan; with ferric seams	P=4.0	25	59	24	35	88	+40 Sieve=4%, +4 Sieve=0%
	--tannish brown; with iron ore seams	P=2.75						

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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

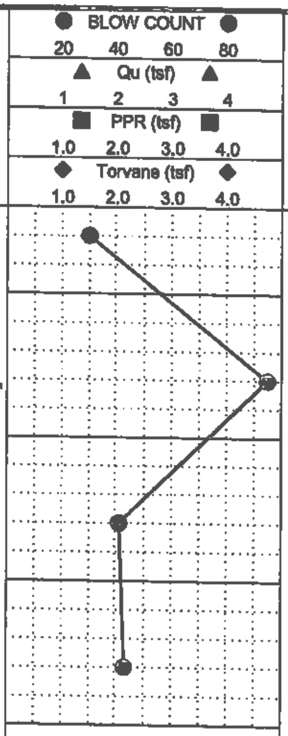
PROJECT NO.: G3242-09

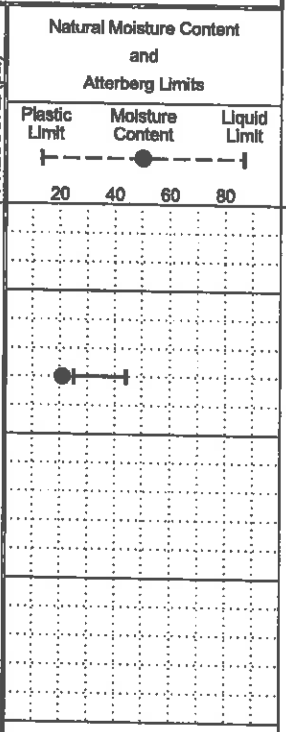
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6

DEPTH (ft)	SAMPLES	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	☒		–hard; light gray; layered and with silt seams	N=30										
40	☒	CL	LEAN CLAY(CL) hard; light gray; layered and with silt seams	N=50/5.75"					21	44	25	19	93	+40 Sieve=1%, +4 Sieve=0%
45	☒		–light gray	N=41										
50	☒		–layered and with sand seams; with lignite	N=43										
			Bottom of Boring @ 50'											





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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

Piezometer B-4

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

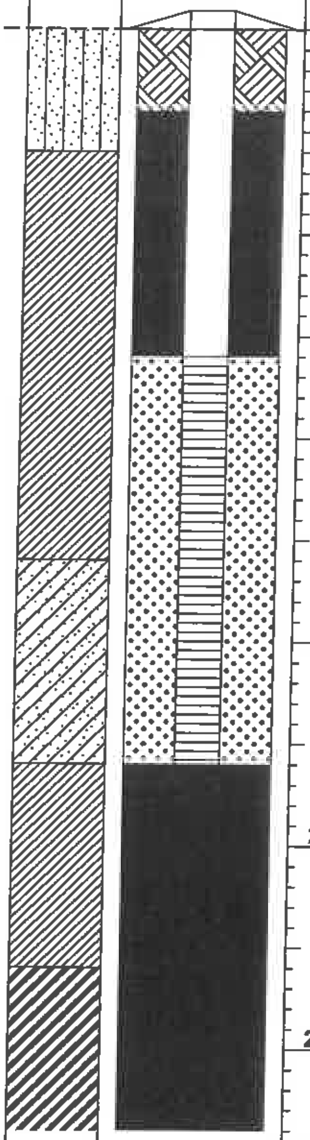
Well No. B-4

Location Pittsburg, Texas

Surface Elev.

Page 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
							T.O.C. Elev.
0		Ground Surface				0	
		SILTY SAND(SM) medium dense; tan; with gravel					
		SANDY LEAN CLAY(CL) dark brown					
		–tannish orange					
5		–hard; orangish tan				5	
10		–very stiff; white				10	
		CLAYEY SAND(SC) medium dense; tan					
15		–orangish gray; with sand seams				15	
		SANDY LEAN CLAY(CL) stiff; orangish tan					
20						20	
		FAT CLAY(CH) very stiff; orangish tan; with ferric seams					
25						25	



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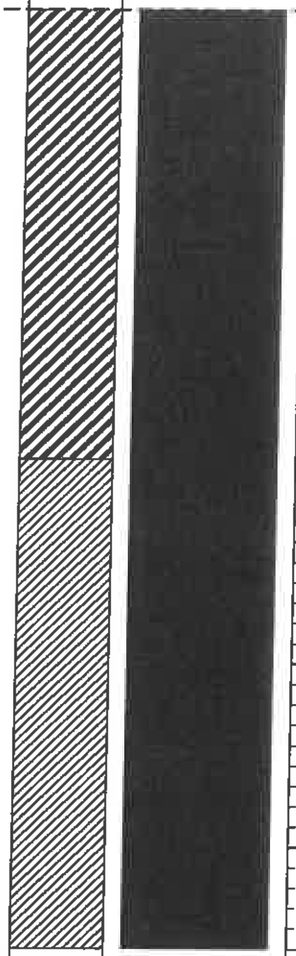
Driller Doug Hinds	**Drilling Method** Soild Stem Auger	**Bentonite Seal** 2-8' & 18-50'
Logged By James Griffith	**Borehole Diameter** 6.5"	**Filter Pack Qty.** 6-18'
Drilling Started 10/27/09	**Well Casing** 2.0" **Dia.** 0.0' **to** 8.0'	**Filter Pack Type** 20/40 Sand
Drilling Completed 10/27/09	**Casing Type** PVC	**Static Water Level**
Construction Completed	**Well Screen** 2.0" **Dia.** 8.0' **to** 18.0'	
Development Completed	**Screen Type** Slotted	**Notes:**
Type of Well	**Slot Size** 0.010"	
	Grout Type Bentonite	

ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**

Well No. B-4
Location Pittsburg, Texas
Surface Elev.
Page 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
		Continued from previous page					
		--tannish brown; with iron ore seams					
30						30	
		--hard; light gray; layered and with silt seams					
35						35	
		LEAN CLAY(CL) hard; light gray; layered and with silt seams					
40						40	
		--light gray					
45						45	
		--layered and with sand seams; with lignite					
50						50	
		Bottom of Boring @ 50'					
55							
60							



Piezometer B-5

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-5

PROJECT: Welsh Power Plant
Pittsburgh, Texas

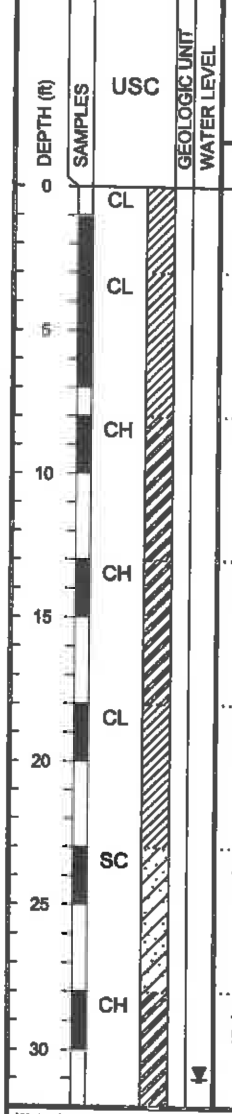
PROJECT NO.: G3242-09

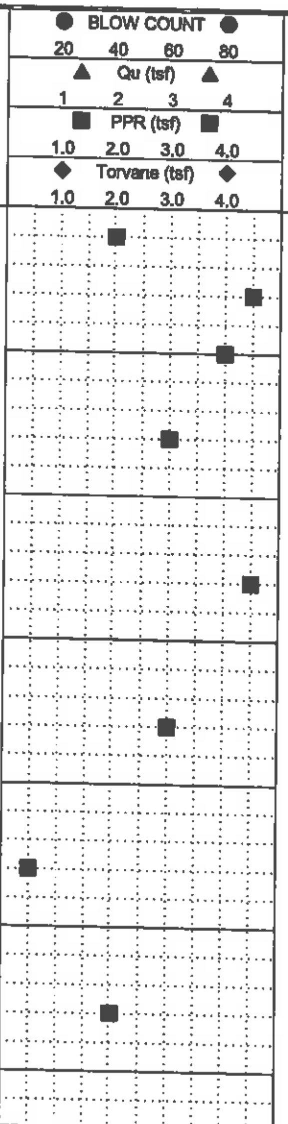
BORING TYPE: Flight Auger

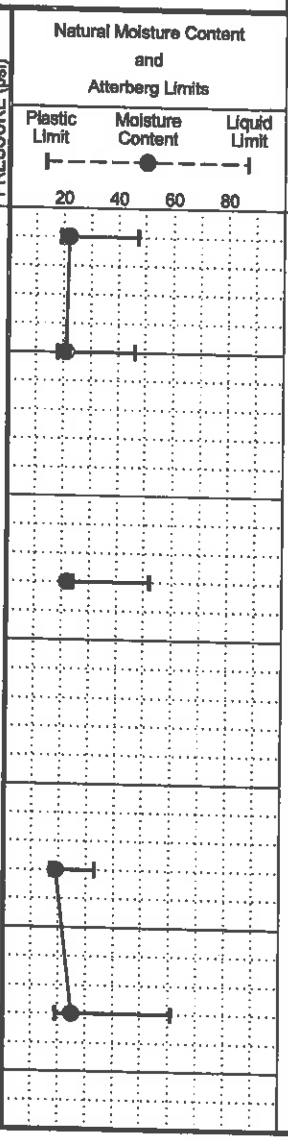
DATE 10/27/09

SURFACE ELEVATION 340.0

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) stiff; red and tan	P=2.0					22	47	19	28	81	+40 Sieve=9%, +4 Sieve=3%
CL	LEAN CLAY(CL) hard; red and tan	P=4.5+										
	–very stiff	P=4.0					21	46	18	28	94	+40 Sieve=3%, +4 Sieve=0%
CH	FAT CLAY(CL) very stiff; brown and tan	P=3.0										
CH	FAT CLAY WITH SAND(CH) hard; red and tan	P=4.5+					22	52	24	28	88	+40 Sieve=3%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams	P=3.0										
SC	CLAYEY SAND(SC) very loose; tan, red, and gray	P=0.5					19	33	17	16	44	+40 Sieve=1%, +4 Sieve=0%
CH	FAT CLAY WITH SAND(CH) stiff; red and gray	P=2.0					25	61	19	42	83	+40 Sieve=5%, +4 Sieve=3%







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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

ETTL
ENGINEERS &
CONSULTANTS

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

LOG OF BORING B-5

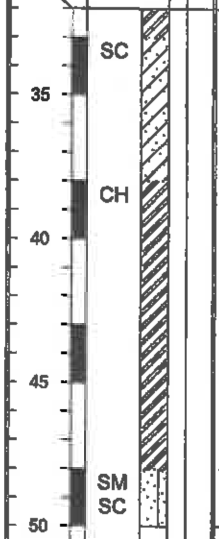
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

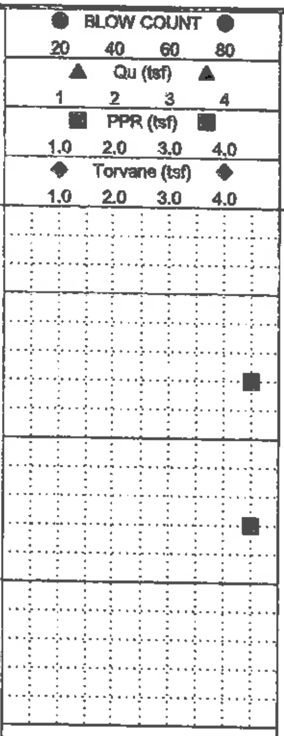
BORING TYPE: Flight Auger

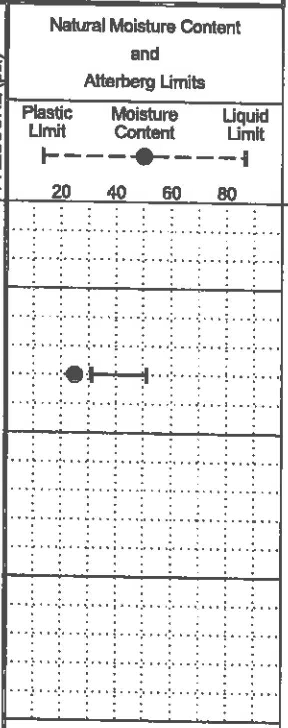
DATE 10/27/09

SURFACE ELEVATION 340.0



DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	SC	SILTY CLAYEY SAND(SC) gray and red; saturated	SF										
	CH	FAT CLAY(CH) hard; red and gray; with sand seams	P=4.5+					25	51	31	20	87	+40 Sieve=6%, +4 Sieve=0%
		–gray, tan, and red; with sand seams	P=4.5+										
	SM SC	SILTY SAND(SM-SC) red and gray	SF										
50		Bottom of Boring @ 50'											





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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

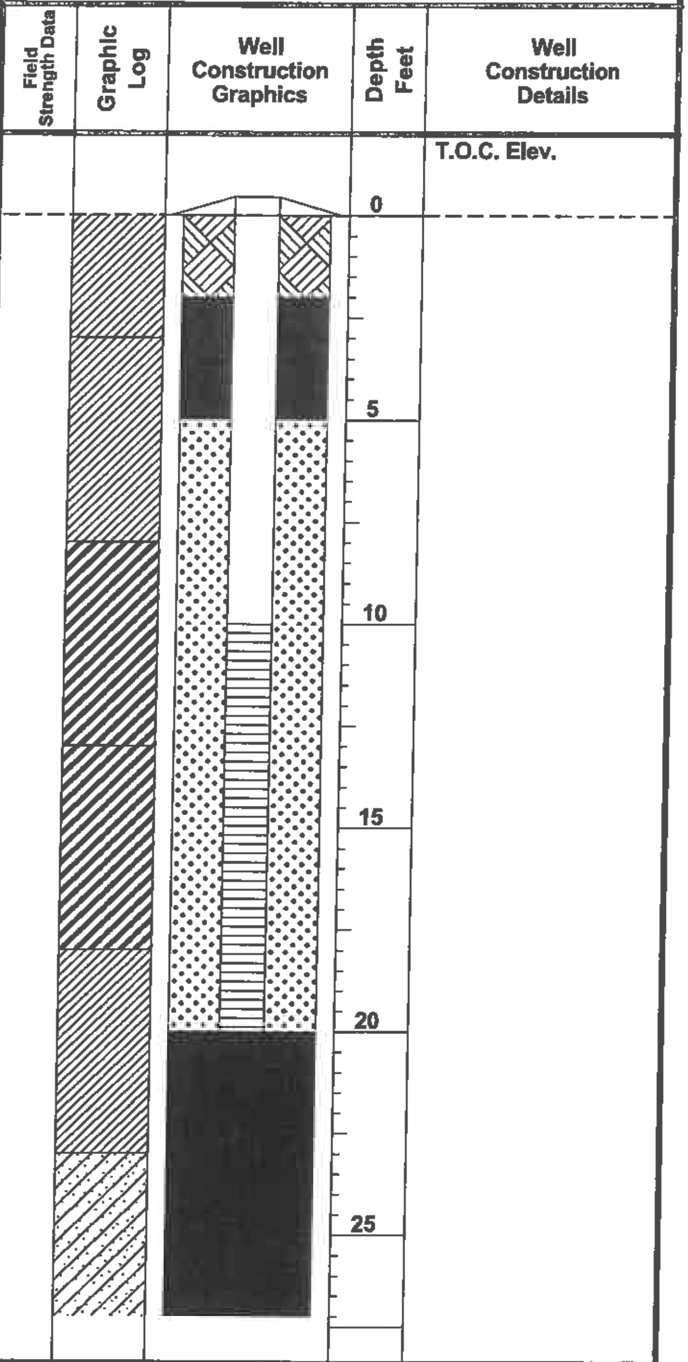
Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

Pezometer P-5

ENVIRONMENTAL LOG **Client:** Welsh Power Plant	**Well No.** B-5
	Location Pittsburg, Texas
Project No: G3242-095 **Phase** **Task**	**Surface Elev.** **Page** 1 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description
0		Ground Surface
		LEAN CLAY WITH SAND(CL) stiff; red and tan
		LEAN CLAY(CL) hard; red and tan
5		--very stiff
		FAT CLAY(CL) very stiff; brown and tan
10		
		FAT CLAY WITH SAND(CH) hard; red and tan
15		
		SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams
20		
		CLAYEY SAND(SC) very loose; tan, red, and gray
25		

Continued Next Page



Driller Doug Hinds

Logged By James Griffith

Drilling Started 10/27/09

Drilling Completed 10/27/09

Construction Completed

Development Completed

Type of Well

Drilling Method Soild Stem Auger

Borehole Diameter 6.5"

Well Casing 2.0" **Dia.** 0.0' **to** 10.0'

Casing Type PVC

Well Screen 2.0" **Dia.** 10.0' **to** 20.0'

Screen Type Slotted

Slot Size 0.010"

Grout Type Bentonite

Bentonite Seal 2-5' & 20-50'

Filter Pack Qty. 5-20'

Filter Pack Type 20/40 Sand

Static Water Level

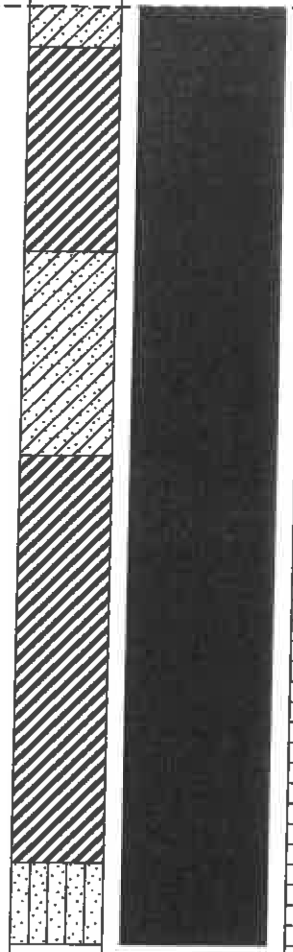
Notes:

ENVIRONMENTAL LOG

Client: Welsh Power Plant
Project No: G3242-095 **Phase** **Task**

Well No. B-5
Location Pittsburg, Texas
Surface Elev.
Page 2 **of** 2

Depth Feet	Sampler	Overburden/Lithologic Description	Field Strength Data	Depth Feet	Well Construction Details
		Continued from previous page			
		FAT CLAY WITH SAND(CH) stiff; red and gray			
30				30	
		SILTY CLAYEY SAND(SC) gray and red; saturated			
35				35	
		FAT CLAY(CH) hard; red and gray; with sand seams			
40				40	
		–gray, tan, and red; with sand seams			
45				45	
		SILTY SAND(SM-SC) red and gray			
50		Bottom of Boring @ 50'		50	
55					
60					



Piezometer B-6

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

LOG OF BORING B-6

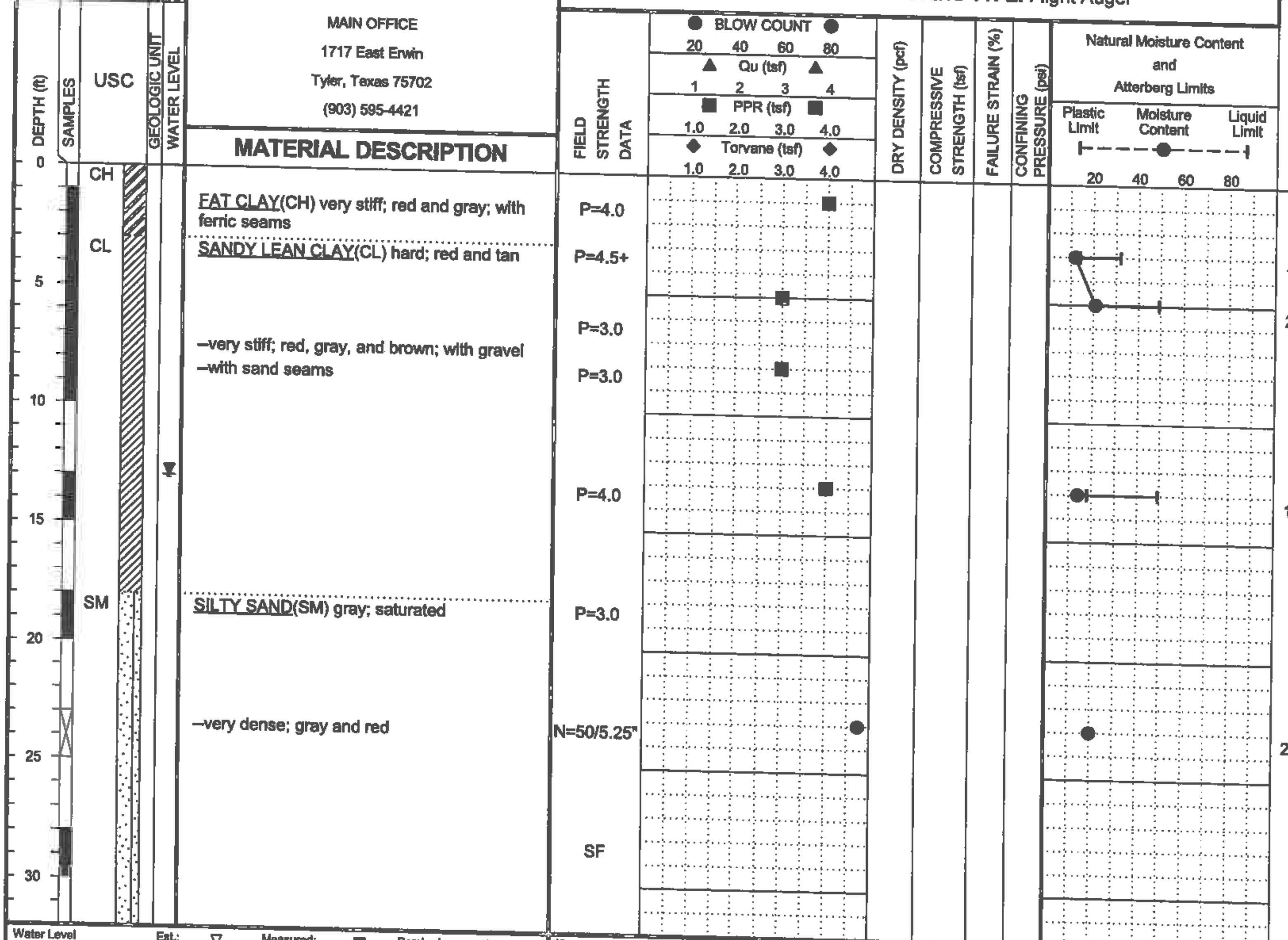
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1



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. #)
FAT CLAY(CH) very stiff; red and gray; with ferric seams	P=4.0						
SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	12	32	14	18	60	+40 Sieve=0%, +4 Sieve=0%
	P=3.0	21	49	20	29	93	+40 Sieve=2%, +4 Sieve=0%
–very stiff; red, gray, and brown; with gravel –with sand seams	P=3.0						
	P=4.0	14	49	18	31	65	+40 Sieve=0%, +4 Sieve=0%
SILTY SAND(SM) gray; saturated	P=3.0						
–very dense; gray and red	N=50/5.25"	20				18	+40 Sieve=0%, +4 Sieve=0%
	SF						

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

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

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

LOG OF BORING B-6

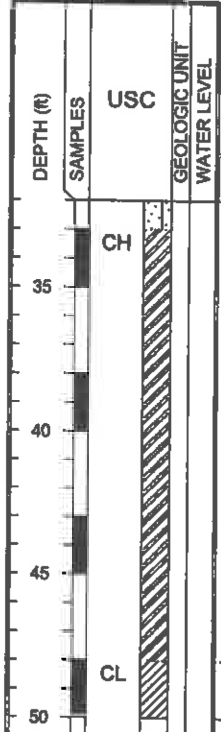
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

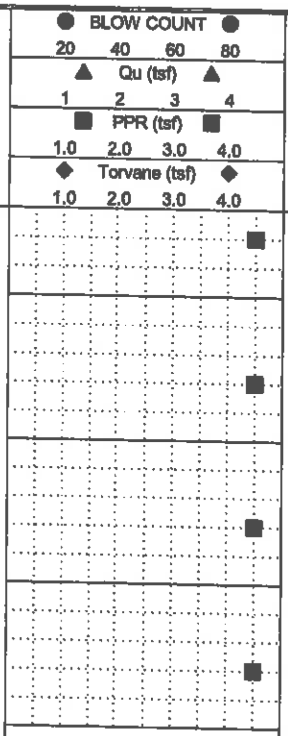
BORING TYPE: Flight Auger

DATE 10/27/09

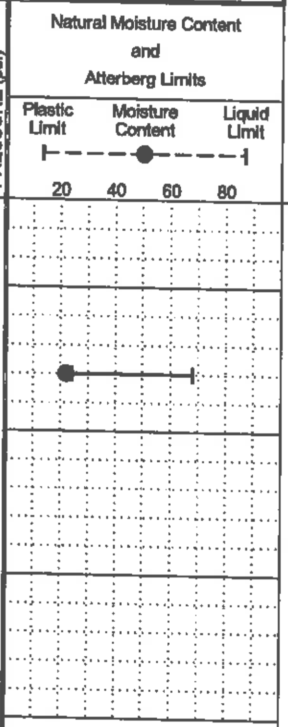
SURFACE ELEVATION 340.1



MATERIAL DESCRIPTION	FIELD STRENGTH DATA
FAT CLAY(CH) hard; brown; with sand seams	P=4.5+
	P=4.5+
--dark green	P=4.5+
LEAN CLAY(CL) hard; dark green; laminated with lignite	P=4.5+
Bottom of Boring @ 50'	



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. #)
22	68	24	44	95	+40 Sieve=0%, +4 Sieve=0%

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

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

Piezometer B-6

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

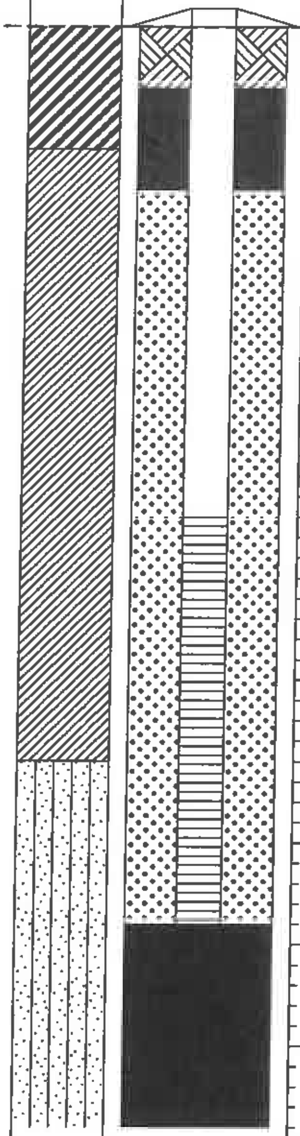
Well No. B-6

Location Pittsburg, Texas

Surface Elev.

Page 1 **of** 2

Depth Feet Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
						T.O.C. Elev.
0	Ground Surface				0	
	FAT CLAY(CH) very stiff; red and gray; with ferric seams					
	SANDY LEAN CLAY(CL) hard; red and tan					
5					5	
	–very stiff; red, gray, and brown; with gravel					
	–with sand seams					
10					10	
15					15	
	SILTY SAND(SM) gray; saturated					
20					20	
	–very dense; gray and red					
25					25	



Continued Next Page

Driller Doug Hinds

Logged By James Griffith

Drilling Started 10/28/09

Drilling Completed 10/28/09

Construction Completed ____

Development Completed ____

Type of Well ____

Drilling Method Soild Stem Auger

Borehole Diameter 6.5"

Well Casing 2.0" **Dia.** 0.0' **to** 12.0'

Casing Type PVC

Well Screen 2.0" **Dia.** 12.0' **to** 22.0'

Screen Type Slotted

Slot Size 0.010"

Grout Type Bentonite

Bentonite Seal 1.5-4' & 22-50'

Filter Pack Qty. 4-22'

Filter Pack Type 20/40 Sand

Static Water Level ____

Notes: ____

ENVIRONMENTAL LOG

Client: Welsh Power Plant

Project No: G3242-095 **Phase** **Task**

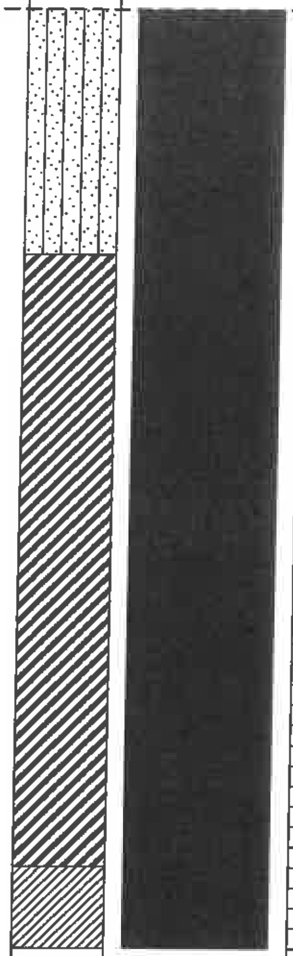
Well No. B-6

Location Pittsburg, Texas

Surface Elev.

Page 2 **of** 2

Depth Feet Sampler	Overburden/Lithologic Description	Field Strength Data	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
	Continued from previous page					
30					30	
	FAT CLAY(CH) hard; brown; with sand seams					
35					35	
40					40	
	--dark green					
45					45	
	LEAN CLAY(CL) hard; dark green; laminated with lignite					
50					50	
	Bottom of Boring @ 50'					
55						
60						



LOG OF BORING B-7

ETTL ENGINEERS & CONSULTANTS

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

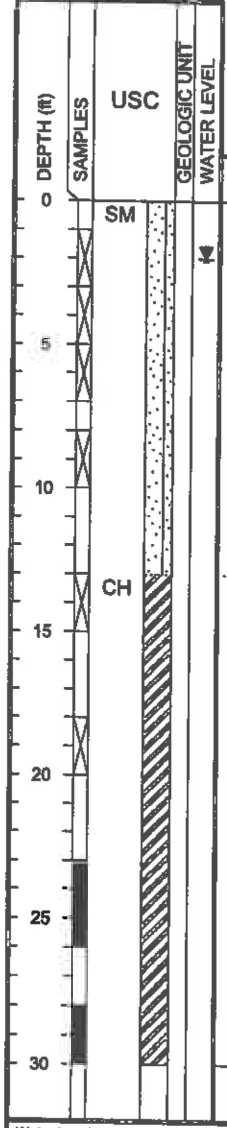
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

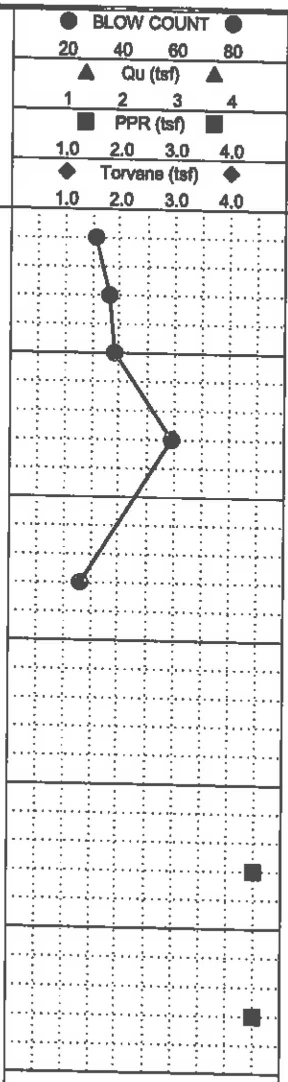
DATE 10/27/09

SURFACE ELEVATION 340.4

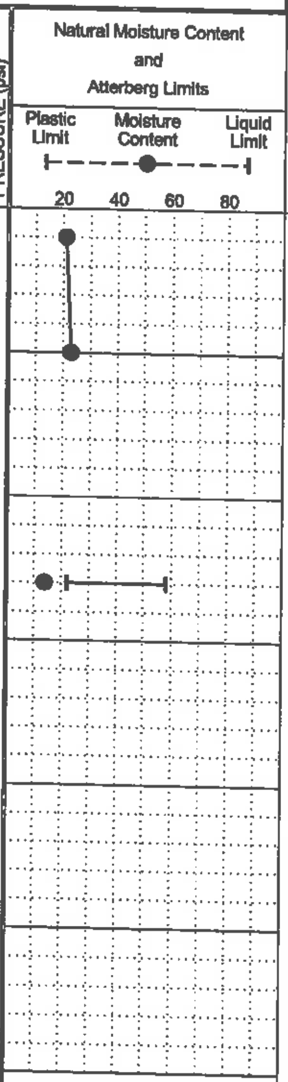


MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) dense; tan	N=31	21				21	+40 Sieve=0%, +4 Sieve=0%
		N=36						
	--gray; saturated	N=38	23				15	+40 Sieve=0%, +4 Sieve=0%
	--very dense	N=59						
CH	FAT CLAY(CH) very stiff; dark gray; with silt and ferric seams	N=26	14	58	22	36	98	+40 Sieve=0%, +4 Sieve=0%
	--hard; gray and black; with trace of lignite	P=4.5+						
	--gray	P=4.5+						
	Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



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

Water Observations: Seepage @ 4' while drilling. Water level @ 2' and open to 7' upon completion.

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

Notes:
GPS Coordinates: N 33°02.898', W 94°50.519'

Landfill Boring B-2

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-2

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

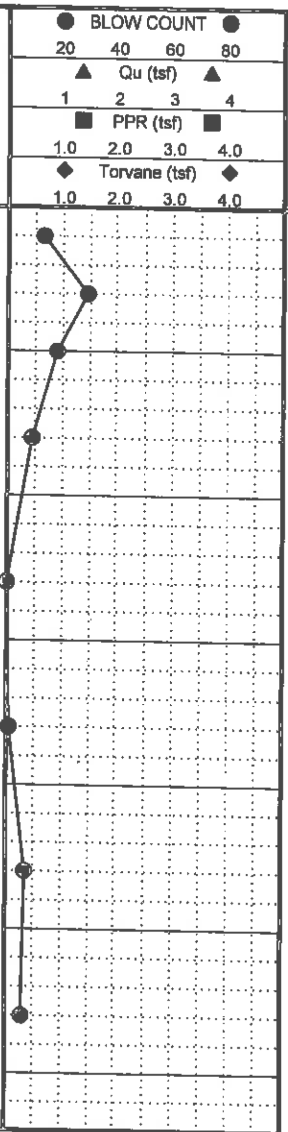
PROJECT NO.: G4207-146

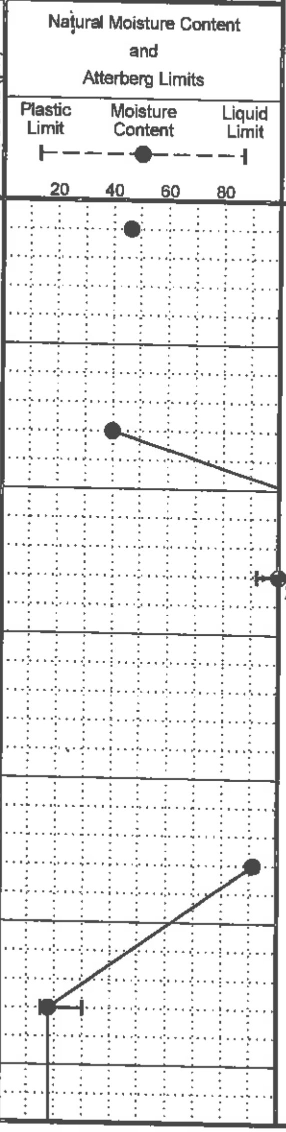
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 373.8

DEPTH (ft)	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	ML SM	Eqc @ 28-43' & Er @ 43-60'		ASH (SILT WITH GRAVEL(ML)) medium dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=13					46				59	+40 Sieve=27% +4 Sieve=16%
					N=29										
5				ASH (SILTY SAND(SM)) medium dense; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces	N=18										
10				--loose; moist	N=9					40				40	+40 Sieve=19% +4 Sieve=2%
15	MH		▼	ASH (ELASTIC SILT(MH)) very loose; black; with fine-grained sand and lightly cemented gravel pieces; saturated	N=0					200	134	92	42	100	+40 Sieve=0% +4 Sieve=0%
20	SM			ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=1										
25				--loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					91				61	+40 Sieve=11% +4 Sieve=1%
30	CL			SANDY LEAN CLAY(CL) medium stiff; dark brown and black; with fine-grained sand and cemented gravel pieces; saturated	N=6					18	30	15	15	63	+40 Sieve=1% +4 Sieve=0%





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

Water Observations: Water level @ 13'.

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

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

ETTL
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CONSULTANTS

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

LOG OF BORING B-2 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

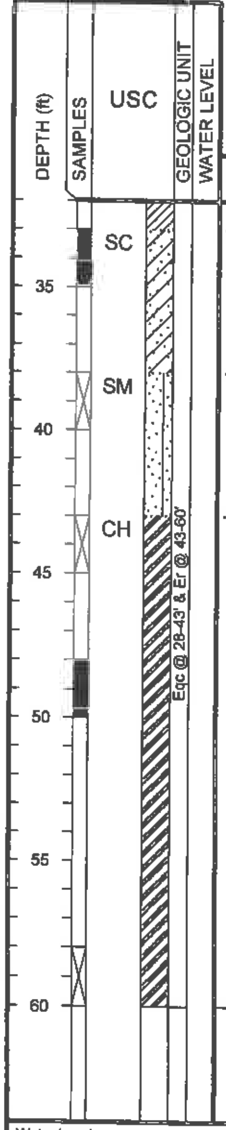
PROJECT NO.: G4207-146

DRILL RIG: B-61 HDX

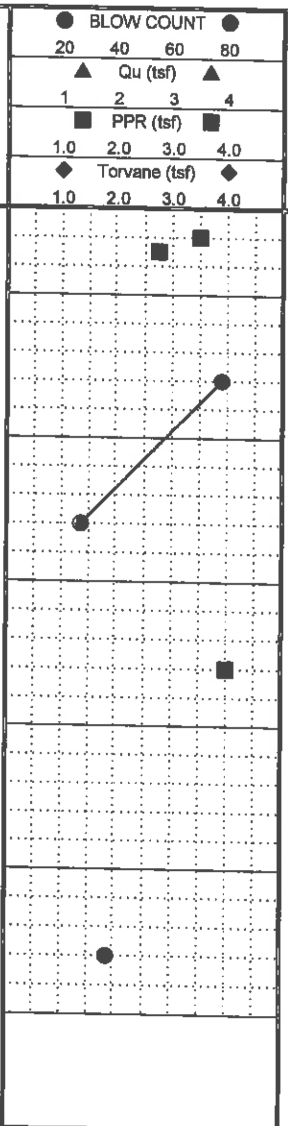
BORING TYPE: Rotary Wash/Flight Auger

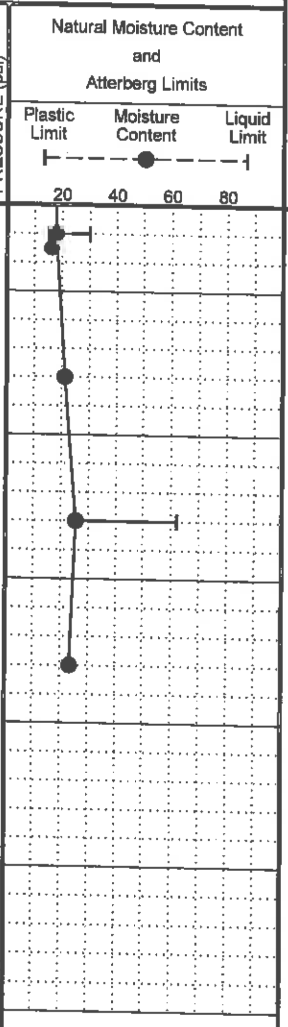
DATE 10/8/14

SURFACE ELEVATION 373.8



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) dense; light brown, light gray and reddish brown; moist; with fine-grained sand; mottled	P=3.5 P=2.75	110	1.39	4.3	21	18 16	30	15	15	39	+40 Sieve=0% +4 Sieve=0%
SM	SILTY SAND(SM) very dense; light brown, yellowish brown and light gray; moist; mottled; with fine-grained sand	N=78					21				24	+40 Sieve=0% +4 Sieve=0%
CH	FAT CLAY(CH) very stiff; dark brown and light brown; moist; with sand seams; laminated	N=27					25	62	26	36	96	+40 Sieve=2% +4 Sieve=0%
	--dark brown with light gray; moist; with silt seams	P=4.0	98				24					
	--hard; dark brown; moist	N=37										
	Bottom of Boring @ 60'											





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

Water Observations: Water level @ 13'.

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

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

Landfill boring B-10

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LOG OF BORING B-10

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

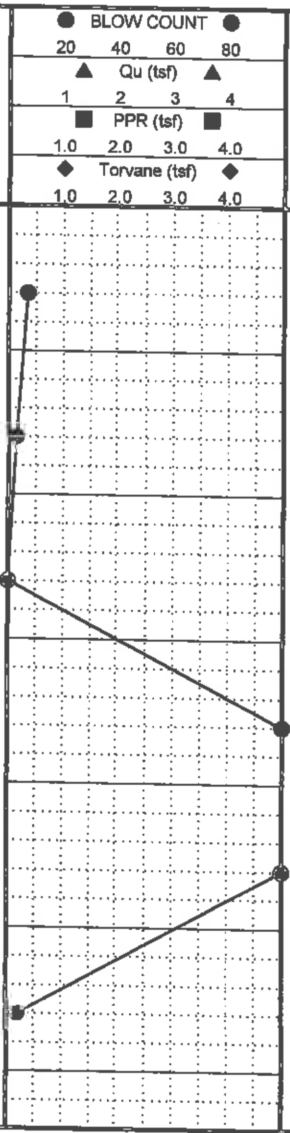
PROJECT NO.: G4207-146

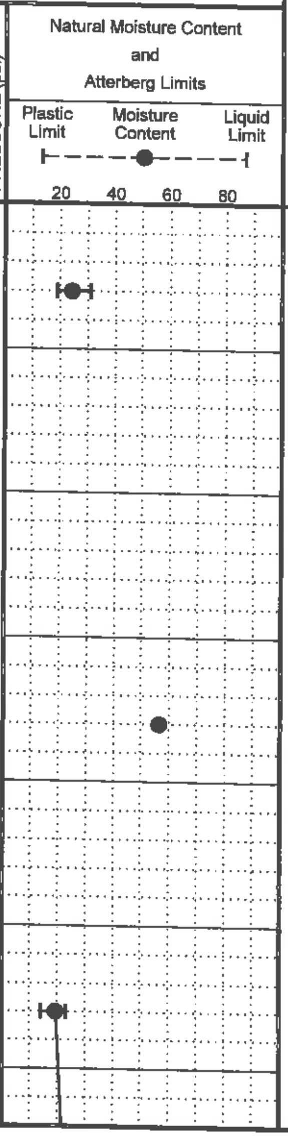
DRILL RIG: B-61 HDX

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 373.2





DEPTH (ft)	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0–9	SC	Egc @ 27-43' & Er @ 43-60'		ASH (CLAYEY SAND(SC)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					24	31	19	12	41	+40 Sieve=21% +4 Sieve=11%
9–17.5	MH			ASH (ELASTIC SILT(MH)) very loose; black; moist	N=3										
			▽	--wet	N=0										
17.5–27	SM			ASH (SILTY SAND WITH GRAVEL(SM)) very dense; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist; cemented layer from 17.5' to 21'	N=50/1"					56				14	+40 Sieve=71% +4 Sieve=28%
				--cemented layer from 23' to 27'	N=50/4"										
27–	CL			SANDY LEAN CLAY(CL) medium stiff; grayish brown and yellowish brown; saturated; mottled	N=4					19	23	14	9	57	+40 Sieve=1% +4 Sieve=0%

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

Water Observations: Seepage @ 13' while drilling.

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

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

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CONSULTANTS

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

LOG OF BORING B-10 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

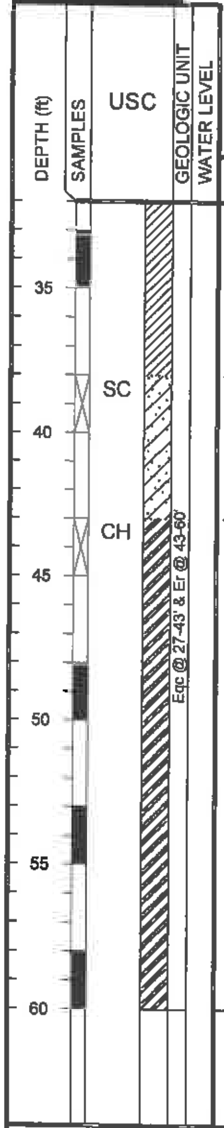
PROJECT NO.: G4207-146

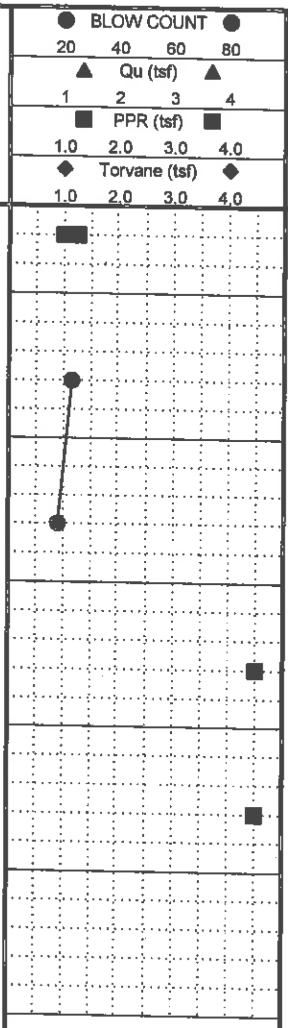
DRILL RIG: B-61 HDX

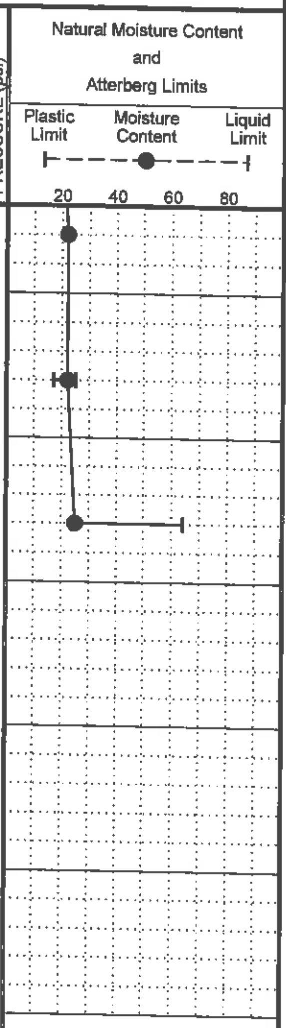
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 373.2







MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	P=1.25 P=1.0	107	2.10	6.1	21	22					
CLAYEY SAND(SC) medium dense; reddish brown and grayish brown; moist; mottled	N=23					22	25	17	8	27	+40 Sieve=3% +4 Sieve=0%
FAT CLAY(CH) very stiff; dark brown with light gray; with silt seams; moist	N=18					25	64	24	40	90	+40 Sieve=7% +4 Sieve=0%
--hard	P=4.5+										
	P=4.5+										
Bottom of Boring @ 60'											

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

Water Observations: Seepage @ 13' while drilling.

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

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

Landfill Boring B-12

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-12

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

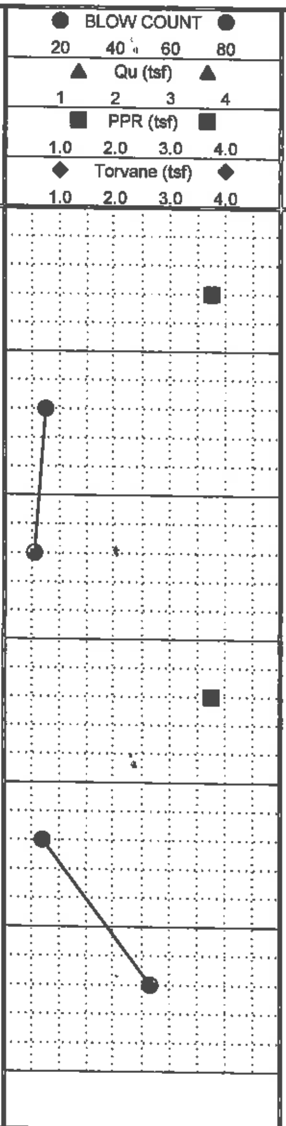
PROJECT NO.: G4207-146

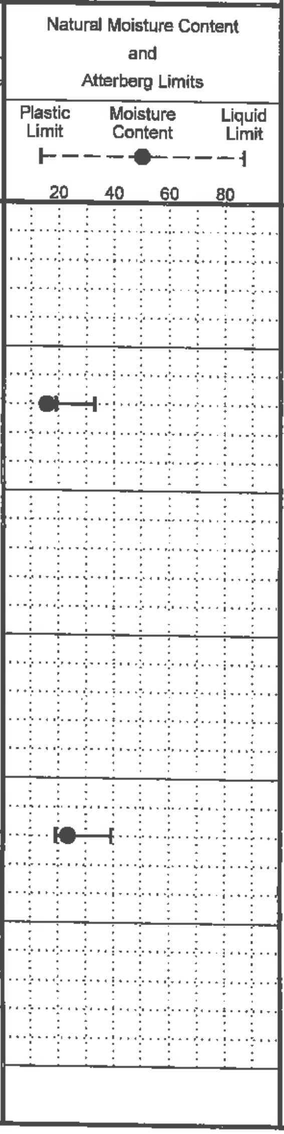
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.7

DEPTH (ft)	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	Egc		LEAN CLAY WITH SAND(CL) stiff; light gray and reddish brown; moist; mottled	P=3.75						
5	CL			SANDY LEAN CLAY(CL) stiff; light brown, light gray and reddish brown; moist; mottled	N=15	16	33	19	14	58	+40 Sieve=1% +4 Sieve=0%
10				--grayish brown and brown; moist	N=11						
15	CH			FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; moist; mottled; with ferric seams	P=3.75						
20					N=14	24	39	19	20	93	+40 Sieve=1% +4 Sieve=0%
	CL			LEAN CLAY(CL) stiff; light gray and brownish gray; moist; layered with silt							
25	ML		▼	SILT WITH SAND(ML) very dense; light brown and yellowish brown; moist; with clay seams	N=53						
30				Bottom of Boring @ 30'							





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

Water Observations: Water level @ 27' 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:

GPS Coordinates: N33.04713°, W94.84486°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Land RV Boring B-13

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

LOG OF BORING B-13

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

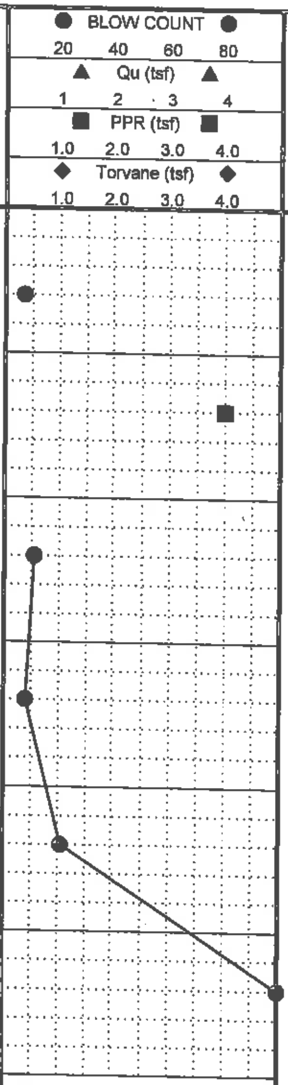
PROJECT NO.: G4207-146

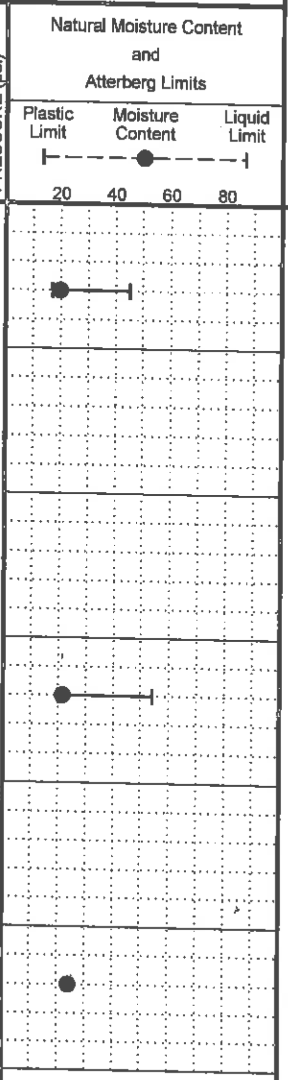
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.4

DEPTH (ft)	USC	GEOLOGIC UNIT	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	Egc	LEAN CLAY WITH SAND(CL) medium stiff; reddish brown with light gray; moist	N=7	20	45	17	28	76	+40 Sieve=1% +4 Sieve=0%
	CL		SANDY LEAN CLAY(CL) very stiff; light brown, gray and reddish brown; moist; mottled	P=4.0						
	SC		CLAYEY SAND(SC) medium dense; grayish brown; moist							
	CH		FAT CLAY WITH SAND(CH) medium stiff; reddish brown and light gray; moist; mottled	N=11						
				N=8	22	54	20	34	79	+40 Sieve=1% +4 Sieve=0%
	CL		LEAN CLAY(CL) very stiff; light gray and grayish brown; moist; layered with silt	N=21						
	ML		SILT WITH SAND(ML) very dense; light gray and yellowish brown; wet; with clay seams	N=50/5"	24				80	+40 Sieve=0% +4 Sieve=0%
30			Bottom of Boring @ 30'							





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 28' 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:

GPS Coordinates: N33.047160°, W94.84384°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-14

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

PROJECT NO.: G4207-146

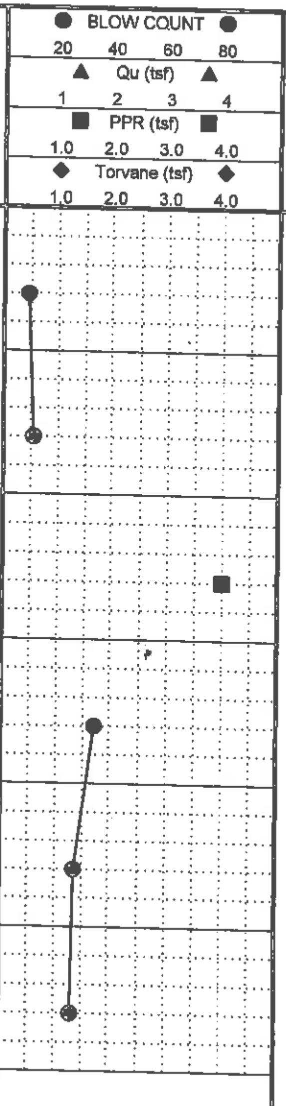
BORING TYPE: Flight Auger

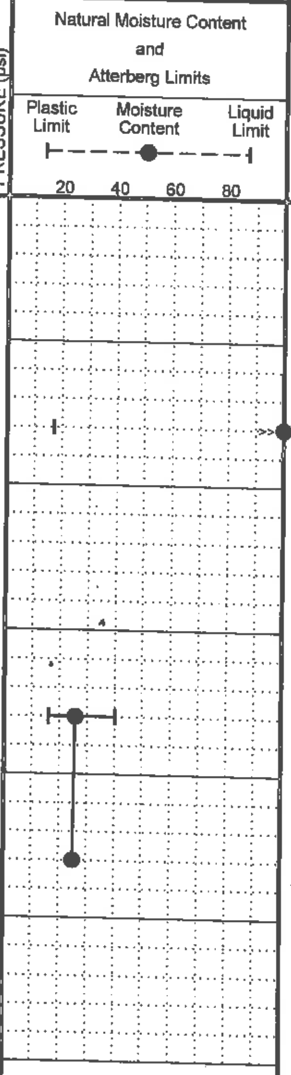
DATE 10/14/14

SURFACE ELEVATION 347.2

GEOLOGIC UNIT: Eqc @ 0-28' & Er @ 28-30'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) medium stiff; yellowish brown with reddish brown; dry; with clay seams	N=9						
	ML	SANDY SILT(ML) medium dense; grayish brown; moist; with clay seams	N=11	>>108	17	17	NP	68	+40 Sieve=1% +4 Sieve=1%
	CL	SANDY LEAN CLAY(CL) very stiff; light gray and gray; moist	P=4.0						
		--light gray and grayish brown; moist; layered with silt	N=34	26	40	16	24	67	+40 Sieve=1% +4 Sieve=0%
	SP SM	POORLY GRADED SAND WITH SILT(SP-SM) medium dense; yellowish brown, light gray and reddish brown; wet	N=27	25				10	+40 Sieve=0% +4 Sieve=0%
30	CL	LEAN CLAY(CL) very stiff; dark brown; moist; with silt partings	N=26						
		Bottom of Boring @ 30'							





Columns: DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi)

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

Water Observations: Water level @ 17' and caved to 23' upon completion.

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

Notes:

GPS Coordinates: N33.04774°, W94.84290°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

Landfill Boring B-15

ETTL ENGINEERS & CONSULTANTS

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

LOG OF BORING B-15

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

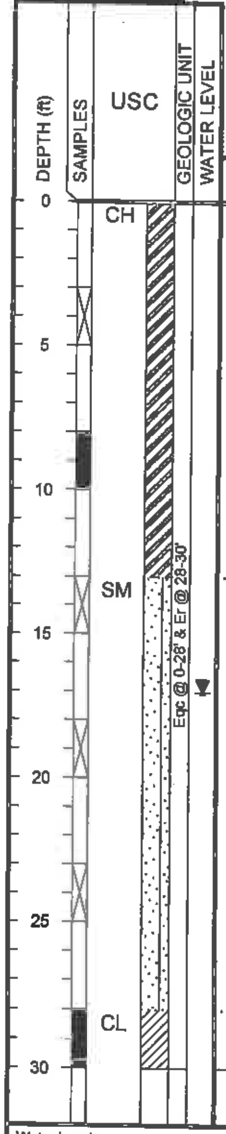
DRILL RIG:

PROJECT NO.: G4207-146

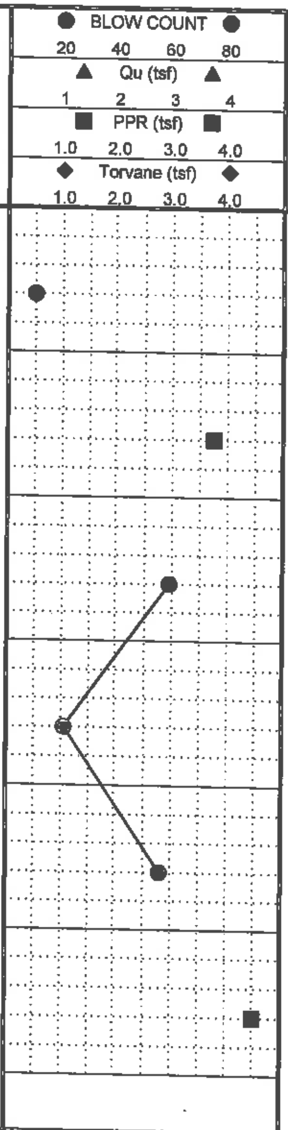
BORING TYPE: Flight Auger

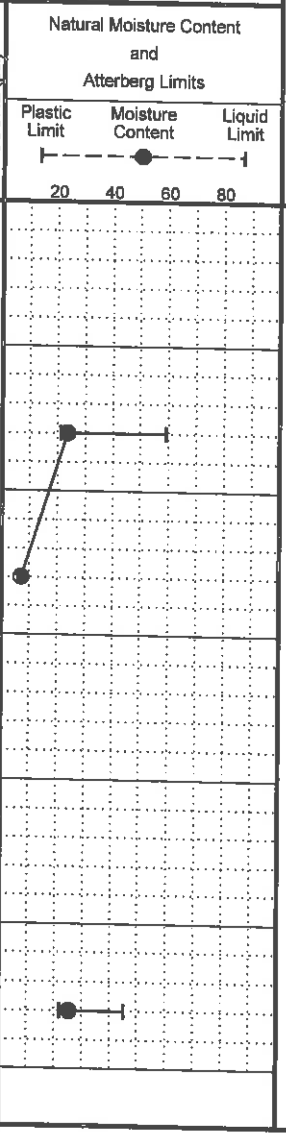
DATE 10/14/14

SURFACE ELEVATION 348.2



MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
FAT CLAY(CH) stiff; reddish brown and light gray; moist; mottled	N=10										
--very stiff; light gray, grayish brown and reddish brown; moist; layered	P=3.75					24	59	21	38	85	+40 Sieve=0% +4 Sieve=0%
SILTY SAND(SM) very dense; light brown; dry	N=59					7				12	+40 Sieve=0% +4 Sieve=0%
--medium dense; wet	N=21										
--very dense	N=56										
LEAN CLAY(CL) hard; dark brown; moist; with silt partings	P=4.5					25	45	22	23	92	+40 Sieve=0% +4 Sieve=0%
Bottom of Boring @ 30'											





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 17' and caved to 19' upon completion.

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

Notes:

GPS Coordinates: N33.04857°, W94.84286°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 1

Date: 8/20/2015

Direction Photo Taken:

North

Description:
Staging area west of landfill.

P8200493

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – J. ROBERT WELSH POWER PLANT

Location:
PITTSBURG, TITUS COUNTY, TEXAS

Project No.
OK001625.0001

Photo No. 2

Date: 8/20/2015

Direction Photo Taken:

South Southeast

Description:

Potential wetland on the top (west) end of the Primary Ash Pond.

P8200495

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 3

Date: 8/20/2015

Direction Photo Taken:

West Northwest

Description:

Ditch between road and railway west of landfill, this ditch would be non-jurisdictional.

P8200497

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 4

Date: 8/20/2015

Direction Photo Taken:

Northeast

Description:

Ground Water Monitoring Well AD-12 near northwest end of landfill.

P8200501

ARCADIS

PHOTOGRAPHIC LOG

Project Name:

AEP – J. ROBERT WELSH POWER PLANT

Location:

PITTSBURG, TITUS COUNTY, TEXAS

Project No.

OK001625.0001

Photo No.
5

Date:
8/20/2015

Direction Photo Taken:

East Northeast

Description:

View of plant from top of landfill. Primary ash pond is within the wooded area on left.

P8200506

ARCADIS

PHOTOGRAPHIC LOG

Project Name:

AEP – J. ROBERT WELSH POWER PLANT

Location:

PITTSBURG, TITUS COUNTY, TEXAS

Project No.

OK001625.0001

Photo No.
6

Date:
8/20/2015

Direction Photo Taken:

East Northeast

Description:

Drainage canal that drains from primary ash pond to clear water pond.

P8200510

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 7

Date: 8/20/2015

Direction Photo Taken:

West Northwest

Description:

Vegetated strip between landfill and road. This would be isolated due to lack of connectivity.

P8200521

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 8

Date: 8/20/2015

Direction Photo Taken:

North

Description:

Dike between landfill and primary ash pond. Facility in the background.

P8200522

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 9

Date: 8/20/2015

Direction Photo Taken:

West

Description:

Vegetated strip between landfill and road. This area would be isolated due to lack of connectivity.

P8200527

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 10

Date: 8/20/2015

Direction Photo Taken:

North Northeast

Description:

Road east of landfill running toward facility and clear water pond.

P8200530

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 11

Date: 8/20/2015

Direction Photo Taken:

South

Description:

Top of landfill.

P8200534

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 12

Date: 8/20/2015

Direction Photo Taken:

Southeast

Description:

View of lined bottom ash storage pond.

P8200538

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 13

Date: 8/20/2015

Direction Photo Taken:

Southeast

Description:

Lined bottom ash storage pond.

P8200545

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 14

Date: 8/20/2015

Direction Photo Taken:

South

Description:

Southside of lined bottom ash storage pond.

P8200547

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No.	**Date:**
15	8/20/2015

Direction Photo Taken:

West

Description:

East side of lined bottom ash storage pond.

P8200560

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No.	**Date:**
16	8/20/2015

Direction Photo Taken:

North

Description:

Upland with pine and ground water monitoring well AD-2 south of lined bottom ash storage pond.

P8200563

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 17

Date: 8/20/2015

Direction Photo Taken:

Description:

Outflow of water from plant into the northeast portion of the Primary Ash Pond.

P8200577

Project Name: AEP – J. ROBERT WELSH POWER PLANT	**Location:** PITTSBURG, TITUS COUNTY, TEXAS	**Project No.** OK001625.0001

Photo No. 18

Date: 8/20/2015

Direction Photo Taken:

South Southwest

Description:

Northeast portion of primary ash pond, view facing south-southwest.

P8200578

Appendix E

The Most Recent Structural Stability Assessment

Required at 40 CFR §257.73(d)

STRUCTURAL STABILITY ASSESSMENT

CFR 257.73(d)

Primary Bottom Ash Pond

Welsh Plant
Pittsburg, Texas

October, 2016

Prepared for: Southwest Electric Power Company (SWEPCO) – Welsh Plant

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

Document No. GERS-16-132

Structural Stability Assessment
CFR 257.73(d)
Welsh Plant
Primary Bottom Ash Pond

PREPARED BY	Brett A. Dreger Brett A. Dreger, P.E.	DATE	10/12/2016
REVIEWED BY	Shah S. Baig, P.E.	DATE	10-13-16
APPROVED BY	Gary F. Zych Gary Zych, P.E. Manager – AEP Geotechnical Engineering	DATE	10/13/2016

10-13-2016

SHAHRIYAR S. BAIG

92172

LICENSED PROFESSIONAL ENGINEER

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 AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The facility operates two surface impoundments for storing CCR materials called the Primary Bottom Ash pond and the Bottom Ash Storage pond. This report addresses the closure plan for the Primary Bottom Ash Pond. The Primary Bottom Ash pond CCR unit is located southwest of the Plant and directly west of the Welsh Reservoir.

The Primary Bottom Ash pond is bounded by natural ground surface (topographically higher areas) to the north and west, and embankment dikes to the south and east. The elevation at the top of embankment along the crest area is approximately 340.0 feet above msl. Presently, economizer ash from the generating plant is sluiced to the Primary Bottom Ash pond. On occasion, bottom ash is sluiced to the Primary Bottom Ash pond.

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 Primary Bottom Ash Pond embankment consist primarily of stiff to hard lean clay (CL) and fat clay (CH) with intermittent layers of medium dense to very dense clayey sand (SC) and silty sand (SM). There is a thick layer of very dense silty sand (SM) which is apparently the native surficial soils near the previous creek bed. Atterberg Plasticity Indices of the tested soils ranged between a low of 9 to a high of 44. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the Primary 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 primary bottom ash pond unit has been constructed with a layer of bottom ash on the interior slope of the ash pond and limited riprap on the interior slopes of random areas that require slope protection from erosion and wave action. The exterior slopes consist of vegetative cover on the upper half of the slope while the lower half of the slope is protected by large rip rap for armor protection. 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 Primary Bottom Ash Pond embankment is constructed of compacted earth fill. The source and type of soils used for earth fill is unknown. However, AEP contracted with ETTL Engineers & Consultants Inc. of Tyler, Texas to perform a Geotechnical Investigation of Existing Ash Storage Ponds Embankments on June 21, 2010. The evaluation of the existing earthen embankments consisted of slope stability and seepage analyses for the embankments. The evaluation was performed using information obtained from soil borings located on the crest and outside toe of the embankments. The embankment for the Primary bottom Ash Pond was investigated. Three borings were drilled to 50 feet depth at the crest of the embankment (Appendix C). The fill material in the containment berm consists primarily of stiff to hard lean clay (CL), fat clay (CH) and medium dense clayey sand (SC) overlying the native soils which consist primarily of stiff to hard lean clay (CL) and fat clay (CH) with intermittent layers of medium dense to very dense clayey sand (SC) and silty sand (SM). Atterberg Plasticity Indices of the tested soils ranged between a low of 9 to a high 44. Based on the slope stability evaluation and the engineering properties of the subsurface soils, it is concluded that the Primary 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 Primary Bottom Ash Pond is the 100-year storm event.

The principal spillway weir box for the Primary Ash Pond is located in the canal connecting the Primary and Secondary Ash Ponds. The Primary Pond receives effluent from the ash sluice lines that transport the ash slurry on the east side of the pond. The ash settles, and the decant water flows to a 48-inch wide concrete weir box and into the Secondary Pond via an approximate 1,950-foot long discharge canal which originates at the southwest corner of the

Primary Pond. The weir box has a minimum crest elevation of 325.0 feet, and flows through the weir box are controlled by installing 12-inch stop logs that are 55 inches long. Flows are conveyed through the weir box by a sheet piling wall installed across the discharge canal, on either side of the weir box. The Primary Pond has a 90-foot wide earthen emergency spillway on the south side of the pond; the spillway crest elevation is 334.0 feet. The emergency spillway overflows from the Primary Pond directly into the discharge canal at approximate midpoint of the discharge canal. Based on the Hydrology and Hydraulic analysis the Primary Bottom Ash Storage pond 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.]

There are no pipes that are part of the spillway system that are buried within or beneath the embankment.

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 downslope is partially inundated by the Swauano Creek reservoir. The reservoir is used to supply the power plant with a source of water for operations. The service spillway is a concrete morning glory drop inlet with a concrete conduit through the dam. It has a low level drain pipe (18-inch diameter) located at the bottom of the drop inlet and discharges into the concrete conduit. The emergency spillway is a broad-crested earthen spillway located in the right abutment of the dam. The service spillway overflow section is only activated during large precipitation events and the emergency spillway section has never been activated since the construction of the dam. The water level of the lake is also maintained via a make-up water line from a nearby reservoir that keeps the reservoir near normal pool levels. The water intake for the plant operations is maintained via pumps. In general, the reservoir area and volume is large compared to the intake pump capacity of the plant. Therefore, since the water level in the lake cannot increase or decrease significantly in a rapid manner, the condition for a sudden drawdown of the reservoir is not feasible.

STRUCTURAL STABILITY ASSESSMENT

CFR 257.73(d)

Bottom Ash Storage Pond

Welsh Plant
Pittsburg, Texas

October, 2016

Prepared for: Southwest Electric Power Company (SWEPCO) – Welsh Plant

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

Document No. GERS-16-133

Structural Stability Assessment
CFR 257.73(d)
Welsh Plant
Bottom Ash Storage 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

10-13-2016
STATE OF TEXAS
SHAHRIYAR S. BAIG
92172
LICENSED PROFESSIONAL ENGINEER
Shah Baig

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 AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The facility operates two surface impoundments for storing CCR materials called the Primary Bottom Ash Pond and the Bottom Ash Storage pond. This report addresses the Bottom Ash Storage Pond. The Bottom Ash Storage Pond CCR unit is located at the south end of the Plant and approximately 1,000 feet west of the Welsh Reservoir.

The Bottom Ash Storage Pond embankments are approximately 20 feet in height and are constructed on a 3:1 slope (3 feet horizontal, 1 foot vertical). The elevation at the base of the embankment is approximately 340 feet above msl, and the elevation at the top of the embankment around the perimeter of the Bottom Ash Storage Pond is approximately 360 feet above msl. Presently a combination of economizer ash, bottom ash and some fly ash is sluiced to the bottom ash storage pond from the primary bottom ash pond.

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.]

Native coarse grained (or sandy) material underlying the Bottom Ash Pond generally consists of medium dense to very dense silty sand (SM), clayey sand (SC) and silt (ML) and fine grained (clayey) material consist of medium stiff to hard lean clay and fat clay (CL and CH) soils. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the Bottom Ash Storage 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 bottom ash storage pond interior has been constructed with a geomembrane liner. The impoundment's storage area is lined with a 60 mil HDPE liner. The geomembrane extends all the way to the crest of the interior slope to protect areas that require 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 Bottom Ash Storage Pond embankment is constructed of compacted earth fill. The source and type of soils used for earth fill is unknown. However, AEP contracted with Auckland Consulting, Inc. of Tyler, Texas to perform a Geotechnical Investigation of Existing Bottom Ash Storage Pond Embankments in 2016. The evaluation of the existing earthen embankments consisted of slope stability and seepage analyses for the embankments. The evaluation was performed using information obtained from soil borings drilled on the crest and outside toe of the embankments. The embankments for the Bottom Ash Storage were investigated. The subsurface exploration of the embankment consisted of advancing a total of seven (7) borings located in potentially critical areas of the embankment. Four (4) borings (Boring Nos. 2 through 5) were completed along the embankment crest with termination depths ranging from approximately 40 to 50 feet. Three (3) borings (Boring Nos. 6 through 8) were completed along the embankment toe and were advanced to termination depths of approximately 40 feet.

Based on subsurface soils and field sampling and testing, the existing embankment is primarily lean clay (CL) with existing side slopes (upstream and downstream) of approximately 3:1 (H:V). Based on the slope stability evaluation and the engineering properties of the subsurface soils, it is concluded that the Bottom Ash Storage 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 Bottom Ash Storage Pond is the 100-year storm event.

The principal spillway for the Bottom Ash Pond is a 40-foot long broad-crested weir with 6:1 side slopes and crest at elevation 355.0 ft-msl. However, this spillway does not act as the hydraulic control for the Bottom Ash Storage Pond. Discharges from the Bottom Ash Storage Pond are initially controlled by an 18-inch HDPE pipe with an invert elevation of 350.5 feet penetrating the 40 foot wide interior spillway, and then by a 30-inch HDPE pipe with an invert elevation of 350.0 feet located in the sump area; flows through this pipe are directed back to Primary Pond. The Bottom Ash Storage Pond has an 8-foot wide emergency spillway with a crest elevation of 358.0 feet. The emergency spillway channel is lined with rock riprap and discharges into an unnamed tributary of Swauano Creek just upstream of the south end of the Welsh Reservoir emergency spillway. Based on the Hydrology and Hydraulic analysis the bottom ash storage pond 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.]

The 30-inch diameter HDPE discharge pipe for the principal spillway area extends through the top portion of the embankment of the bottom ash pond. The elevation of the pipe through the embankment is equal to the normal operating pool level of the pond. Once the pipe exits the embankment, it runs along the outside slope area until it reaches its discharge point. Based on examination of the exposed areas of the pipe along the outside slope area, the pipe appears to be in satisfactory 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 F

The Most Recent Safety Factor Assessment

Required at 40 CFR §257.73(e)

Initial Safety Factor Assessment – Primary Bottom Ash Pond

Welsh Power Generating Station
Pittsburgh, Texas

Auckland Project No. 2015-008A (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 Primary Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Welsh Power Station near Pittsburgh, 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 Primary Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the Primary 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 *Welsh Power Station, Existing Ash Storage Pond Embankment Investigation, Pittsburg, Texas* dated June 21, 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 Primary 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.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Freese and Nichols titled *Hydraulic Analysis of Welsh Power Plant Ash Ponds* dated December 29, 2010 (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. 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 2.5:1 (H:V), maximum embankment height of 35 feet (downstream) and top of dam elevation of 340.0 feet MSL. The crest width of the embankment is approximately 50 feet. An embankment cutoff key (key trench) extends below the core structure approximately five (5) feet and has an approximate bottom width of 20 feet.

The downstream toe of the Primary Ash Pond extends below the impounded water level of the adjacent Welsh Reservoir. Based on information provided by the client, the normal pool elevation for the Welsh Reservoir is approximately 320.0 feet (MSL). Reservoir levels are monitored and adjusted as needed to maintain a constant pool elevation of approximately 320.0 feet (MSL). Based on the active management and control of the Welsh Reservoir pool elevation, the downstream toe of the Primary Ash Pond should not be subject to sudden or rapid drawdown conditions, notwithstanding a catastrophic failure of or uncontrolled release from the Welsh Reservoir. Regardless, the sudden drawdown of the Welsh Reservoir along the downstream slope of the Primary Ash Pond is modeled herein (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 Primary Ash Pond as determined by the 25-year, 24-hour storm event is 329.35 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 330.0 feet (MSL) was utilized. Likewise the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 330.80 feet (MSL), for this evaluation a maximum surcharge loading elevation of 331.0 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), four (4) 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, steady state seepage condition with seismic loading under maximum storage pool conditions, and rapid drawdown (of the inundated downstream slope). 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) and guidance provided by the United States Army Corps of Engineers (USACE).

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
Rapid Drawdown – Downstream Slope	Effective and Total Stress	1.20
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1). Minimum factor of safety for Rapid Drawdown based on guidance provided by the United States Army Corps of Engineers (USACE).		

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 Primary Ash Pond generally consist of medium stiff to hard lean clay and fat clay (CL and CH) soils and coarse grained (or sandy) material consist of medium dense to very dense clayey sand (SC), silty sand (SM) and silty clayey sand (SC-SM) soils. Based on these soil characteristics and that the Primary Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of

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[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

either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

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. Selection of the critical slope section 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:

Material Type	Unit Weight (pcf)	Consolidated-Undrained Cohesion (psf)	Consolidated-Undrained Angle of Internal Friction (degrees)
Embankment Fill	125	570	12
Clayey Sand (SC)	130	360	10
Silty Sand (SM)	125	0	30
Fat Clay (CH)	130	320	19

NOTE: Properties used for Steady State Seepage with Seismic and Rapid Drawdown analyses.

Summary of Long Term, Effective Stress Soil Parameters

Material Type	Unit Weight (pcf)	Consolidated-Drained Cohesion (psf)	Consolidated-Drained Angle of Internal Friction (degrees)
Embankment Fill	125	310	23
Clayey Sand (SC)	130	320	15
Silty Sand (SM)	125	0	30
Fat Clay (CH)	130	300	28

NOTE: Properties used for Steady State Seepage and Rapid Drawdown analyses. 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

Material Type	Permeability (ft/sec)
Embankment Fill	1×10^{-9}
Clayey Sand (SC)	1×10^{-7}
Silty Sand (SM)	1×10^{-5}
Fat Clay (CH)	1×10^{-8}

2.5 Stability Analysis Results

The following table 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

Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	1.51	1.50
Steady State Seepage – Surcharge Pool	1.51	1.40
Steady State Seepage with Seismic – Maximum Pool	1.07	1.00
Rapid Drawdown – Downstream Slope	1.21	1.20

Based on the findings of this analysis, the evaluated embankment appears 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 Primary Ash Pond (Welsh Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

By: ______________________

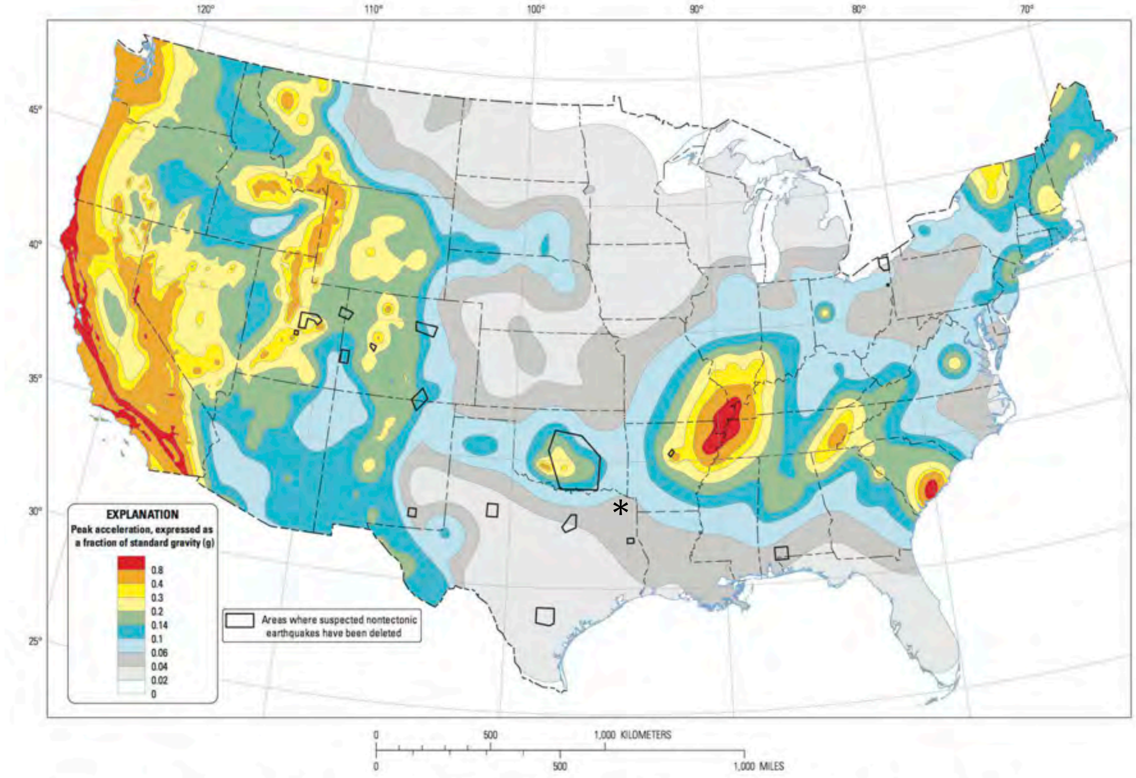
Dated: January 14, 2016

JOHN J. TAYNTOR
99202

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 Welsh Power Generating Station

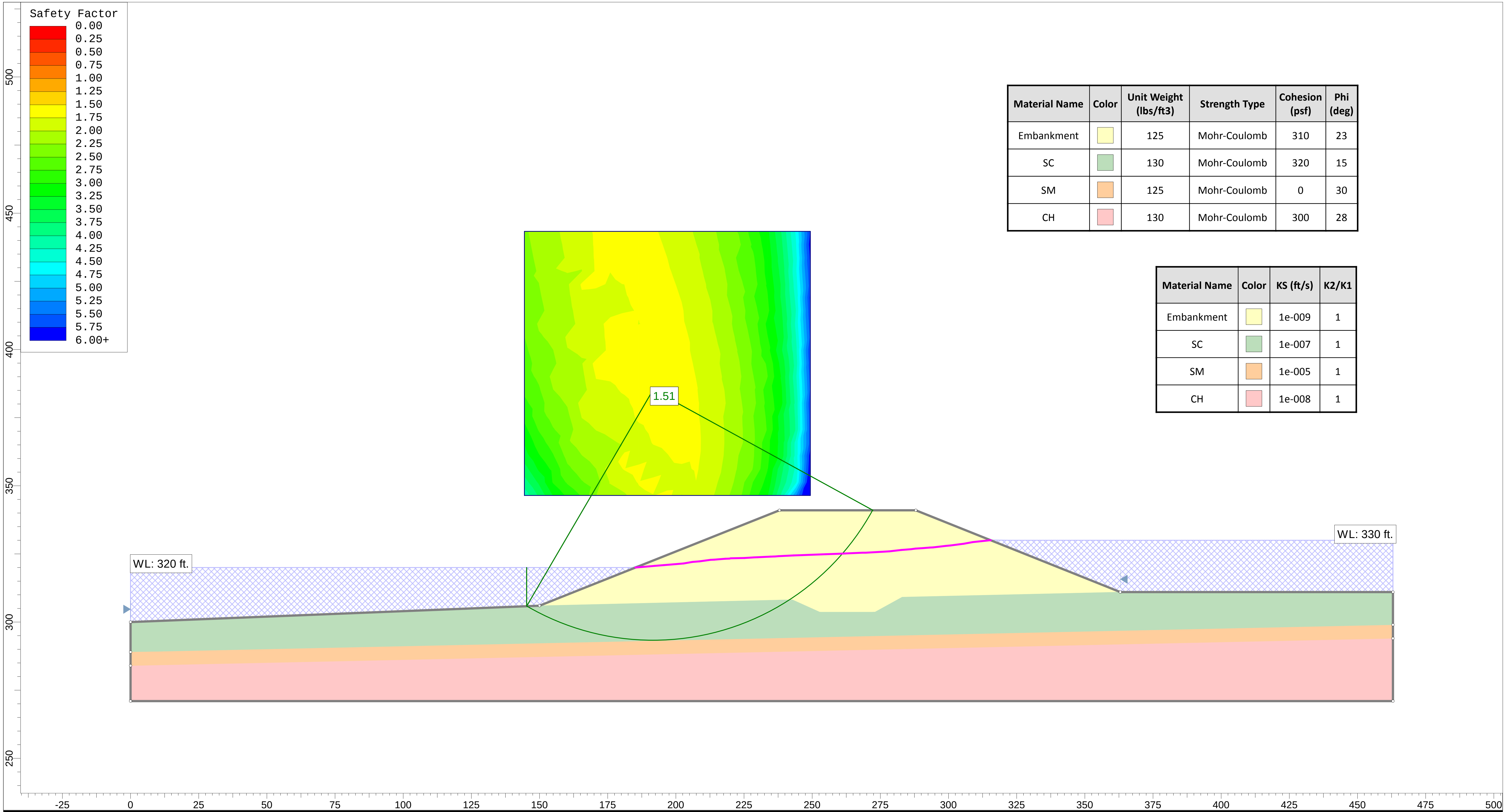
Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map

Scale: N/A

Auckland Project No. 2015-008A

Welsh Power Generating Station
Initial Safety Factor Assessment - Primary Ash Pond
Pittsburgh, Texas



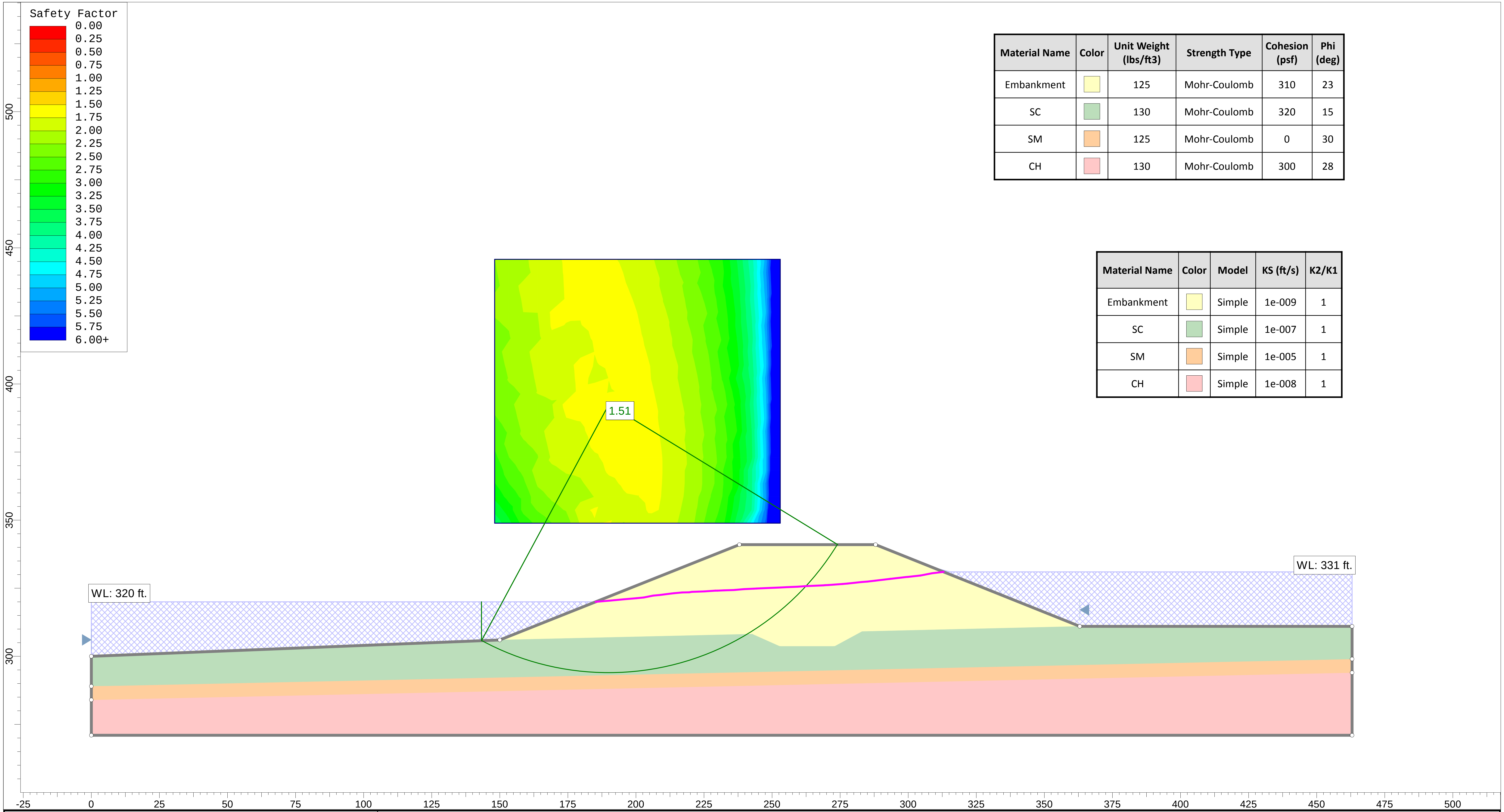
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	310	23
SC	🟩	130	Mohr-Coulomb	320	15
SM	🟧	125	Mohr-Coulomb	0	30
CH	🟥	130	Mohr-Coulomb	300	28

Material Name	Color	KS (ft/s)	K2/K1
Embankment	🟨	1e-009	1
SC	🟩	1e-007	1
SM	🟧	1e-005	1
CH	🟥	1e-008	1

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project Welsh Power Station - Primary Ash Pond	
Analysis Description Maximum Storage Pool at Normal Reservior Pool	
Drawn By JJT	*Company*
Date 12/2/2015	*File Name* Primary_SSS_normal_25yr pool_Rev1.slim



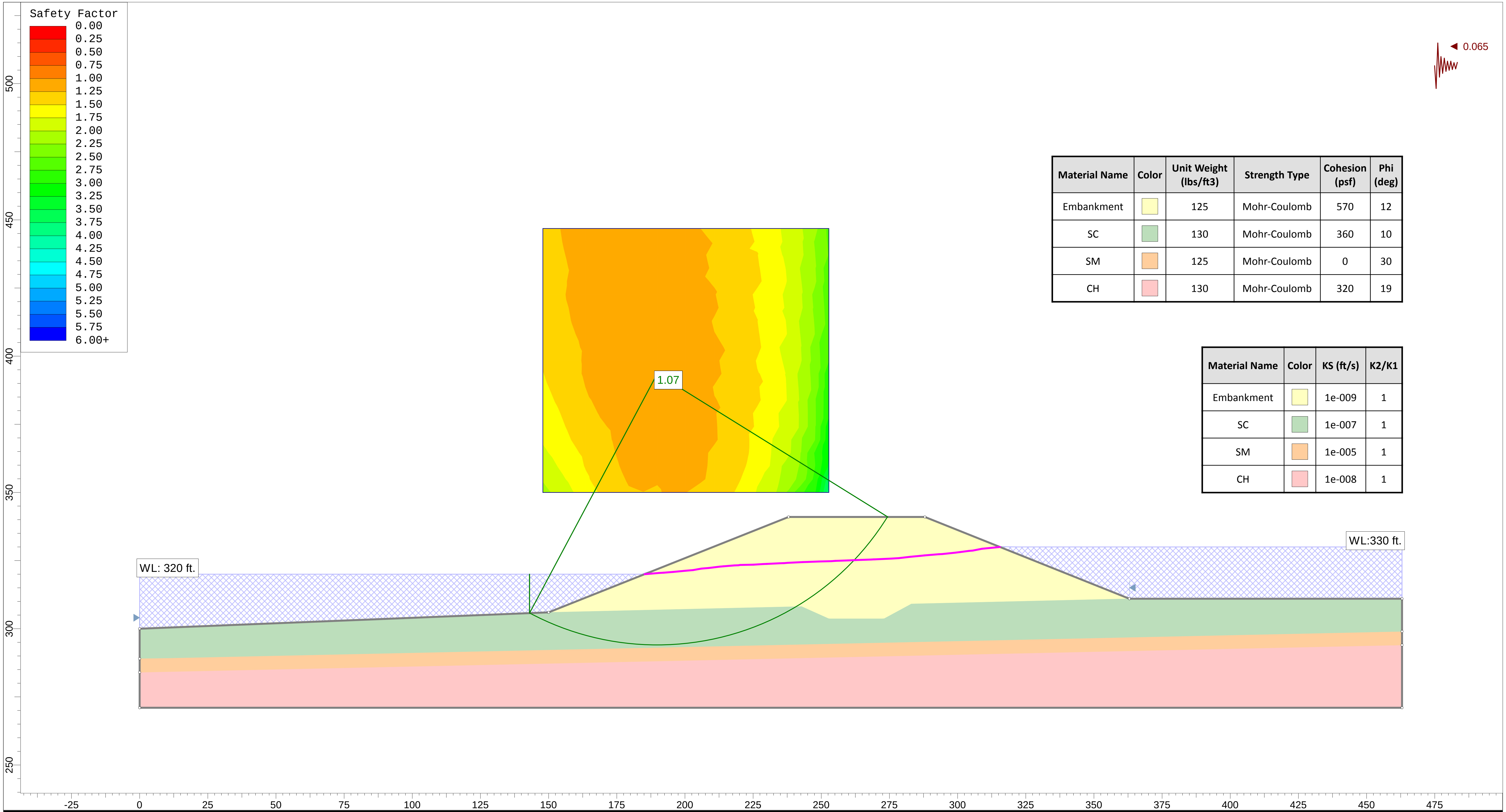
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	310	23
SC	🟩	130	Mohr-Coulomb	320	15
SM	🟧	125	Mohr-Coulomb	0	30
CH	🟥	130	Mohr-Coulomb	300	28

Material Name	Color	Model	KS (ft/s)	K2/K1
Embankment	🟨	Simple	1e-009	1
SC	🟩	Simple	1e-007	1
SM	🟧	Simple	1e-005	1
CH	🟥	Simple	1e-008	1

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Primary Ash Pond
Analysis Description	Maximum Surcharge Pool at Normal Reservior Pool
Drawn By	JJT
Company	
Date	12/2/2015
File Name	Primary_SSS_normal_100 yr pool_Rev1.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	570	12
SC	🟩	130	Mohr-Coulomb	360	10
SM	🟧	125	Mohr-Coulomb	0	30
CH	🟥	130	Mohr-Coulomb	320	19

Material Name	Color	KS (ft/s)	K2/K1
Embankment	🟨	1e-009	1
SC	🟩	1e-007	1
SM	🟧	1e-005	1
CH	🟥	1e-008	1

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Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project
Welsh Power Station - Primary Ash Pond

Analysis Description
Maximum Storage Pool at Normal Reservior Pool, Seismic Analysis

Drawn By
JJT

Company

Date
12/23/2015

File Name
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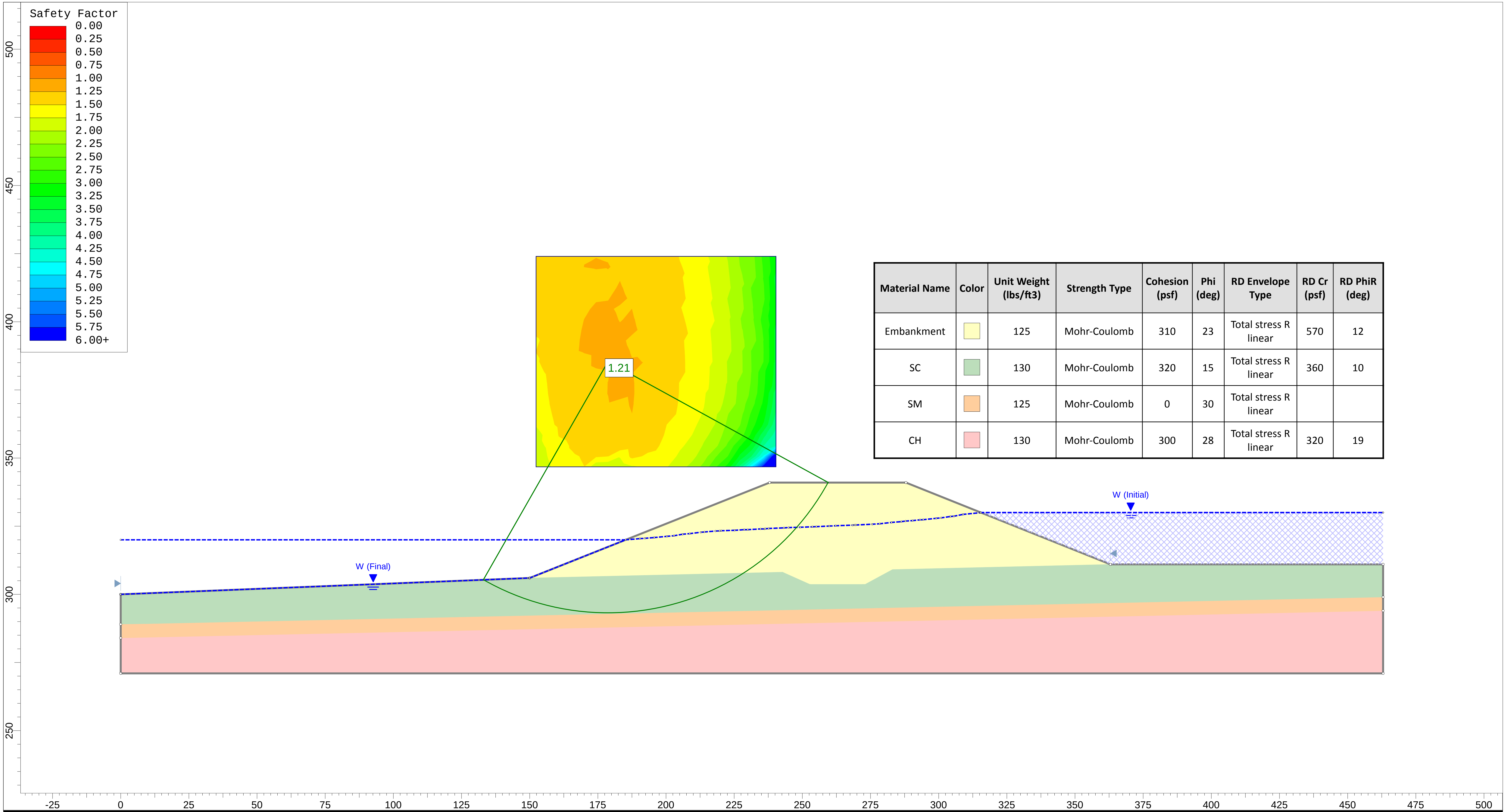

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	RD Envelope Type	RD Cr (psf)	RD PhiR (deg)
Embankment	🟨	125	Mohr-Coulomb	310	23	Total stress R linear	570	12
SC	🟩	130	Mohr-Coulomb	320	15	Total stress R linear	360	10
SM	🟧	125	Mohr-Coulomb	0	30	Total stress R linear		
CH	🟥	130	Mohr-Coulomb	300	28	Total stress R linear	320	19

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SLIDEINTERPRET 6.036

Project Welsh Power Station - Primary Ash Pond

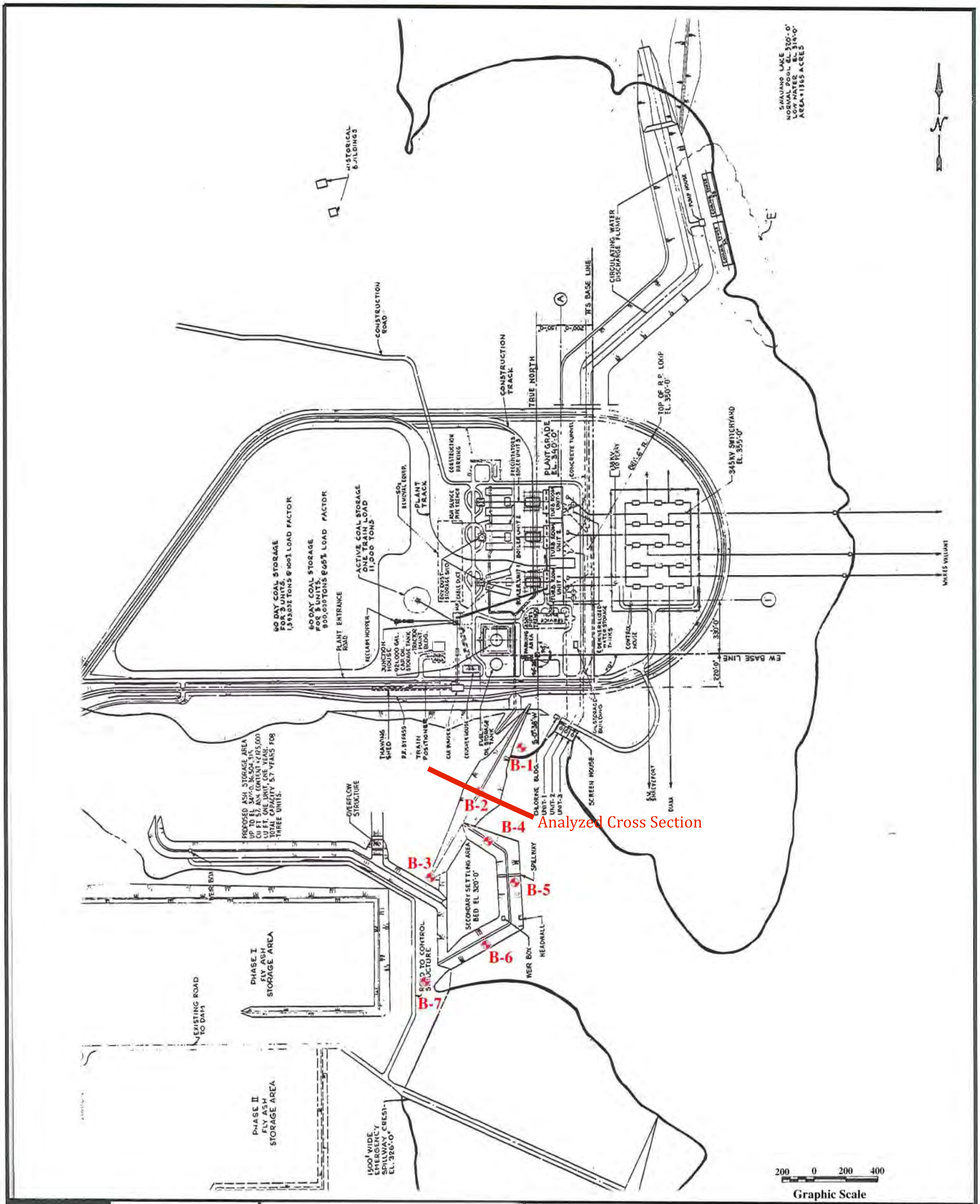
Analysis Description Maximum Storage Pool with Rapid Drawdown of Reservior Pool

Drawn By JJT

Company

Date 12/2/2015

File Name Primary_RD Res_normal_25yr pool.slim



ETTL ENGINEERS & CONSULTANTS
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Tyler, Texas 75702
(903) 595-4421

WELSH POWER PLANT
PITTSBURGH, TEXAS

PLATE 1 - PLAN OF BORINGS

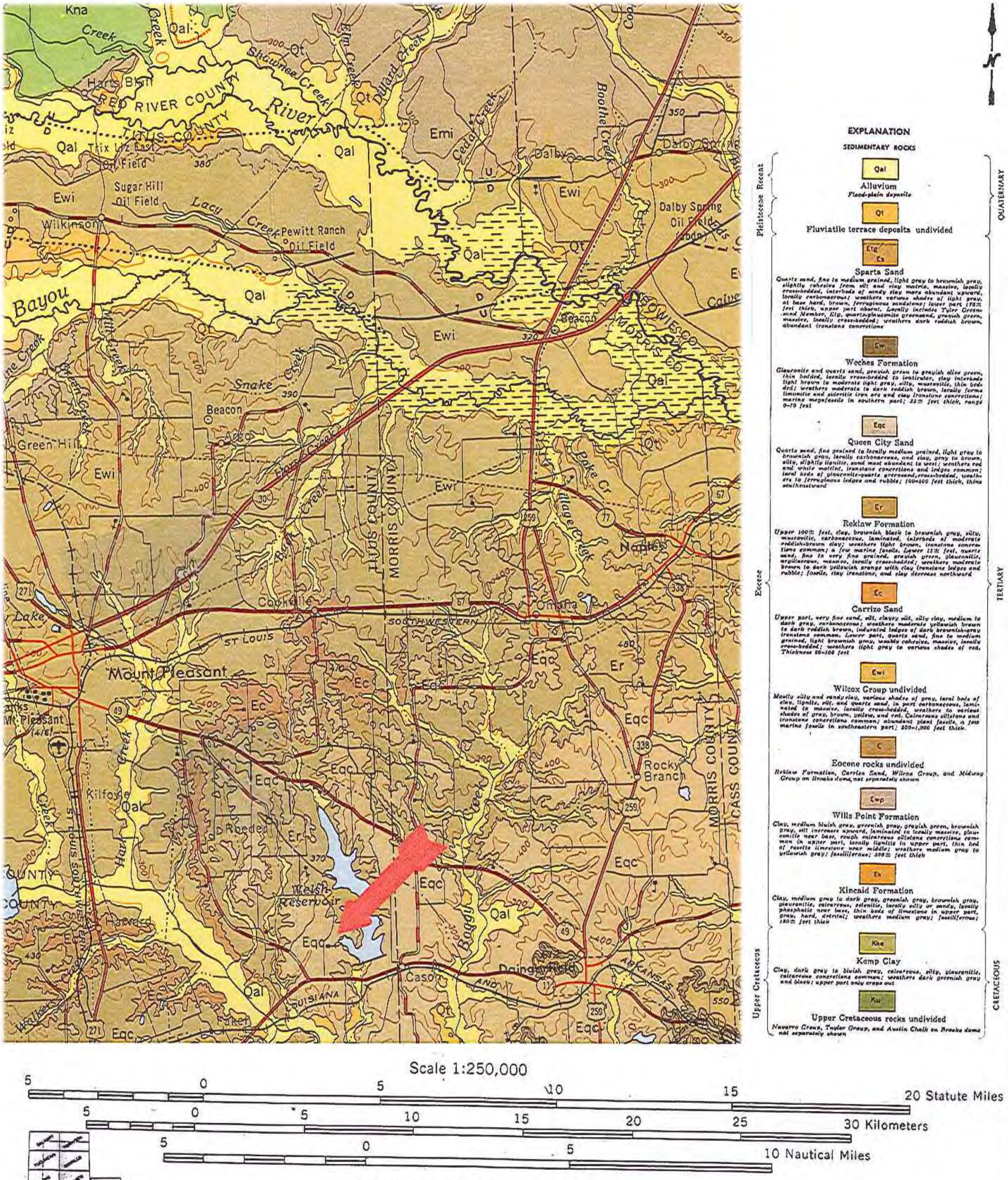
JOB NO.: G3242-095

DATE: JAN. 2010

SCALE: AS SHOWN

APPROVED BY:

DRAWN BY: K.C.R.



EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

Pleistocene Recent

Qal

Alluvium

Flood-plain deposits

Qt

Fluviatile terrace deposits undivided

TERTIARY

Eocene

Etg / Es

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, Etg, quartz-glauconite greensand, grayish green, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions

Ew

Weches Formation

Glauconite and quartz sand, grayish green to grayish olive green, thin bedded, locally cross-bedded to lenticular, clay interbeds light brown to moderate light gray, silty, muscovitic, thin bedded; weathers moderate to dark reddish brown, locally forms limonitic and sideritic iron ore and clay ironstone concretions; marine megafossils in southern part; 25± feet thick, range 0–70 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 most abundant to west; weathers red and white mottled, ironstone concretions and ledges common; local beds of glauconite-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, muscovitic, 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, grayish 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

Ec

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 brownish-gray 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 20–100 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; 500–1,000 feet thick.

E

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, grayish green, brownish gray, silt increases upward, laminated to locally massive, glauconitic near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of fossilic 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, selenitic, locally silty or sandy, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 180± feet thick

CRETACEOUS

Upper Cretaceous

Kkc

Kemp Clay

Clay, dark gray to bluish gray, calcareous, silty, glauconitic, calcareous concretions common; weathers dark greenish gray and black; upper part only crops out

Ku

Upper Cretaceous rocks undivided

Navarro Group, Taylor Group, and Austin Chalk on Brooks dome not separately shown

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS

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SITE SURFACE GEOLOGY

JOB No.: G3242-09

DATE: 1975

SCALE: 1:250,000

ETTL
ENGINEERS &
CONSULTANTS

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

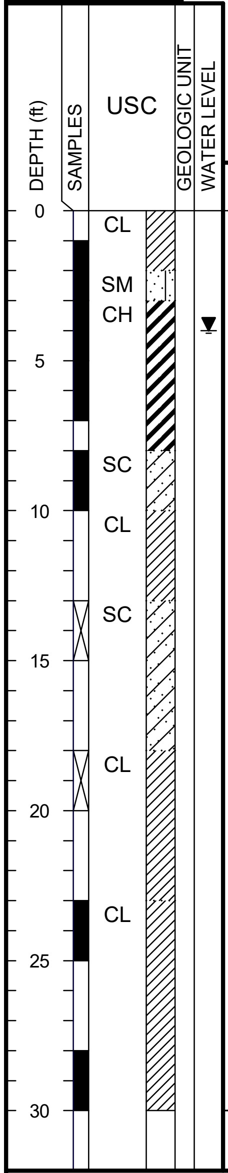
LOG OF BORING B-1

PROJECT: Welsh Power Plant
Pittsburgh, Texas

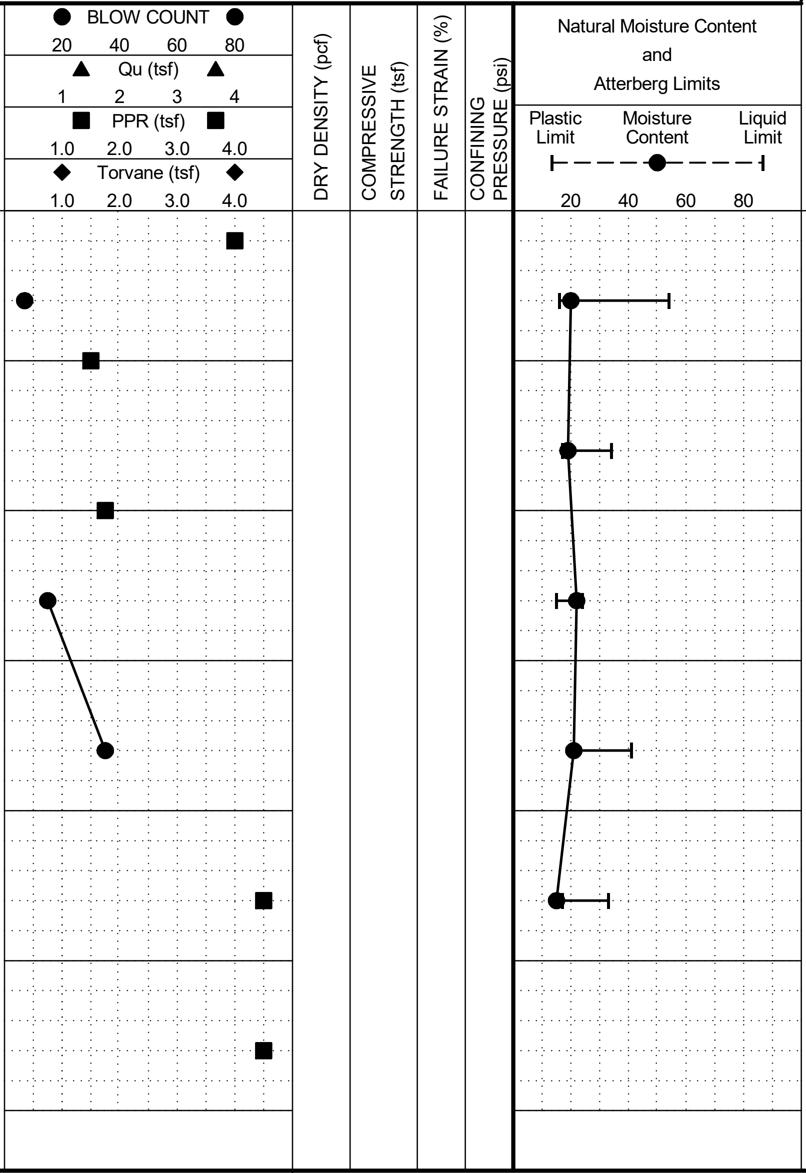
PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 324.1



USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL		SANDY LEAN CLAY(CL) very stiff; brownish orange	P=4.0						
SM		SILTY SAND(SM) tannish orange	SF						
CH	▼	SANDY FAT CLAY(CH) medium stiff; tannish orange	N=7	20	54	16	38	63	+40Sieve=10%, +4 Sieve=1%
		--stiff	P=1.5						
SC		CLAYEY SAND(SC) medium dense; tannish orange; with clay seams	P=1.75	19	34	17	17	32	+40 Sieve=7%, +4 Sieve=3%
CL		SANDY LEAN CLAY(CL) stiff; orange							
SC		CLAYEY SAND(SC) medium dense; orange; saturated; with iron oxide cemented sandstone rock	N=15	22	24	15	9	19	+40Sieve=35%, +4 Sieve=22%
CL		LEAN CLAY WITH SAND(CL) hard; dark gray; with clay seams	N=35	21	41	21	20	75	+40 Sieve=2%, +4 Sieve=0%
CL		SANDY LEAN CLAY(CL) hard; dark brown	P=4.5+	15	33	17	16	52	+40 Sieve=1%, +4 Sieve=0%
		--grayish brown; laminated with silt	P=4.5+						
		Bottom of Boring @ 30'							



Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 5' while drilling. Water level @ 4' and open to 30' upon completion.

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

Notes:
GPS Coordinates: N 33°03.090', W 94°50.417'

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
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LOG OF BORING B-2

PROJECT: Welsh Power Plant
Pittsburgh, Texas

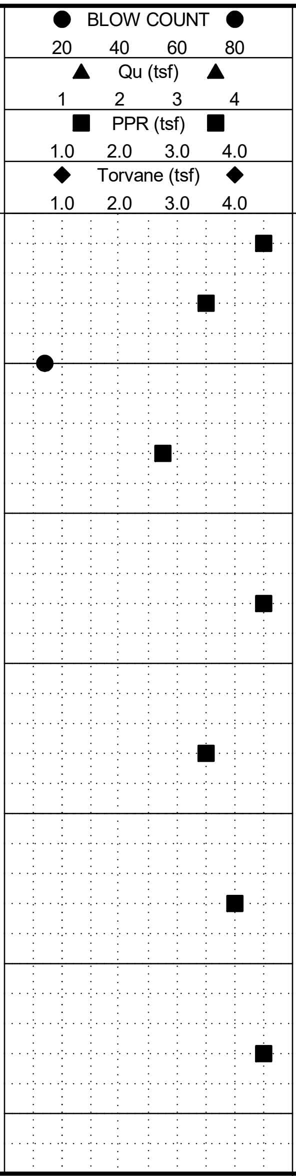
PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

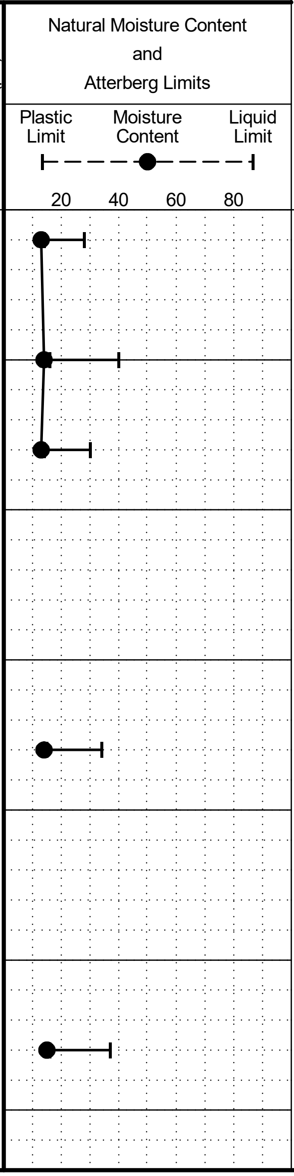
DATE 10/28/09

SURFACE ELEVATION 339.7

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL								
1.5		SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	13	28	14	14	61	+40 Sieve=3%, +4 Sieve=0%
3.5		--very stiff	P=3.5						
5.5		--stiff	N=14	14	40	16	24	65	+40 Sieve=0%, +4 Sieve=0%
8.5		--very stiff; reddish brown	P=2.75	13	30	14	16	58	+40 Sieve=0%, +4 Sieve=0%
13.5	CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+						
18.5		--very stiff	P=3.5	14	34	15	19	54	+40 Sieve=0%, +4 Sieve=0%
23.5			P=4.0						
28.5	SC	CLAYEY SAND(SC) medium dense; tan, red, and gray	P=4.5	15	37	16	21	47	+40 Sieve=5%, +4 Sieve=3%



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



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

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

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LOG OF BORING B-2

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

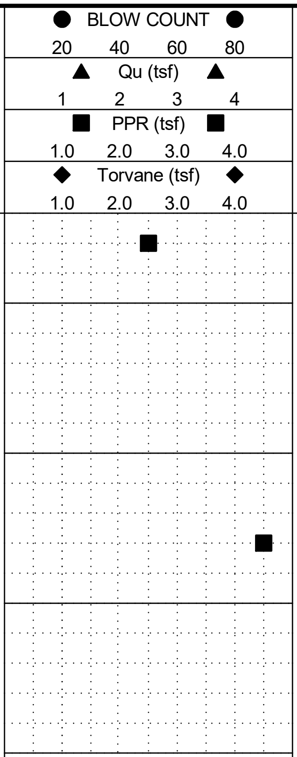
DATE 10/28/09

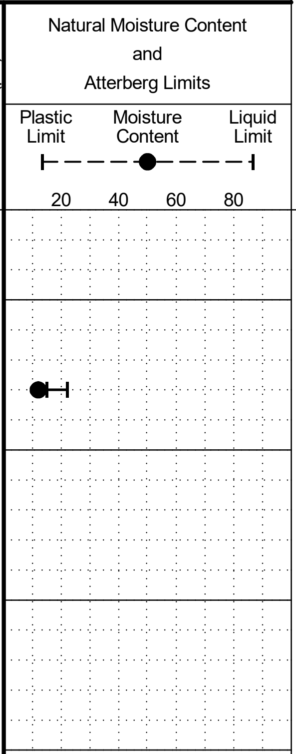
SURFACE ELEVATION 339.7

MATERIAL DESCRIPTION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		--red and tan	P=2.5						
35									
	SM SC	SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated	SF	12	22	15	7	48	+40 Sieve=0%, +4 Sieve=0%
40									
	CH	FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams	P=4.5+						
45									
	SM	SILTY SAND(SM) black and gray	SF						
50		Bottom of Boring @ 50'							

Columns also printed (no entries): SAMPLES, GEOLOGIC UNIT, WATER LEVEL, DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi)





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

Water Observations: Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

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LOG OF BORING B-3

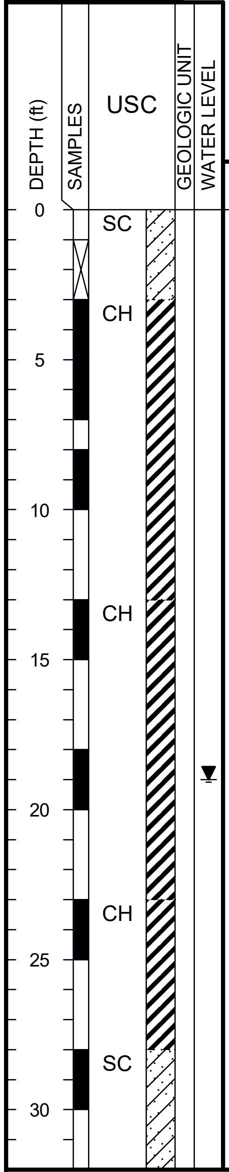
PROJECT: Welsh Power Plant
Pittsburgh, Texas

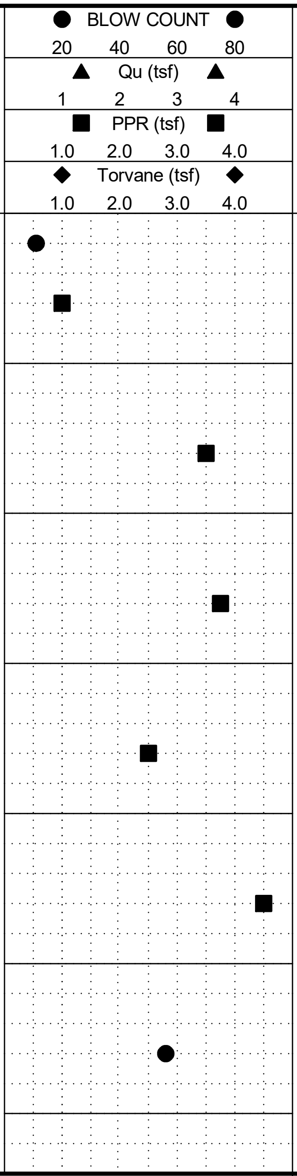
PROJECT NO.: G3242-09

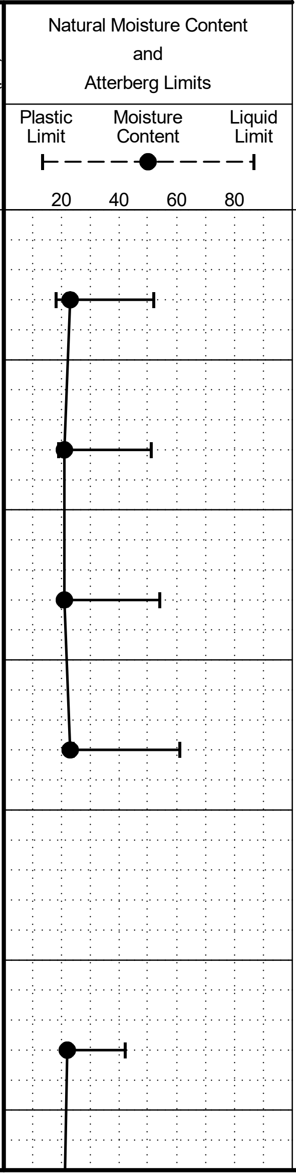
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; gray and red	N=11										
CH	FAT CLAY(CH) stiff; red and tan; with sand seams	P=1.0					23	52	18	34	87	+40 Sieve=3%, +4 Sieve=0%
	--very stiff	P=3.5					21	51	19	32	86	+40 Sieve=3%, +4 Sieve=0%
CH	FAT CLAY WITH SAND(CH) very stiff; brown; with ferric joints	P=3.75					21	54	20	34	85	+40Sieve=10%, +4 Sieve=1%
	--red and tan; layered; with ferric seams	P=2.5					23	61	24	37	81	+40Sieve=11%, +4 Sieve=0%
CH	FAT CLAY(CH) hard; gray; with sand seams	P=4.5+										
SC	CLAYEY SAND(SC) very dense; gray; with sand seams	N=56					22	42	22	20	35	+40 Sieve=1%, +4 Sieve=0%

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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

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LOG OF BORING B-3

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
33–35	CH	FAT CLAY(CH) hard; brown; layered and with sand seams	P=4.5+	21	60	24	36	95	+40 Sieve=1%, +4 Sieve=0%
38–40		--gray and green	P=4.5+						
43–45	CL	SANDY LEAN CLAY(CL) very stiff; gray and dark green; layered; with sand seams	P=3.5						
48–50	CH	FAT CLAY(CH) hard; gray and dark green; layered; with silt seams	P=4.5+						
50		Bottom of Boring @ 50'							

SAMPLES; GEOLOGIC UNIT; WATER LEVEL; 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; ATTERBERG LIMITS(%): LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX.

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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
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Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

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LOG OF BORING B-4

PROJECT: Welsh Power Plant
Pittsburgh, Texas

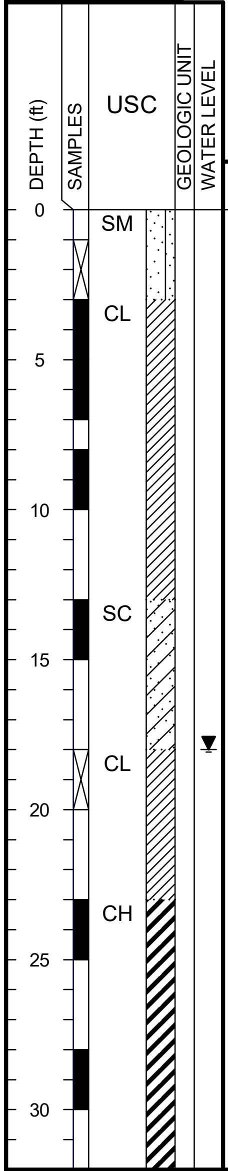
PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

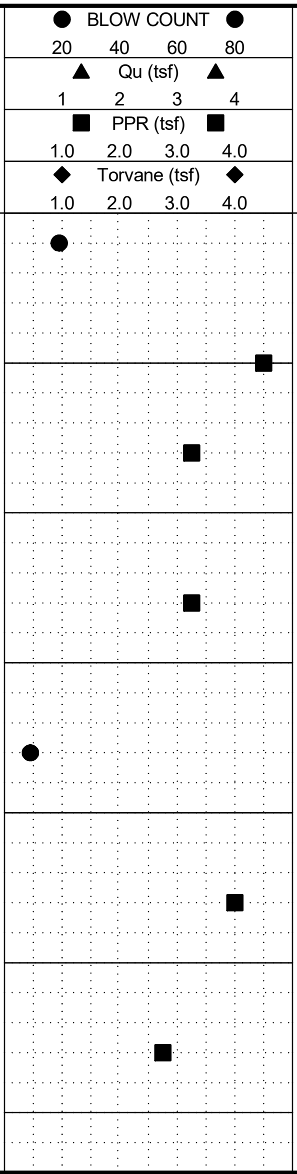
DATE 10/27/09

SURFACE ELEVATION 340.6

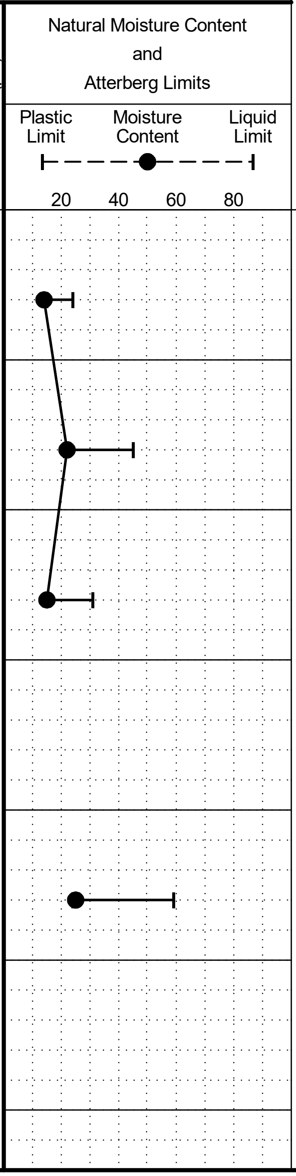
MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) medium dense; tan; with gravel	N=19						
CL	SANDY LEAN CLAY(CL) dark brown	SF	14	24	15	9	59	+40 Sieve=1%, +4 Sieve=0%
	--tannish orange							
	--hard; orangish tan	P=4.5						
		P=3.25	22	45	21	24	94	+40 Sieve=2%, +4 Sieve=0%
	--very stiff; white							
SC	CLAYEY SAND(SC) medium dense; tan	P=3.25	15	31	15	16	40	+40 Sieve=1%, +4 Sieve=0%
	--orangish gray; with sand seams							
CL	SANDY LEAN CLAY(CL) stiff; orangish tan	N=9						
CH	FAT CLAY(CH) very stiff; orangish tan; with ferric seams	P=4.0	25	59	24	35	88	+40 Sieve=4%, +4 Sieve=0%
	--tannish brown; with iron ore seams	P=2.75						





DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

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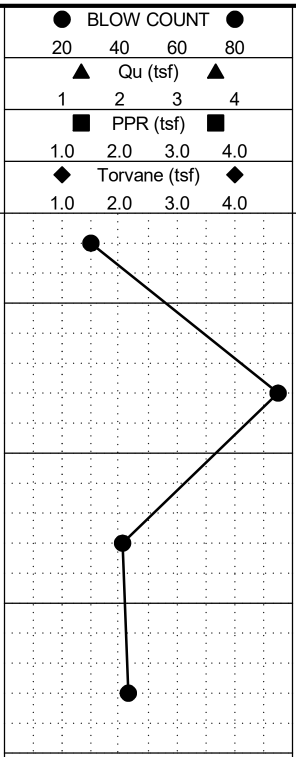
LOG OF BORING B-4

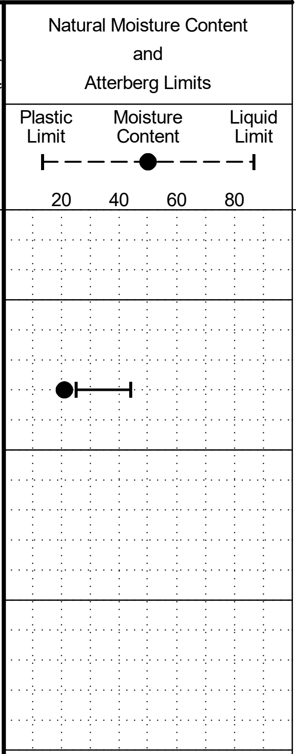
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6





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. #)
35	☒		▨		--hard; light gray; layered and with silt seams	N=30										
	☒	CL	▨		LEAN CLAY(CL) hard; light gray; layered and with silt seams	N=50/5.75"					21	44	25	19	93	+40 Sieve=1%, +4 Sieve=0%
40																
	☒		▨		--light gray	N=41										
45																
	☒		▨		--layered and with sand seams; with lignite	N=43										
50					Bottom of Boring @ 50'											

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

Water Observations: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

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LOG OF BORING B-5

PROJECT: Welsh Power Plant
Pittsburgh, Texas

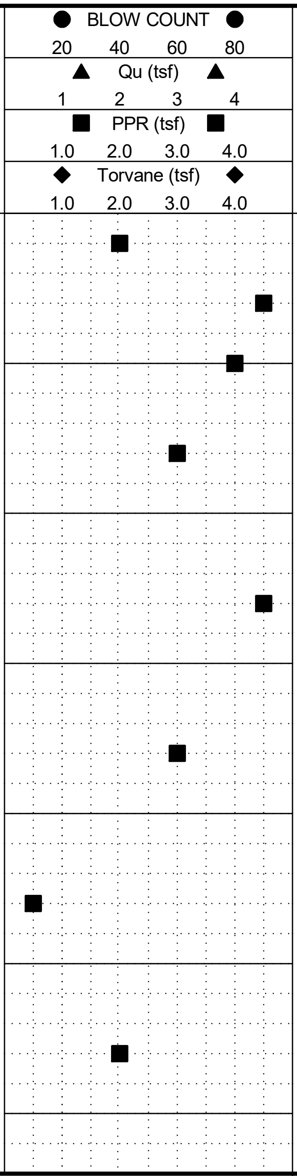
PROJECT NO.: G3242-09

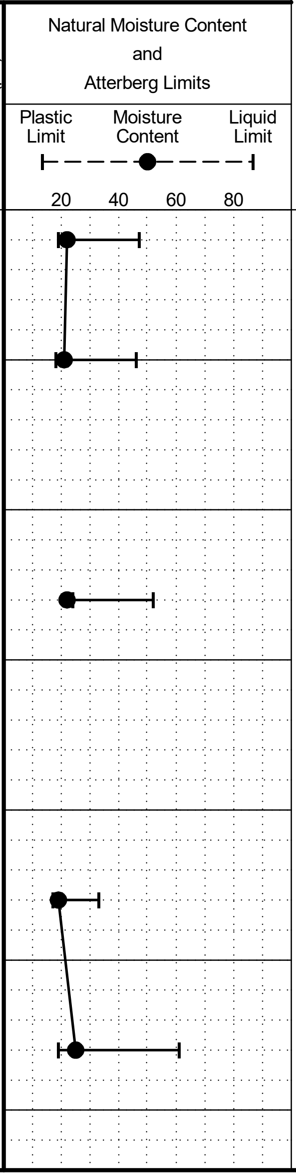
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.0

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) stiff; red and tan	P=2.0	22	47	19	28	81	+40 Sieve=9%, +4 Sieve=3%
CL	LEAN CLAY(CL) hard; red and tan	P=4.5+						
	--very stiff	P=4.0	21	46	18	28	94	+40 Sieve=3%, +4 Sieve=0%
CH	FAT CLAY(CL) very stiff; brown and tan	P=3.0						
CH	FAT CLAY WITH SAND(CH) hard; red and tan	P=4.5+	22	52	24	28	88	+40 Sieve=3%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams	P=3.0						
SC	CLAYEY SAND(SC) very loose; tan, red, and gray	P=0.5	19	33	17	16	44	+40 Sieve=1%, +4 Sieve=0%
CH	FAT CLAY WITH SAND(CH) stiff; red and gray	P=2.0	25	61	19	42	83	+40 Sieve=5%, +4 Sieve=3%





DEPTH (ft): 0, 5, 10, 15, 20, 25, 30

DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi)

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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

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LOG OF BORING B-5

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

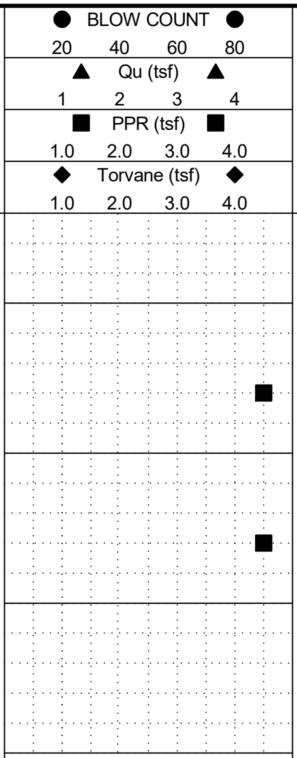
DATE 10/27/09

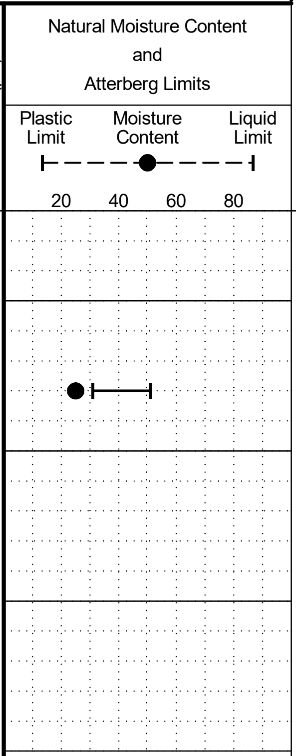
SURFACE ELEVATION 340.0

MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	SILTY CLAYEY SAND(SC) gray and red; saturated	SF						
CH	FAT CLAY(CH) hard; red and gray; with sand seams	P=4.5+	25	51	31	20	87	+40 Sieve=6%, +4 Sieve=0%
	--gray, tan, and red; with sand seams	P=4.5+						
SM SC	SILTY SAND(SM-SC) red and gray	SF						
	Bottom of Boring @ 50'							

DEPTH (ft): 35, 40, 45, 50





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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

LOG OF BORING B-6

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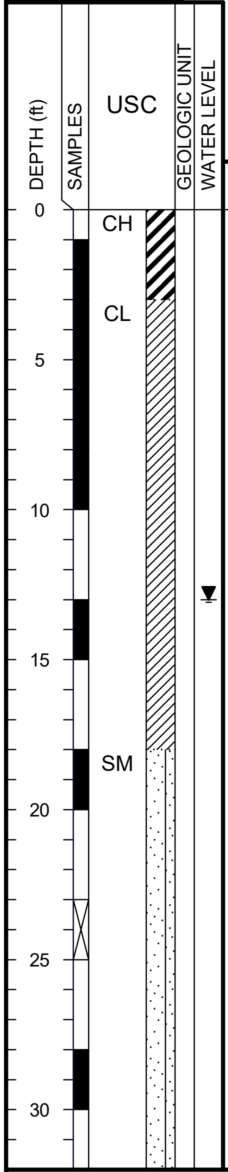
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

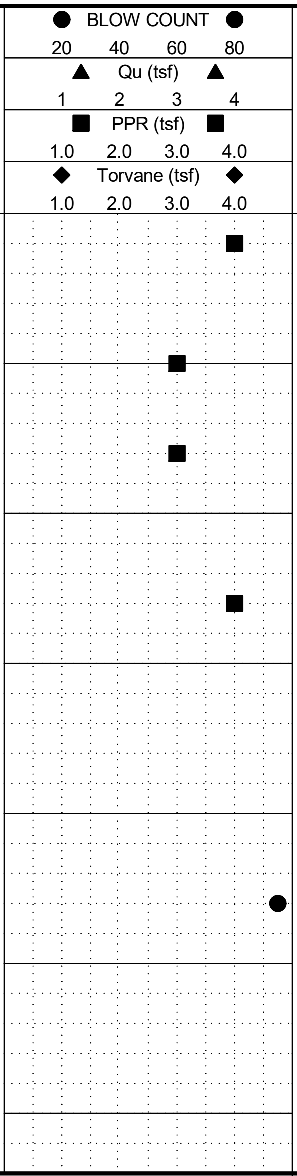
DATE 10/27/09

SURFACE ELEVATION 340.1

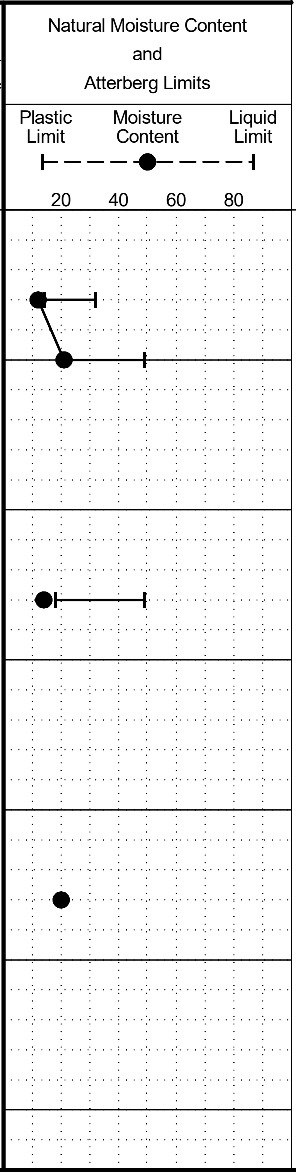


MATERIAL DESCRIPTION

USC	Material Description	Field Strength Data	Moisture Content (%)	LL	PL	PI	Minus #200 Sieve (%)	Other Tests Performed (Page Ref. #)
CH	FAT CLAY(CH) very stiff; red and gray; with ferric seams	P=4.0						
CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+	12	32	14	18	60	+40 Sieve=0%, +4 Sieve=0%
			21	49	20	29	93	+40 Sieve=2%, +4 Sieve=0%
		P=3.0						
	--very stiff; red, gray, and brown; with gravel --with sand seams	P=3.0						
		P=4.0	14	49	18	31	65	+40 Sieve=0%, +4 Sieve=0%
SM	SILTY SAND(SM) gray; saturated	P=3.0						
	--very dense; gray and red	N=50/5.25"	20				18	+40 Sieve=0%, +4 Sieve=0%
		SF						



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



ATTERBERG LIMITS(%): LL – LIQUID LIMIT, PL – PLASTIC LIMIT, PI – PLASTICITY INDEX

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

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

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LOG OF BORING B-6

PROJECT: Welsh Power Plant
Pittsburgh, Texas

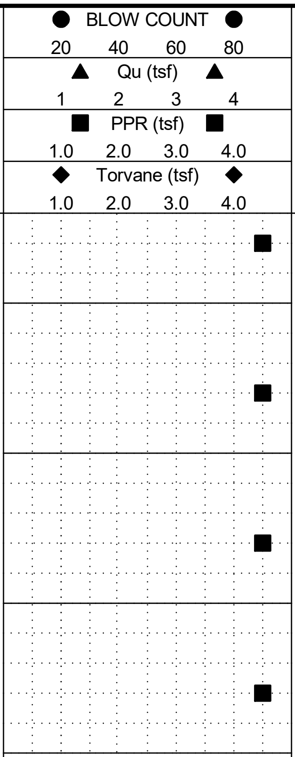
PROJECT NO.: G3242-09

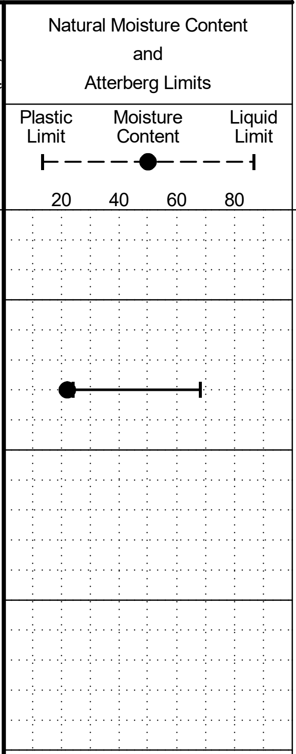
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	CH	FAT CLAY(CH) hard; brown; with sand seams	P=4.5+						
35									
			P=4.5+	22	68	24	44	95	+40 Sieve=0%, +4 Sieve=0%
40									
		--dark green	P=4.5+						
45									
	CL	LEAN CLAY(CL) hard; dark green; laminated with lignite	P=4.5+						
50		Bottom of Boring @ 50'							





DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

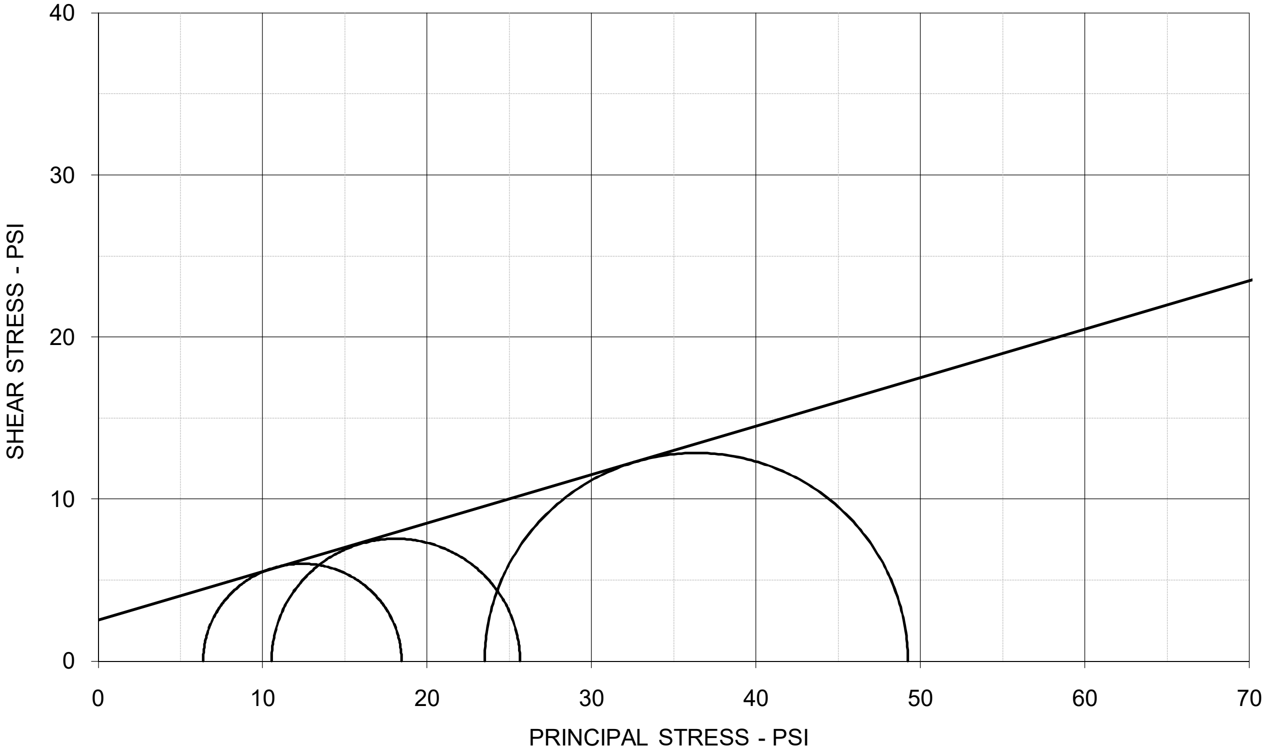
Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

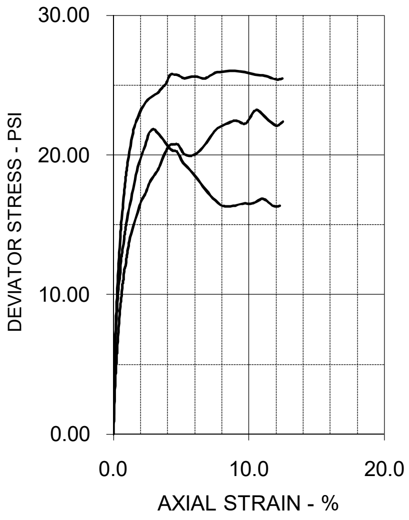
Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' =	16.7 deg	c' =	2.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.9	24.1	26.5	
Dry Density - pcf	102.5	100.6	99.0	
Diameter - inches	2.01	2.00	2.01	
Height - inches	4.00	3.92	3.98	
AT TEST				
Final Moisture - %	25.4	24.3	25.0	
Dry Density - pcf	102.7	102.4	101.9	
Calculated Diameter (in.)	2.01	1.98	1.99	
Height - inches	4.02	3.87	3.92	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.03	15.08	25.71	
Total Pore Pressure - psi	53.6	59.4	66.5	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.9	0.9	4.8	
σ_1' Failure - psi	18.43	25.64	49.23	
σ_3' Failure - psi	6.40	10.56	23.52	

TEST DESCRIPTION

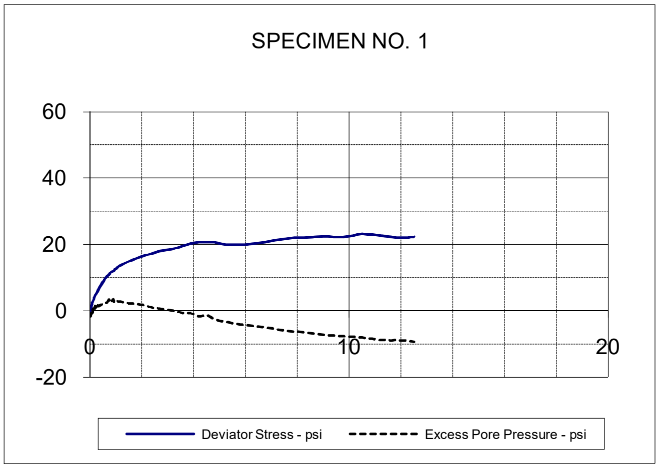
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Tan & Gray Clay & w/ some Ferric Joints
Sampled on Site, B-1 5' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve
G 3242-095, B-1 5'-10' Welsh

PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.1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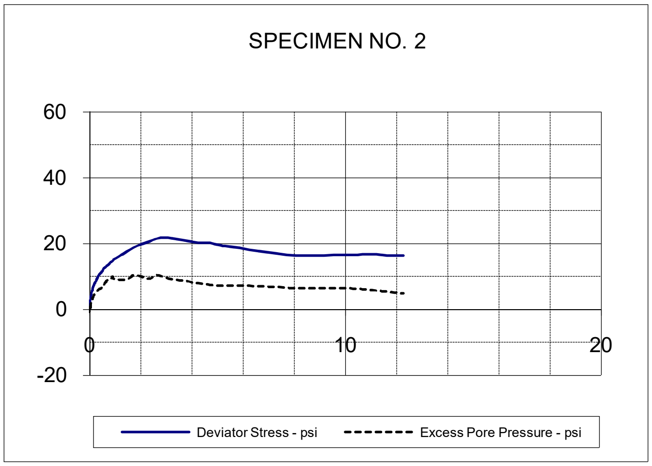
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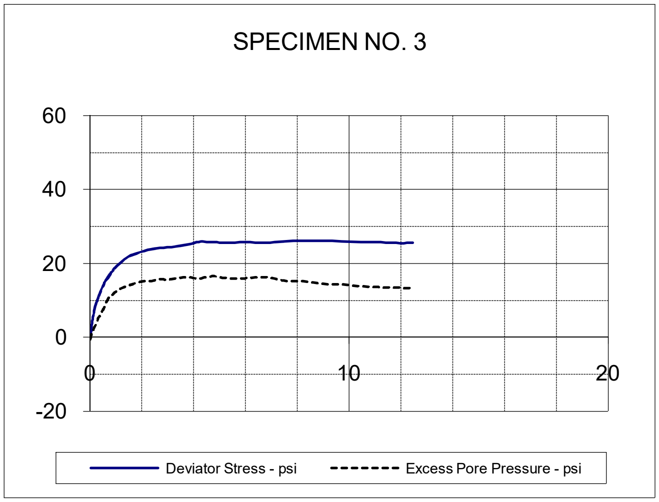
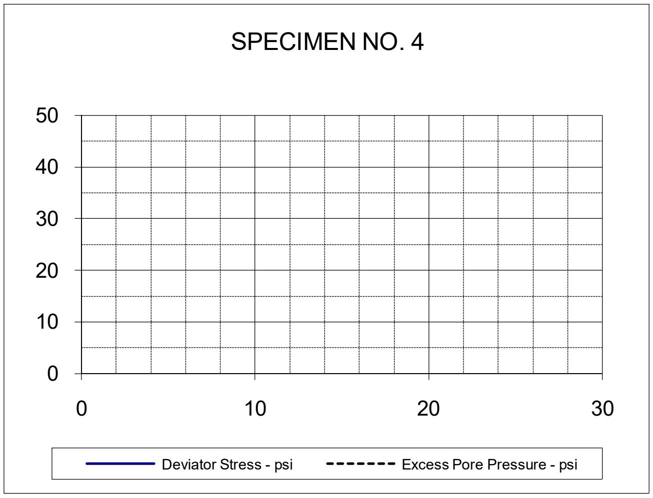

SPECIMEN NO. 3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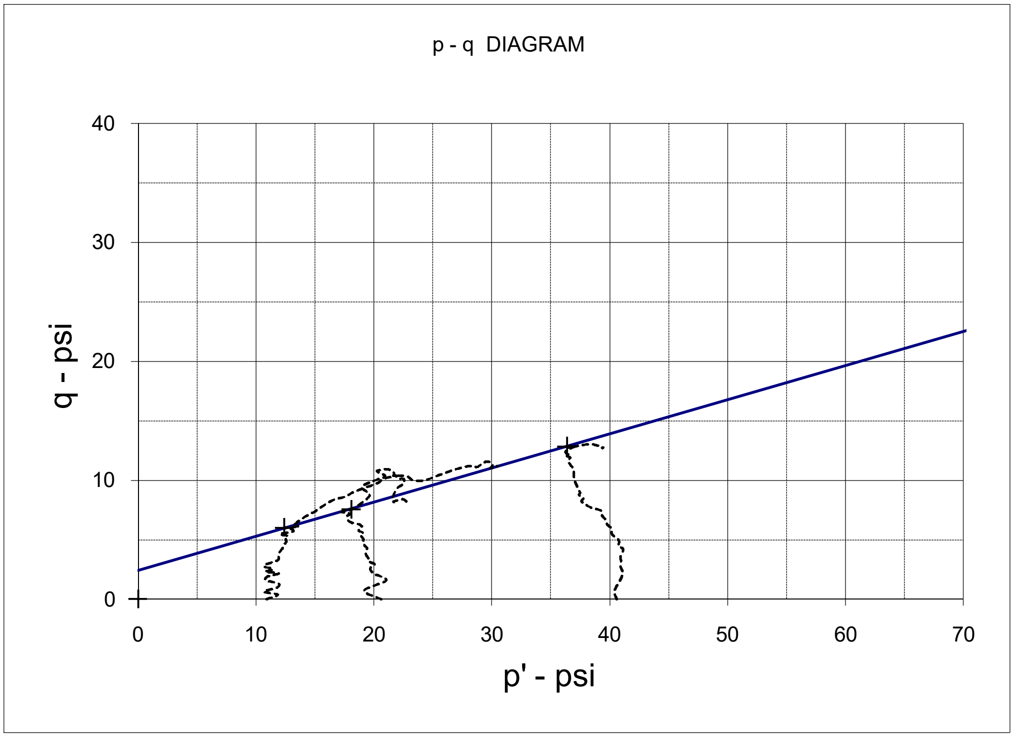
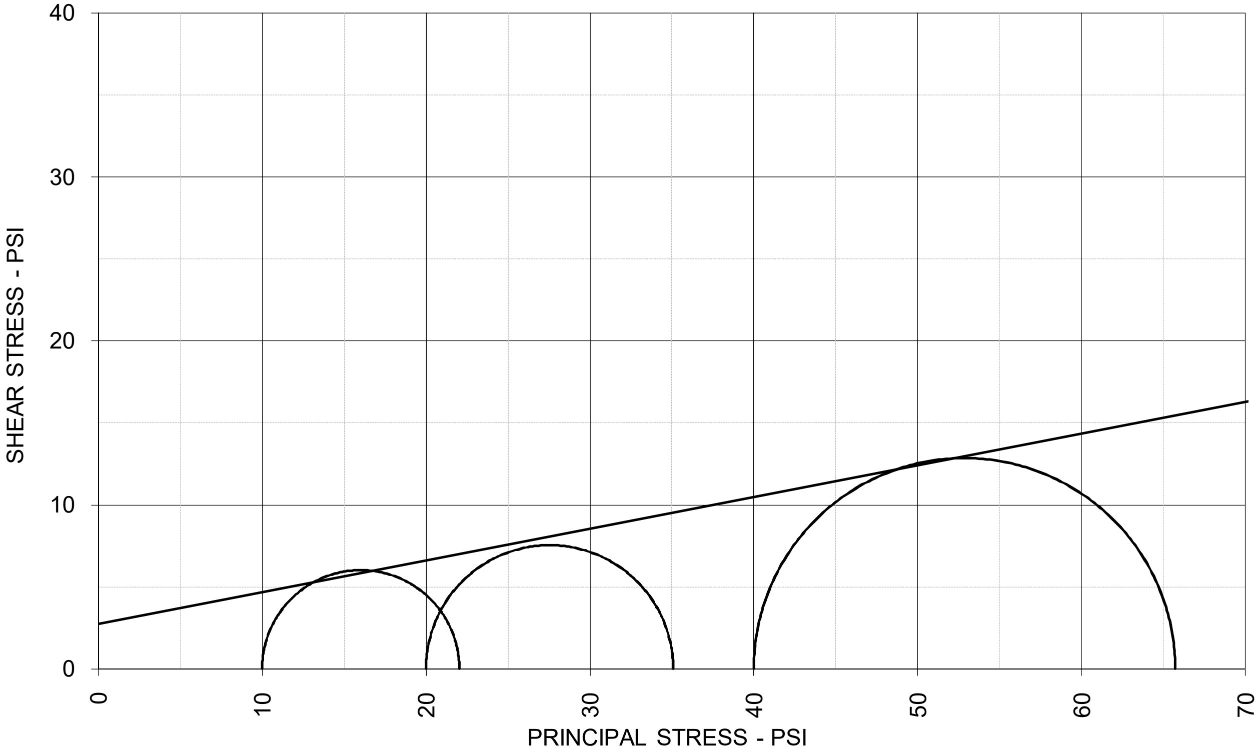

p - q DIAGRAM

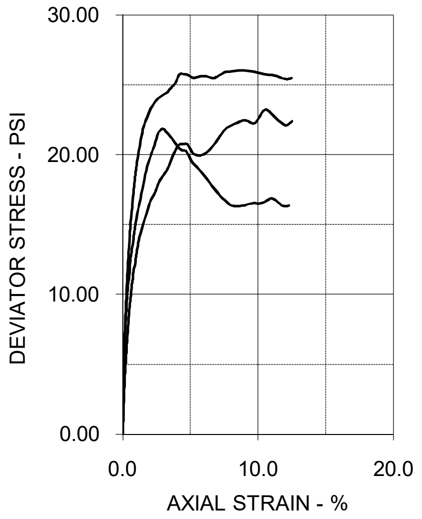
EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 16.0	a (psi) = 2.4
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Tan & Gray Clay & w/ some Ferric Joints			

G 3242-095, B-1 5'-10' Welsh

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ =	10.9 deg	c =	2.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.9	24.1	26.5	
Dry Density - pcf	102.5	100.6	99.0	
Diameter - inches	2.01	2.00	2.01	
Height - inches	4.00	3.92	3.98	
AT TEST				
Final Moisture - %	25.4	24.3	25.0	
Dry Density - pcf	102.7	102.4	101.9	
Calculated Diameter (in.)	2.01	1.98	1.99	
Height - inches	4.02	3.87	3.92	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.03	15.08	25.71	
Total Pore Pressure - psi	53.6	59.4	66.5	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.9	0.9	4.8	
σ_1 Failure - psi	22.03	35.08	65.71	
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: Tan & Gray Clay & w/ some Ferric Joints
Sampled on Site, B-1 5' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

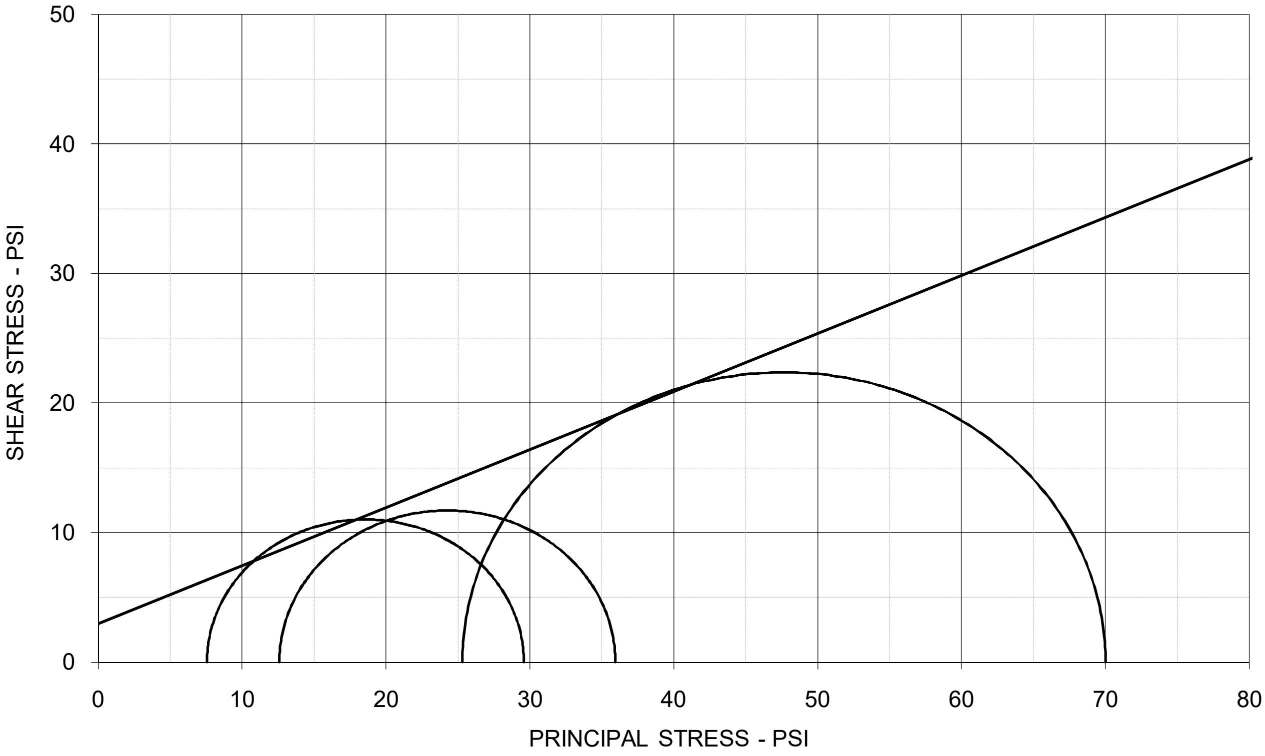
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

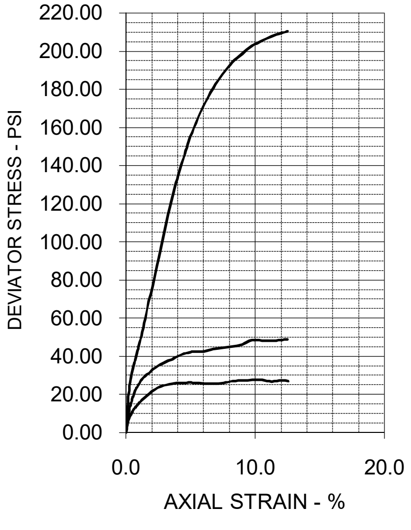
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 24.1 deg	c' = 2.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	14.4	23.6	13.0	
Dry Density - pcf	114.9	100.1	122.2	
Diameter - inches	2.01	2.02	2.00	
Height - inches	4.00	4.00	4.02	
AT TEST				
Final Moisture - %	18.7	24.4	13.2	
Dry Density - pcf	115.2	101.7	123.3	
Calculated Diameter (in.)	2.00	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	22.03	23.38	44.72	
Total Pore Pressure - psi	52.5	57.4	64.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.7	2.4	1.0	
σ_1' Failure - psi	29.58	35.95	70.02	
σ_3' Failure - psi	7.55	12.57	25.30	

TEST DESCRIPTION

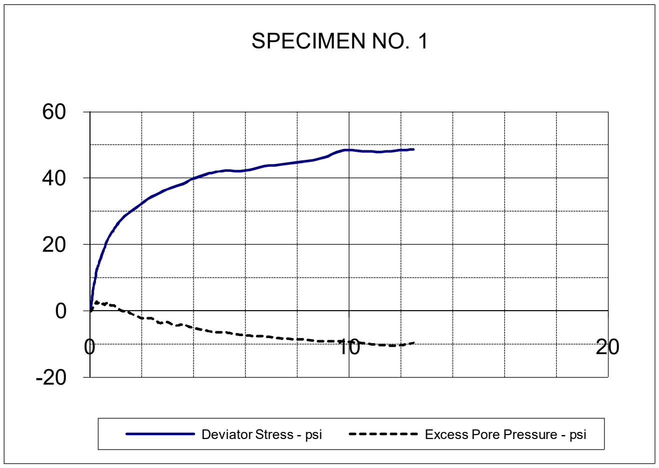
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Reddish Brown Sandy Lean Clay
Sampled on Site, B-2 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

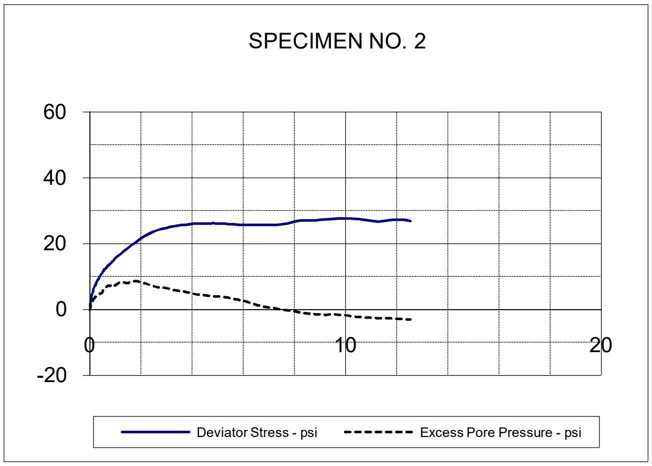
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.1

G 3242-095, B-2 8'-10' Welsh



SPECIMEN NO. 1



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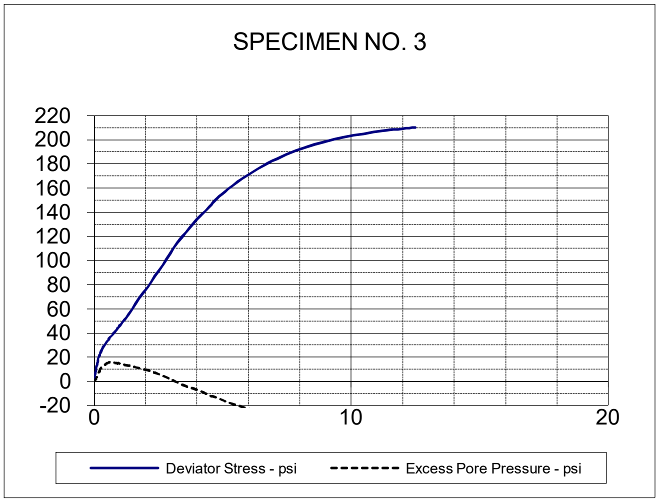
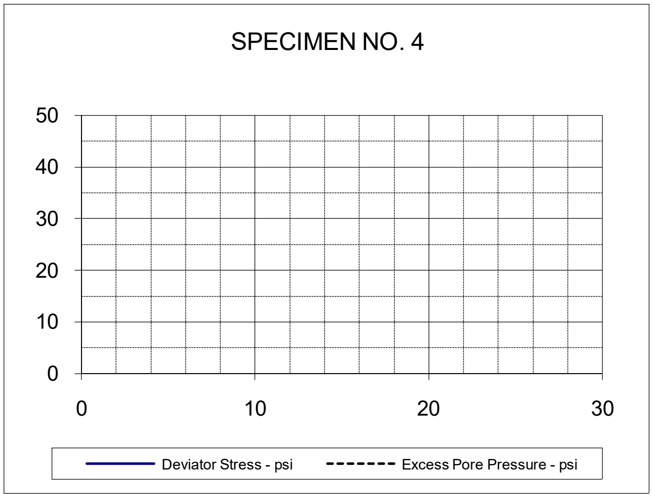
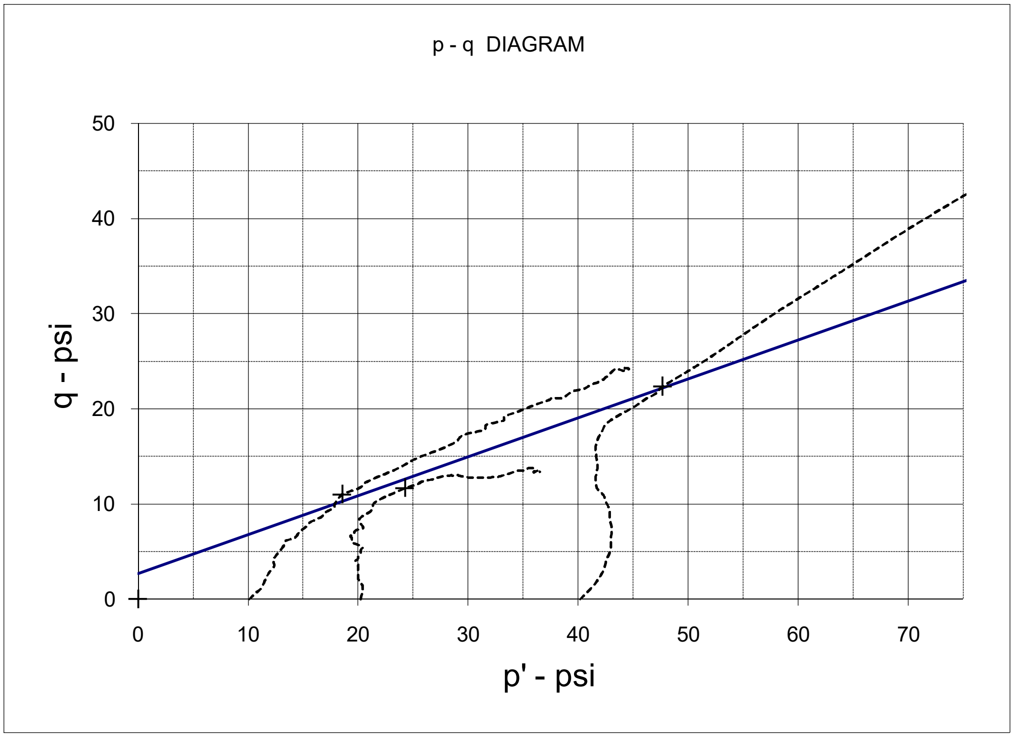


SPECIMEN NO. 3



SPECIMEN NO. 4

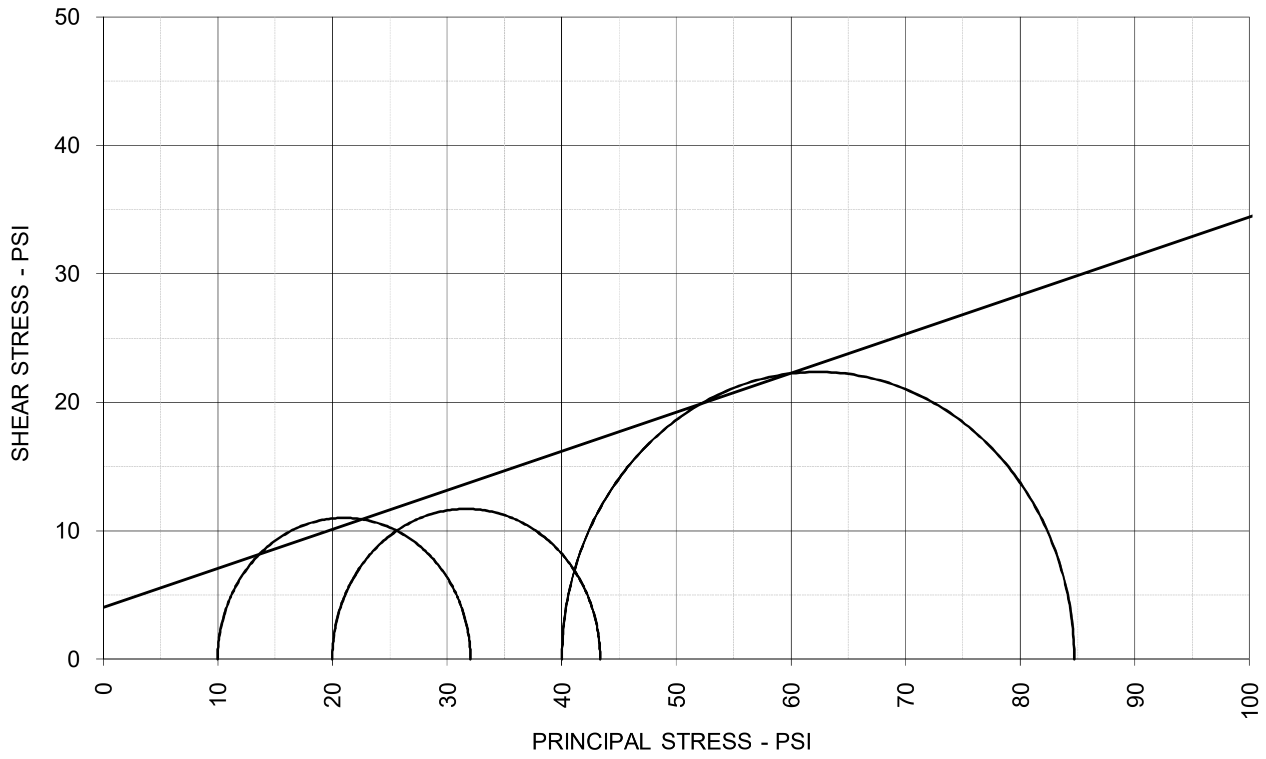


p - q DIAGRAM

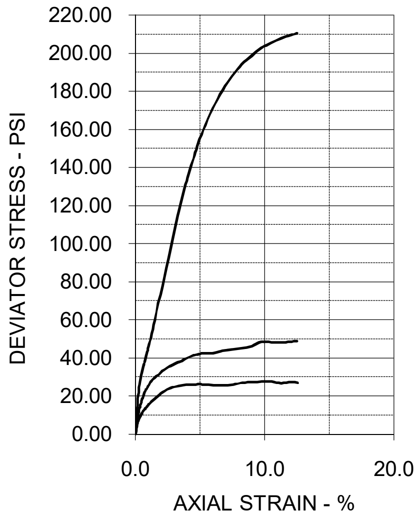
EFFECTIVE STRESS PARAMETERS	$R^2 = 0.98$	α (deg) = 22.3	a (psi) = 2.7
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Reddish Brown Sandy Lean Clay			

G 3242-095, B-2 8'-10' Welsh

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 16.9 deg	c = 4.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	14.4	23.6	13.0	
Dry Density - pcf	114.9	100.1	122.2	
Diameter - inches	2.01	2.02	2.00	
Height - inches	4.00	4.00	4.02	
AT TEST				
Final Moisture - %	18.7	24.4	13.2	
Dry Density - pcf	115.2	101.7	123.3	
Calculated Diameter (in.)	2.00	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	22.03	23.38	44.72	
Total Pore Pressure - psi	52.5	57.4	64.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.7	2.4	1.0	
σ_1 Failure - psi	32.03	43.38	84.72	
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: Reddish Brown Sandy Lean Clay
Sampled on Site, B-2 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

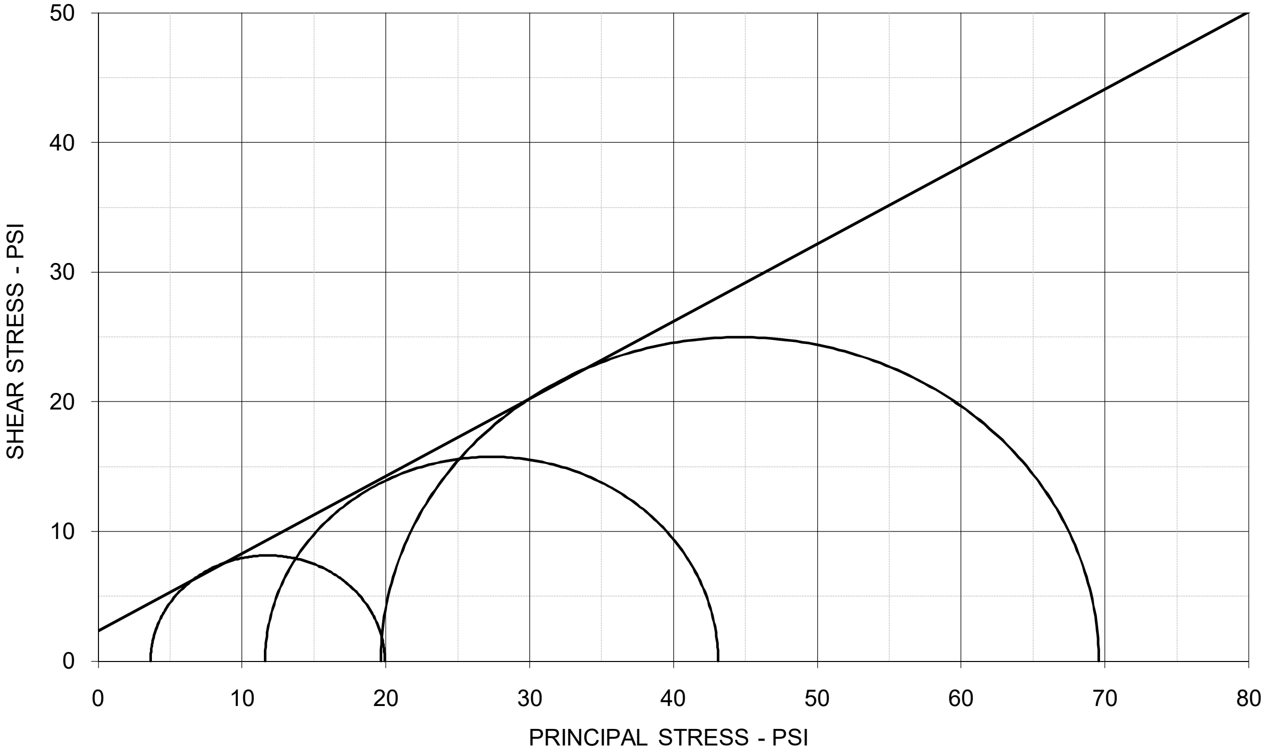
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

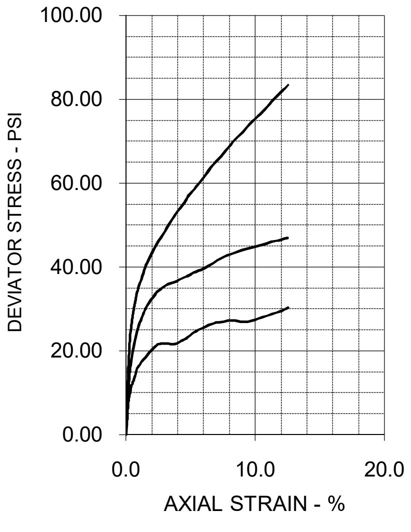
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' =	30.8 deg	c' =	2.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	20.5	17.7	16.0	
Dry Density - pcf	106.7	111.3	117.2	
Diameter - inches	2.00	1.99	1.98	
Height - inches	3.99	3.98	4.00	
AT TEST				
Final Moisture - %	27.8	18.6	16.3	
Dry Density - pcf	106.8	112.4	118.7	
Calculated Diameter (in.)	2.00	1.99	1.97	
Height - inches	3.98	3.97	3.96	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	16.30	31.51	49.94	
Total Pore Pressure - psi	56.4	58.4	70.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	3.3	
σ_1' Failure - psi	19.94	43.12	69.59	
σ_3' Failure - psi	3.64	11.61	19.65	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Tan, Brown, Gray & Red Clayey Sand
Sampled on Site, B-2 28' to 30' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

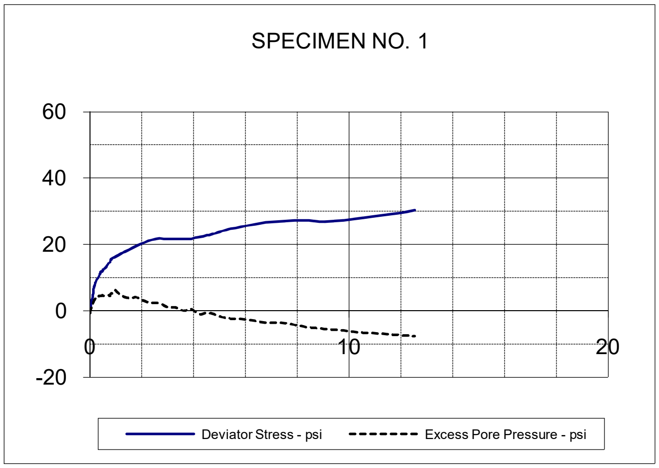
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.1

G 3242-095, B-2 28'-30' Welsh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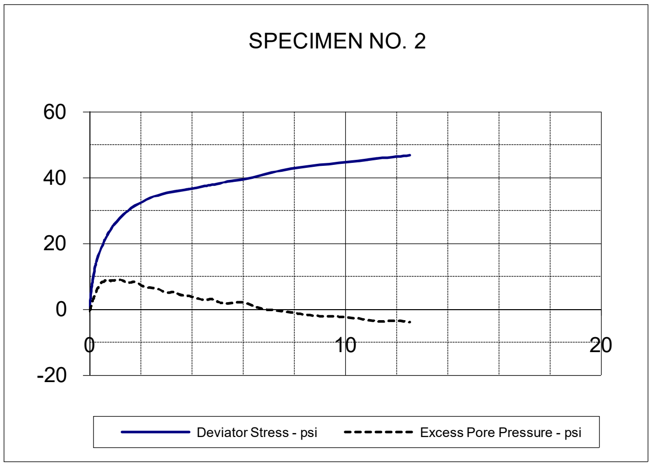
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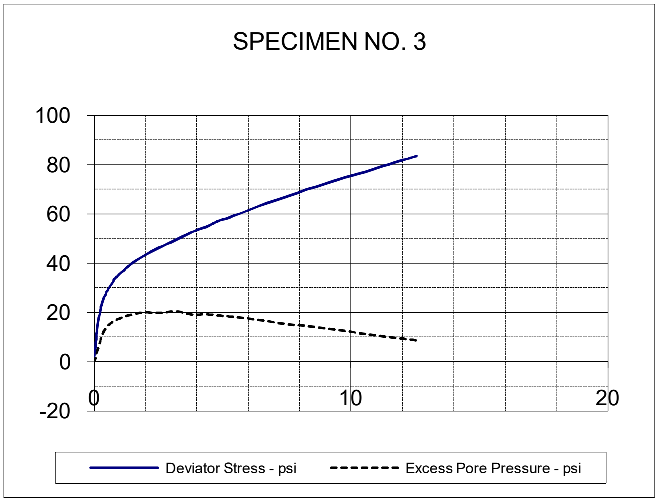
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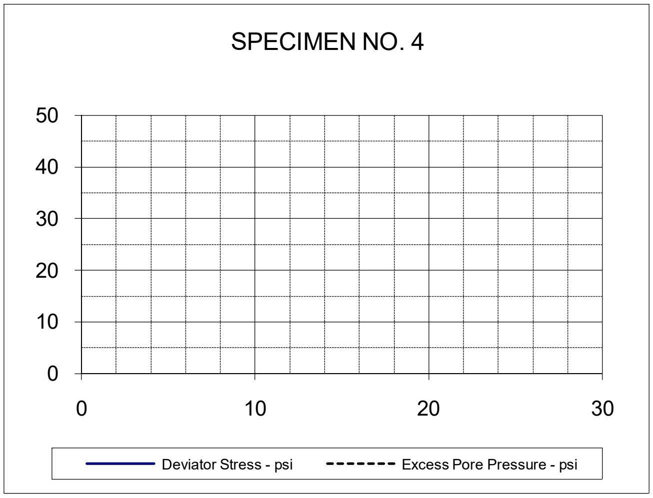
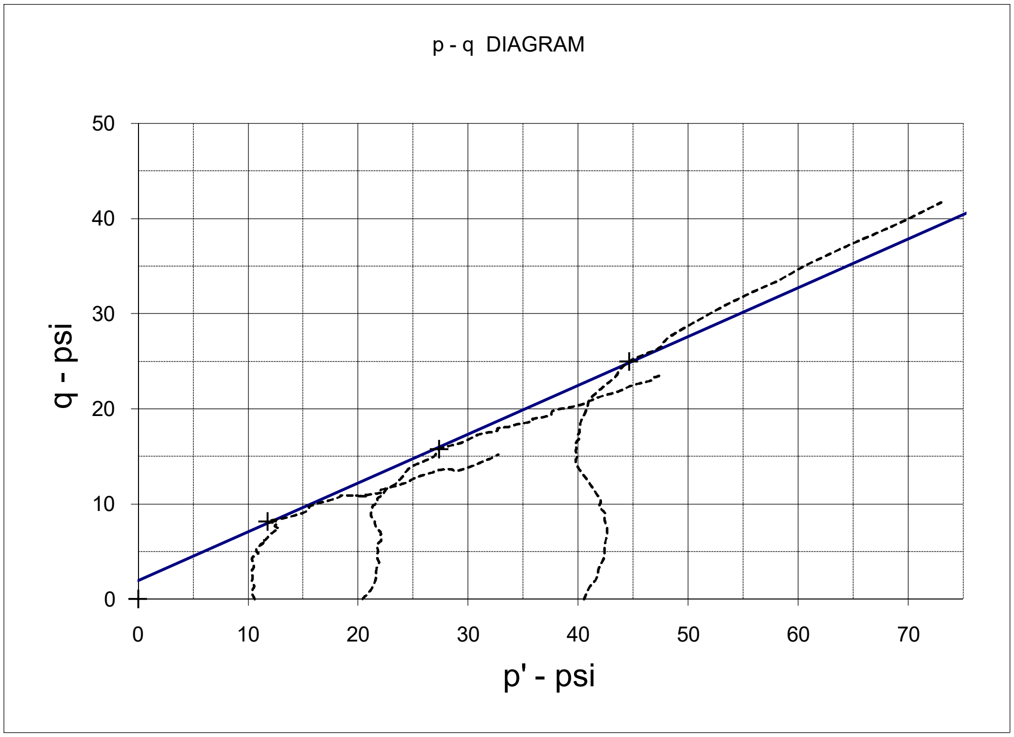

SPECIMEN NO. 4

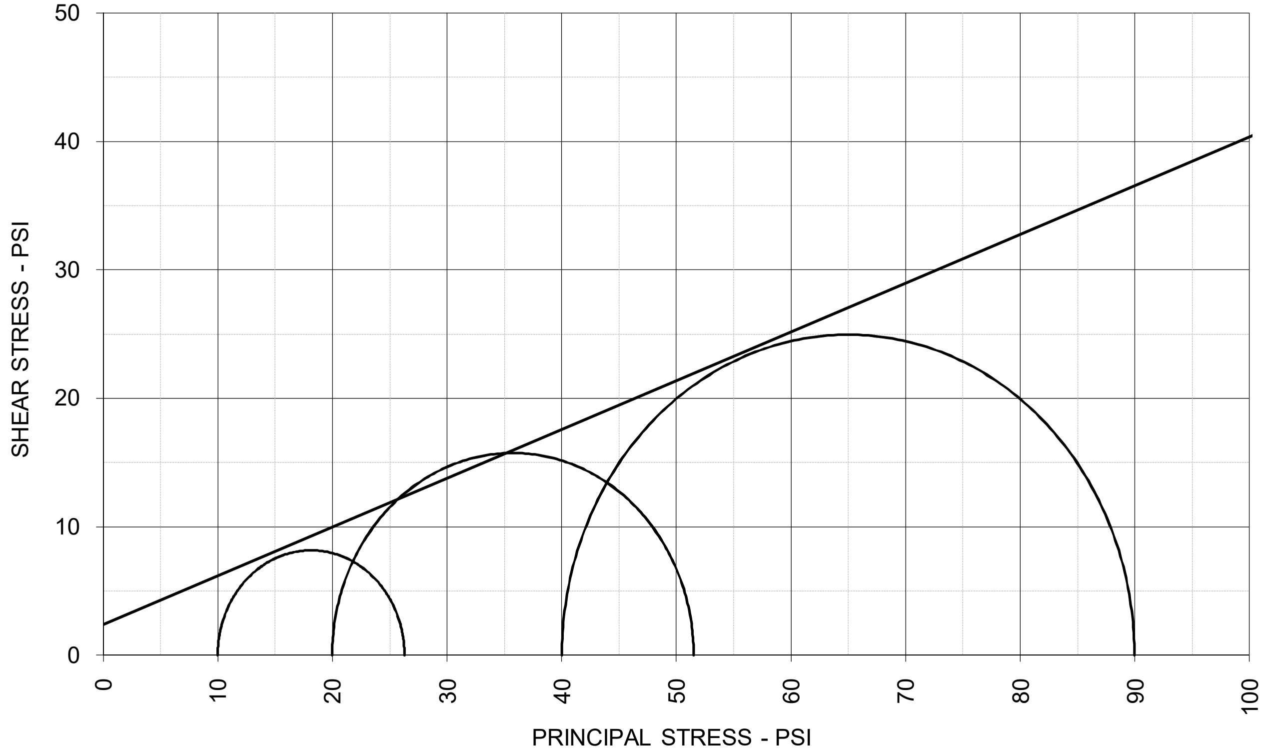

p - q DIAGRAM

EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 27.1	a (psi) = 2.0

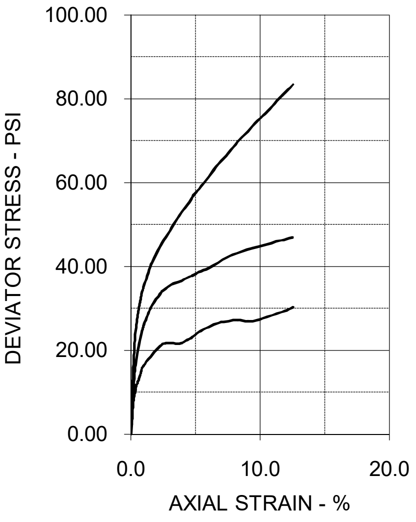
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds	TYPE OF TEST & NO: CU with PP
PROJECT NO: G 3242 - 095	**ETTL ENGINEERS & CONSULTANTS**
DESCRIPTION: Tan, Brown, Gray & Red Clayey Sand	PLATE: B.2

G 3242-095, B-2 28'-30' Welsh

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 20.8 deg	c = 2.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	20.5	17.7	16.0	
Dry Density - pcf	106.7	111.3	117.2	
Diameter - inches	2.00	1.99	1.98	
Height - inches	3.99	3.98	4.00	
AT TEST				
Final Moisture - %	27.8	18.6	16.3	
Dry Density - pcf	106.8	112.4	118.7	
Calculated Diameter (in.)	2.00	1.99	1.97	
Height - inches	3.98	3.97	3.96	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	16.30	31.51	49.94	
Total Pore Pressure - psi	56.4	58.4	70.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	3.3	
σ_1 Failure - psi	26.30	51.51	89.94	
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: Tan, Brown, Gray & Red Clayey Sand
Sampled on Site, B-2 28' to 30' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

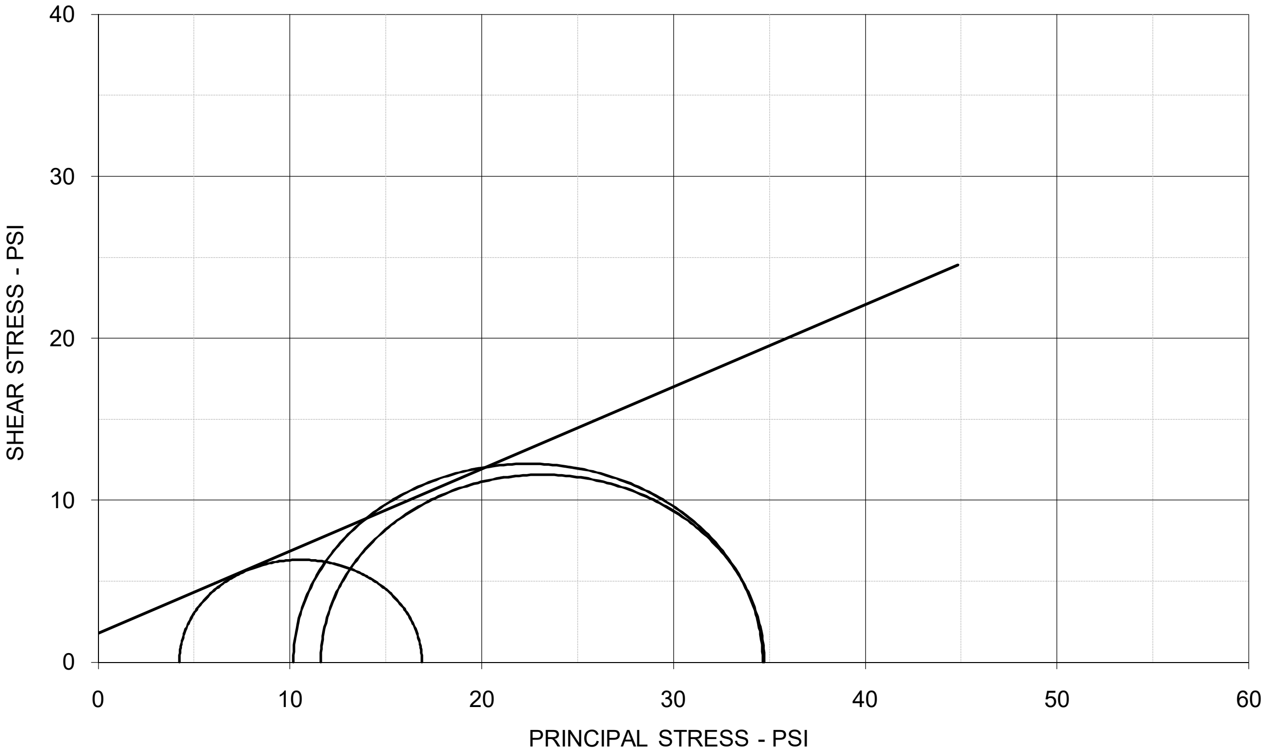
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

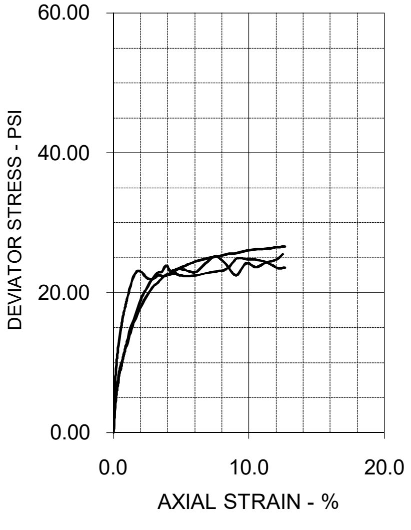
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 26.9 deg	c' = 1.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	24.0	23.2	20.1	
Dry Density - pcf	98.6	102.2	104.5	
Diameter - inches	2.01	2.02	2.00	
Height - inches	3.97	4.01	4.01	
AT TEST				
Final Moisture - %	26.5	24.8	24.2	
Dry Density - pcf	99.5	103.0	105.7	
Calculated Diameter (in.)	2.01	2.02	2.00	
Height - inches	3.99	4.01	4.03	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.64	23.13	24.50	
Total Pore Pressure - psi	55.7	58.4	79.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	6.1	
σ_1' Failure - psi	16.87	34.74	34.66	
σ_3' Failure - psi	4.23	11.61	10.16	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Gray, Brown & Tan Fat Clay w/ Ferric Seams
Sampled on Site, B-5 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

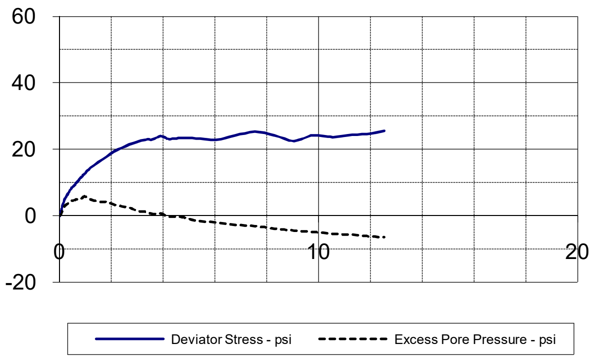
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

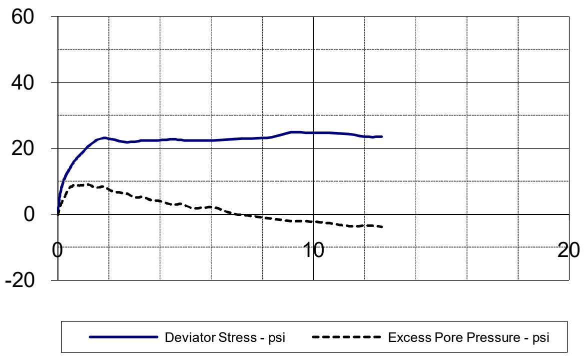
ETTL ENGINEERS & CONSULTANTS PLATE: B.1

G 3242-095, B-5 8'-10' Welsh

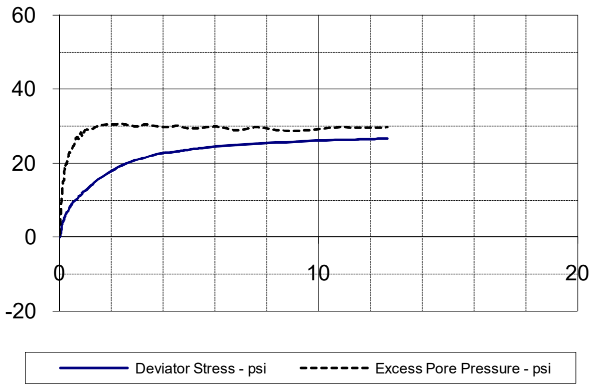
SPECIMEN NO. 1



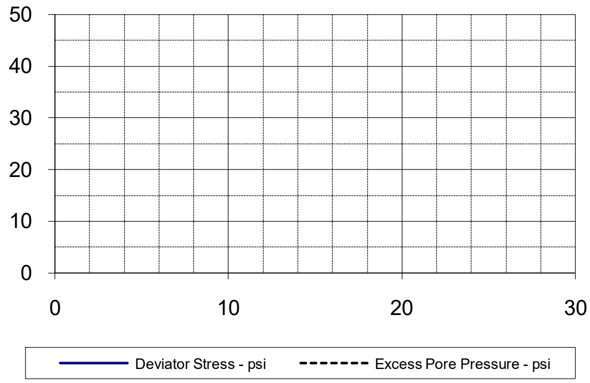
SPECIMEN NO. 2



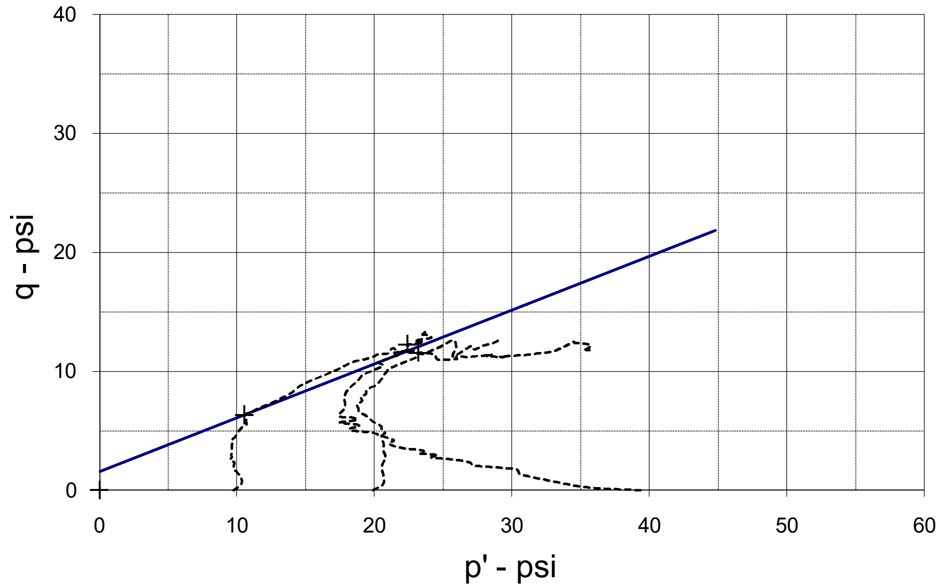
SPECIMEN NO. 3



SPECIMEN NO. 4



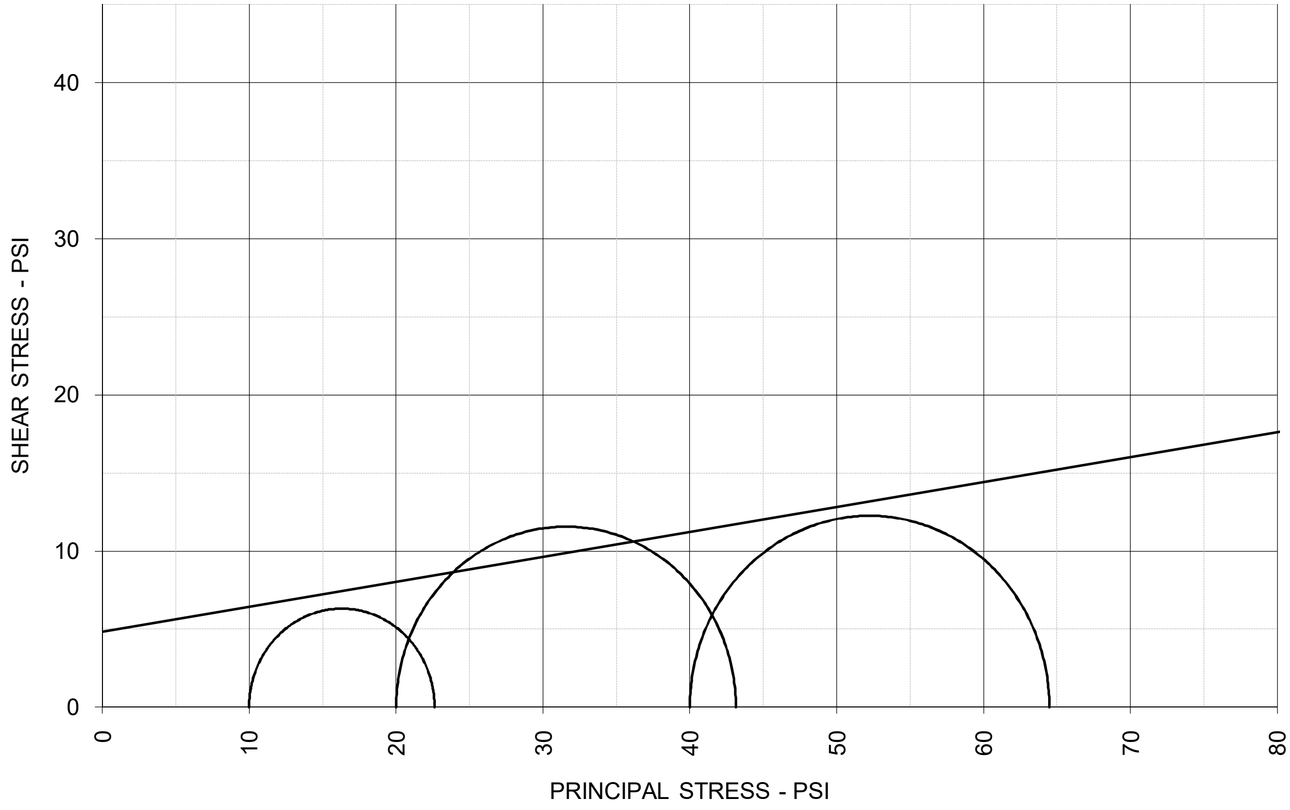
p - q DIAGRAM



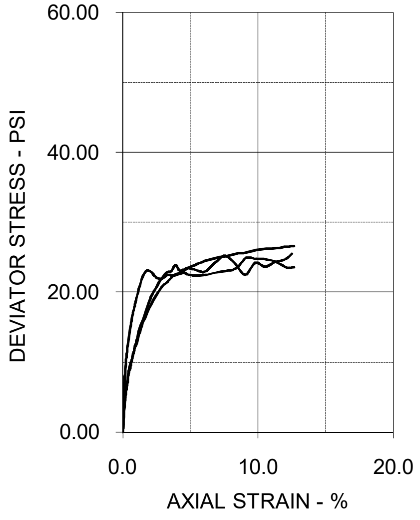
EFFECTIVE STRESS PARAMETERS	R^2 = 0.97	α (deg) = 24.3	a (psi) = 1.6
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Gray, Brown & Tan Fat Clay w/ Ferric Seams			

G 3242-095, B-5 8'-10' Welsh

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ =	9.1 deg	c =	4.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	24.0	23.2	20.1	
Dry Density - pcf	98.6	102.2	104.5	
Diameter - inches	2.01	2.02	2.00	
Height - inches	3.97	4.01	4.01	
AT TEST				
Final Moisture - %	26.5	24.8	24.2	
Dry Density - pcf	99.5	103.0	105.7	
Calculated Diameter (in.)	2.01	2.02	2.00	
Height - inches	3.99	4.01	4.03	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.64	23.13	24.50	
Total Pore Pressure - psi	55.7	58.4	79.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	6.1	
σ_1 Failure - psi	22.64	43.13	64.50	
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: Gray, Brown & Tan Fat Clay w/ Ferric Seams
Sampled on Site, B-5 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

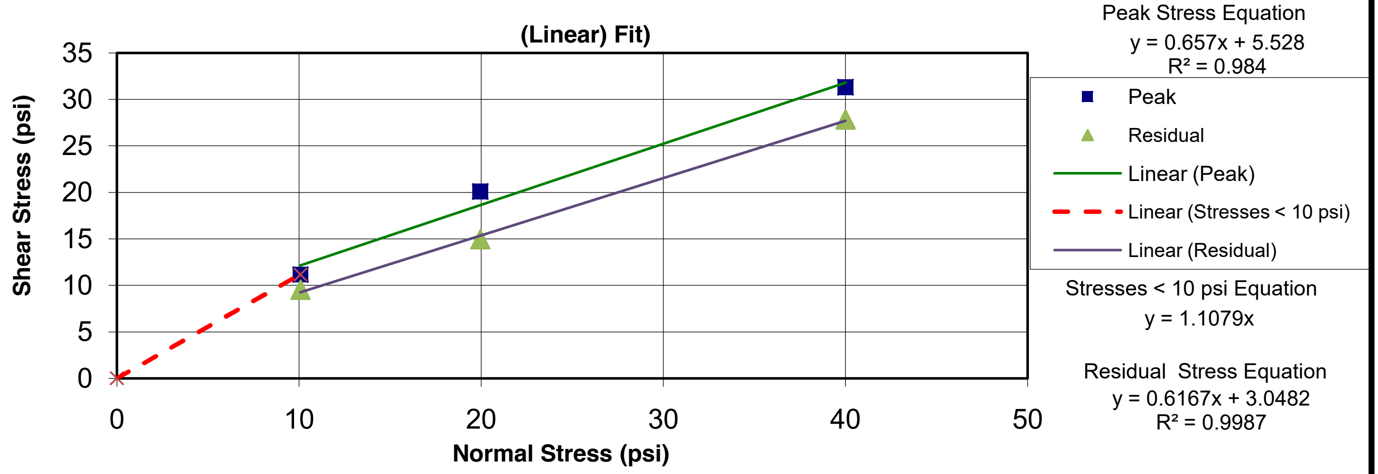
ETTL ENGINEERS & CONSULTANTS

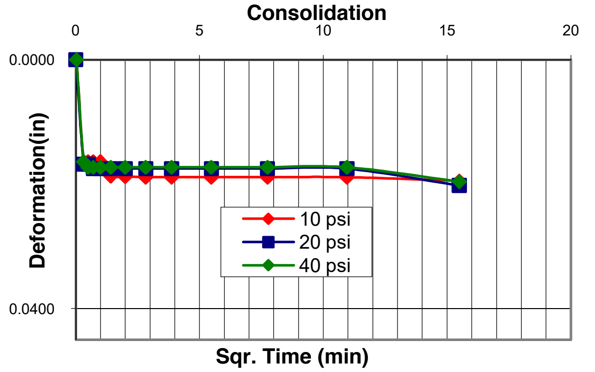
PLATE: B.3

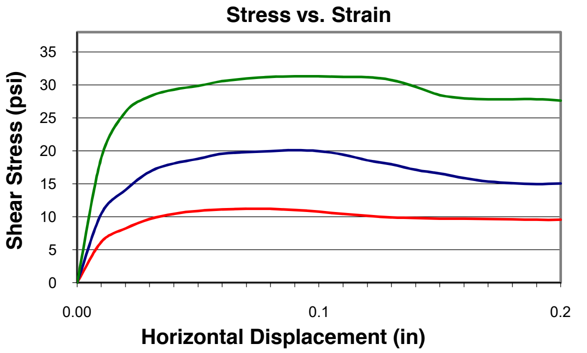
ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

ASTM 3080 Direct Shear Test Report







Peak Strength Parameters

	Peak		Residual	
Friction Angle	33.3 (deg)		31.63 (deg)	
Cohesion	5.53 (psi)	796.0 (psf)	3.05 (psi)	438.9 (psf)
Friction Angle Stresses < 10psi			47.91	(deg)

Specimen Number	1	2	3
Initial			
Moisture Content - %	22.5%	23.5%	23.2%
Dry Density- lb/ft^3	103.8	100.3	101.8
Height-inches	1.008	1.008	1.008
Diameter- inches	2.50	2.50	2.50
Final			
Moisture Content - %	23.1%	25.4%	23.5%
Dry Density- lb/ft^3	103.8	100.9	102.0
Height after shear-(inches)	1.009	1.006	1.006
Height after consolidation (inches)	0.989	0.988	0.988
Normal Stress-(psi)	10	20	40
Peak Failure Stress-(psi)	11.17	20.09	31.31
Residual Failure Stress-(psi)	9.52	14.96	27.84
Strain Rate - (inches/min)	0.0033	0.0033	0.0033

Project Information

Project : Welsh power Plant Embankments
Client: AEP
Material Origin: , TX
Material Description: Dark Red Silty Sand

LL	PL	PI
-	-	NP
-200%	18	

Job No:	G 3241-095	**Technician:**	Owen Sanderson
Boring No:	B-6	**Sample Type:**	Shelby Tube
Depth:	28'-31'	**Sampling method:**	Shelby Tube
Date:	November 24, 2009	**Testing Device:**	Soiltest B-124BY 2.5 in. round

Remarks

When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)

C. Brandon Quinn, P.E.

ETTL Engineers & Consultants Inc.
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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095

Permometer Data

Boring No.:	B-2	a_p =	0.031416 cm^2			**Set Mercury to Pipet Rp at beginning**	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120 cm^2				Pipet **Rp**	**6.7**	cm^3
Depth (ft):	13'-15'	M_1 =	0.030180	C =	0.000444308		Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T =	0.201660671				

Material Description : Red & Tan Sandy Lean Clay

SAMPLE DATA

Wet Wt. sample + ring or tare :			602.32	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			602.32	g
Diameter :	2.73	in	6.94	cm^2
Length :	2.76	in	7.02	cm
Area:	5.87	in^2	37.85	cm^2
Volume :	16.21	in^3	265.71	cm^3
Unit Wt.(wet):	**141.45**	pcf	**2.27**	g/cm^3
Unit Wt.(dry):	**125.06**	pcf	**2.00**	g/cm^3

Before Test		After Test	
Tare No.:	T-16	Tare No.:	T-1
Wet Wt.+tare:	292.51	Wet Wt.+tare:	746.56
Dry Wt.+tare:	276.22	Dry Wt.+tare:	683.49
Tare Wt:	151.95	Tare Wt:	217.27
Dry Wt.:	124.27	Dry Wt.:	466.22
Water Wt.:	16.29	Water Wt.:	63.07
% moist.:	**13.1**	% moist.:	**13.5**

Assumed Specific Gravity: **2.65** Max Dry Density(pcf) = 125.1105 OMC = 13.108554
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 111.02 Void ratio (e) = **0.32** Porosity (n)= **0.24**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.26

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	1680	6	0.6588251	23.5	0.920	3.47E-08	9.84E-05	
12/28/2009	2280	5.9	0.7588251	23.5	0.920	2.98E-08	8.44E-05	
12/28/2009	3180	5.7	0.9588251	23.5	0.920	2.76E-08	7.83E-05	
12/28/2009	4140	5.55	1.1088251	23.5	0.920	2.50E-08	7.09E-05	

SUMMARY

ka = 2.93E-08 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	3.47E-08	cm/sec	18.5	%
k2 =	2.98E-08	cm/sec	1.7	%
k3 =	2.76E-08	cm/sec	5.6	%
k4 =	2.50E-08	cm/sec	14.6	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**2.93E-08**	cm/sec	**8.30E-05**	ft/day
Void Ratio	e =	**0.32**			
Porosity	n =	**0.24**			
Bulk Density	γ =	**2.27**	g/cm^3	**141.5**	pcf
Water Content	W =	**0.26**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**3.00E-13**	cm^2	(at 20 deg C)	

Robert Duke, P.E.

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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009
Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095

Permometer Data

Boring No.:	B-2	a_p =	0.031416 cm^2	**Set Mercury to Pipet Rp at beginning**	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120 cm^2		Pipet **Rp**	**6.7**	cm^3
Depth (ft):	33'-35'	M_1 =	0.030180	C = 0.000433922	Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T = 0.201660671			

Material Description : Red & Tan Clayey Sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			553.04	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			553.04	g
Diameter :	2.76	in	7.01	cm^2
Length :	2.75	in	6.98	cm
Area:	5.97	in^2	38.54	cm^2
Volume :	16.42	in^3	269.13	cm^3
Unit Wt.(wet):	**128.23**	pcf	**2.05**	$g/cm^{\wedge 3}$
Unit Wt.(dry):	**107.70**	pcf	**1.73**	$g/cm^{\wedge 3}$

Before Test		After Test	
Tare No.:	T-21	Tare No.:	T-13
Wet Wt.+tare:	553.04	Wet Wt.+tare:	784.01
Dry Wt.+tare:	464.50	Dry Wt.+tare:	684.19
Tare Wt:	0.00	Tare Wt:	219.69
Dry Wt.:	464.5	Dry Wt.:	464.5
Water Wt.:	88.54	Water Wt.:	99.82
% moist.:	**19.1**	% moist.:	**21.5**

Assumed Specific Gravity: **2.73**
Max Dry Density(pcf) = 107.7462
OMC = 19.0613563
% of max = 100.0
+/- OMC = 0.00
Calculated % saturation: 100.72
Void ratio (e) = **0.58**
Porosity (n)= **0.37**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm
Hydraulic Gradient = 9.31

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	1580	5.4	1.2588251	23.5	0.920	7.40E-08	2.10E-04	
12/28/2009	2310	5	1.6588251	23.5	0.920	7.04E-08	2.00E-04	
12/28/2009	2535	4.9	1.7588251	23.5	0.920	6.90E-08	1.96E-04	
12/28/2009	2775	4.8	1.8588251	23.5	0.920	6.76E-08	1.92E-04	

SUMMARY

ka = 7.03E-08 cm/sec
Acceptance criteria = 25 %

ki			Vm	
k1 =	7.40E-08	cm/sec	5.3	%
k2 =	7.04E-08	cm/sec	0.2	%
k3 =	6.90E-08	cm/sec	1.8	%
k4 =	6.76E-08	cm/sec	3.8	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**7.03E-08**	cm/sec	**1.99E-04**	ft/day
Void Ratio	e =	**0.58**			
Porosity	n =	**0.37**			
Bulk Density	γ =	**2.05**	g/cm^3	**128.2**	pcf
Water Content	W =	**0.33**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**7.20E-13**	cm^2	(at 20 deg C)	

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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095

Permometer Data

Boring No.:	B-3	a_p =	0.031416 cm^2		Set Mercury to Pipet Rp at beginning	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120 cm^2			Pipet **Rp**	**6.7**	cm^3
Depth (ft):	8'-10'	M_1 =	0.030180	C = 0.000431052		Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T = 0.201660671				

Material Description : Red & Tan Fat Clay

SAMPLE DATA

Wet Wt. sample + ring or tare : 559.11 g
Tare or ring Wt. : 0.0 g
Wet Wt: of Sample : 559.11 g

						Before Test		After Test	
					Tare No.:	T-23	Tare No.:	T-3
Diameter :	2.75	in	6.99	cm^2	Wet Wt.+tare:	166.09	Wet Wt.+tare:	783.53
Length :	2.72	in	6.90	cm	Dry Wt.+tare:	162.69	Dry Wt.+tare:	700.67
Area:	5.94	in^2	38.32	cm^2	Tare Wt:	140.30	Tare Wt:	220.71
Volume :	16.13	in^3	264.26	cm^3	Dry Wt.:	22.39	Dry Wt.:	479.96
Unit Wt.(wet):	**132.02**	pcf	**2.12**	g/cm^3	Water Wt.:	3.4	Water Wt.:	82.86
Unit Wt.(dry):	**114.62**	pcf	**1.84**	g/cm^3	% moist.:	**15.2**	% moist.:	**17.3**

Assumed Specific Gravity: **2.68** Max Dry Density(pcf) = 114.6685 OMC = 15.1853506
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 100.64 Void ratio (e) = **0.46** Porosity (n)= **0.31**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.43

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	1476	5.4	1.258825	23.5	0.920	7.87E-08	2.23E-04	
12/28/2009	2205	5	1.658825	23.5	0.920	7.33E-08	2.08E-04	
12/28/2009	2370	4.9	1.758825	23.5	0.920	7.33E-08	2.08E-04	
12/28/2009	2580	4.8	1.858825	23.5	0.920	7.22E-08	2.05E-04	

SUMMARY

ka = 7.44E-08 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	7.87E-08	cm/sec	5.8	%
k2 =	7.33E-08	cm/sec	1.5	%
k3 =	7.33E-08	cm/sec	1.4	%
k4 =	7.22E-08	cm/sec	2.9	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**7.44E-08**	cm/sec	**2.11E-04**	ft/day
Void Ratio	e =	**0.46**			
Porosity	n =	**0.31**			
Bulk Density	γ =	**2.12**	g/cm^3	**132.0**	pcf
Water Content	W =	**0.28**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**7.62E-13**	cm^2	(at 20 deg C)	

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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095

Permometer Data

Boring No.:	B-4	a_p =	0.031416 cm^2	Set Mercury to Pipet Rp at beginning		Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120 cm^2			Pipet **Rp**	**6.7**	cm^3
Depth (ft):	8'-10'	M_1 =	0.030180	C =	0.000429664	Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T =	0.201660671			

Material Description : Dark Brown Sandy Lean Clay

SAMPLE DATA

Wet Wt. sample + ring or tare : 531.96 g
Tare or ring Wt. : 0.0 g
Wet Wt: of Sample : 531.96 g

							Before Test		After Test
						Tare No.:	T-24	Tare No.:	T-6
Diameter :	2.76	in	7.01	cm^2		Wet Wt.+tare:	230.01	Wet Wt.+tare:	759.40
Length :	2.72	in	6.92	cm		Dry Wt.+tare:	207.52	Dry Wt.+tare:	648.84
Area:	5.98	in^2	38.57	cm^2		Tare Wt:	112.35	Tare Wt:	217.34
Volume :	16.29	in^3	266.87	cm^3		Dry Wt.:	95.17	Dry Wt.:	431.5
Unit Wt.(wet):	**124.38**	pcf	**1.99**	$g/cm^{\wedge 3}$		Water Wt.:	22.49	Water Wt.:	110.56
Unit Wt.(dry):	**100.61**	pcf	**1.61**	$g/cm^{\wedge 3}$		% moist.:	**23.6**	% moist.:	**25.6**

Assumed Specific Gravity: **2.72** Max Dry Density(pcf) = 100.6512 OMC = 23.6313964
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 101.32 Void ratio (e) = **0.69** Porosity (n)= **0.41**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.40

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	2280	6.1	0.558825	23.5	0.920	2.07E-08	5.88E-05	
12/28/2009	2940	6	0.658825	23.5	0.920	1.92E-08	5.44E-05	
12/28/2009	3660	5.9	0.758825	23.5	0.920	1.79E-08	5.09E-05	
12/28/2009	4200	5.84	0.818825	23.5	0.920	1.70E-08	4.82E-05	

SUMMARY

ka = 1.87E-08 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	2.07E-08	cm/sec	10.8	%
k2 =	1.92E-08	cm/sec	2.5	%
k3 =	1.79E-08	cm/sec	4.1	%
k4 =	1.70E-08	cm/sec	9.2	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**1.87E-08**	cm/sec	**5.30E-05**	ft/day
Void Ratio	e =	**0.69**			
Porosity	n =	**0.41**			
Bulk Density	γ =	**1.99**	g/cm^3	**124.4**	pcf
Water Content	W =	**0.38**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**1.92E-13**	cm^2	(at 20 deg C)	

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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095

Permometer Data

Boring No.:	B-5	a_p =	0.031416 cm^2		Set Mercury to Pipet Rp at beginning	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120 cm^2			Pipet **Rp**	**6.7**	cm^3
Depth (ft):	23'-25'	M_1 =	0.030180	C =	0.00043565	Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T =	0.201660671			

Material Description : Orangish Tan Fat Clay

SAMPLE DATA

Wet Wt. sample + ring or tare : 532.37 g
Tare or ring Wt. : 0.0 g
Wet Wt: of Sample : 532.37 g

Diameter :	2.74	in	6.97	cm^2
Length :	2.73	in	6.94	cm
Area:	5.91	in^2	38.15	cm^2
Volume :	16.16	in^3	264.75	cm^3
Unit Wt.(wet):	**125.48**	pcf	**2.01**	g/cm^3
Unit Wt.(dry):	**103.94**	pcf	**1.67**	g/cm^3

Before Test		After Test	
Tare No.:	T-25	Tare No.:	T-9
Wet Wt.+tare:	532.37	Wet Wt.+tare:	765.78
Dry Wt.+tare:	441.00	Dry Wt.+tare:	661.51
Tare Wt:	0.00	Tare Wt:	220.51
Dry Wt.:	441	Dry Wt.:	441
Water Wt.:	91.37	Water Wt.:	104.27
% moist.:	**20.7**	% moist.:	**23.6**

Assumed Specific Gravity: **2.72** Max Dry Density(pcf) = 103.9846 OMC = 20.7188209
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 101.48 Void ratio (e) = **0.63** Porosity (n)= **0.39**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.37

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	212	5.5	1.158825	23.5	0.920	5.03E-07	1.43E-03	
12/28/2009	237	5.4	1.258825	23.5	0.920	4.95E-07	1.40E-03	
12/28/2009	259	5.3	1.358825	23.5	0.920	4.96E-07	1.41E-03	
12/28/2009	289	5.2	1.458825	23.5	0.920	4.83E-07	1.37E-03	

SUMMARY

ka = 4.95E-07 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	5.03E-07	cm/sec	1.8	%
k2 =	4.95E-07	cm/sec	0.2	%
k3 =	4.96E-07	cm/sec	0.3	%
k4 =	4.83E-07	cm/sec	2.2	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**4.95E-07**	cm/sec	**1.40E-03**	ft/day
Void Ratio	e =	**0.63**			
Porosity	n =	**0.39**			
Bulk Density	γ =	**2.01**	g/cm^3	**125.5**	pcf
Water Content	W =	**0.35**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**5.07E-12**	cm^2	(at 20 deg C)	

Robert Duke, P.E.

ETTL Engineers & Consultants Inc.
GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095

Permometer Data

Boring No.:	B-6	a_p =	0.031416 cm^2	Set Mercury to Pipet Rp at beginning		Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120 cm^2			Pipet **Rp**	**6.7**	cm^3
Depth (ft):	28'-30'	M_1 =	0.030180	C =	0.000408156	Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T =	0.201660671			

Material Description : Gray Silty Sand

SAMPLE DATA

Wet Wt. sample + ring or tare : 457.40 g
Tare or ring Wt. : 0.0 g
Wet Wt: of Sample : 457.40 g

						Before Test		After Test
					Tare No.:	T-5	Tare No.:	T-10
Diameter :	2.69	in	6.83	cm^2	Wet Wt.+tare:	355.86	Wet Wt.+tare:	661.49
Length :	2.46	in	6.24	cm	Dry Wt.+tare:	328.36	Dry Wt.+tare:	581.76
Area:	5.68	in^2	36.64	cm^2	Tare Wt:	218.80	Tare Wt:	221.13
Volume :	13.96	in^3	228.75	cm^3	Dry Wt.:	109.56	Dry Wt.:	360.63
Unit Wt.(wet):	**124.77**	pcf	**2.00**	g/cm^3	Water Wt.:	27.5	Water Wt.:	79.73
Unit Wt.(dry):	**99.74**	pcf	**1.60**	g/cm^3	% moist.:	**25.1**	% moist.:	**22.1**

Assumed Specific Gravity: **2.55** Max Dry Density(pcf) = 99.78226 OMC = 25.1004016
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 94.57 Void ratio (e) = **0.60** Porosity (n)= **0.37**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 10.42

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	7	4	2.658825	23.5	0.920	4.12E-05	1.17E-01	
12/28/2009	9	3.5	3.158825	23.5	0.920	4.23E-05	1.20E-01	
12/28/2009	11	3	3.658825	23.5	0.920	4.57E-05	1.30E-01	
12/28/2009	16	2.5	4.158825	23.5	0.920	4.28E-05	1.21E-01	

SUMMARY

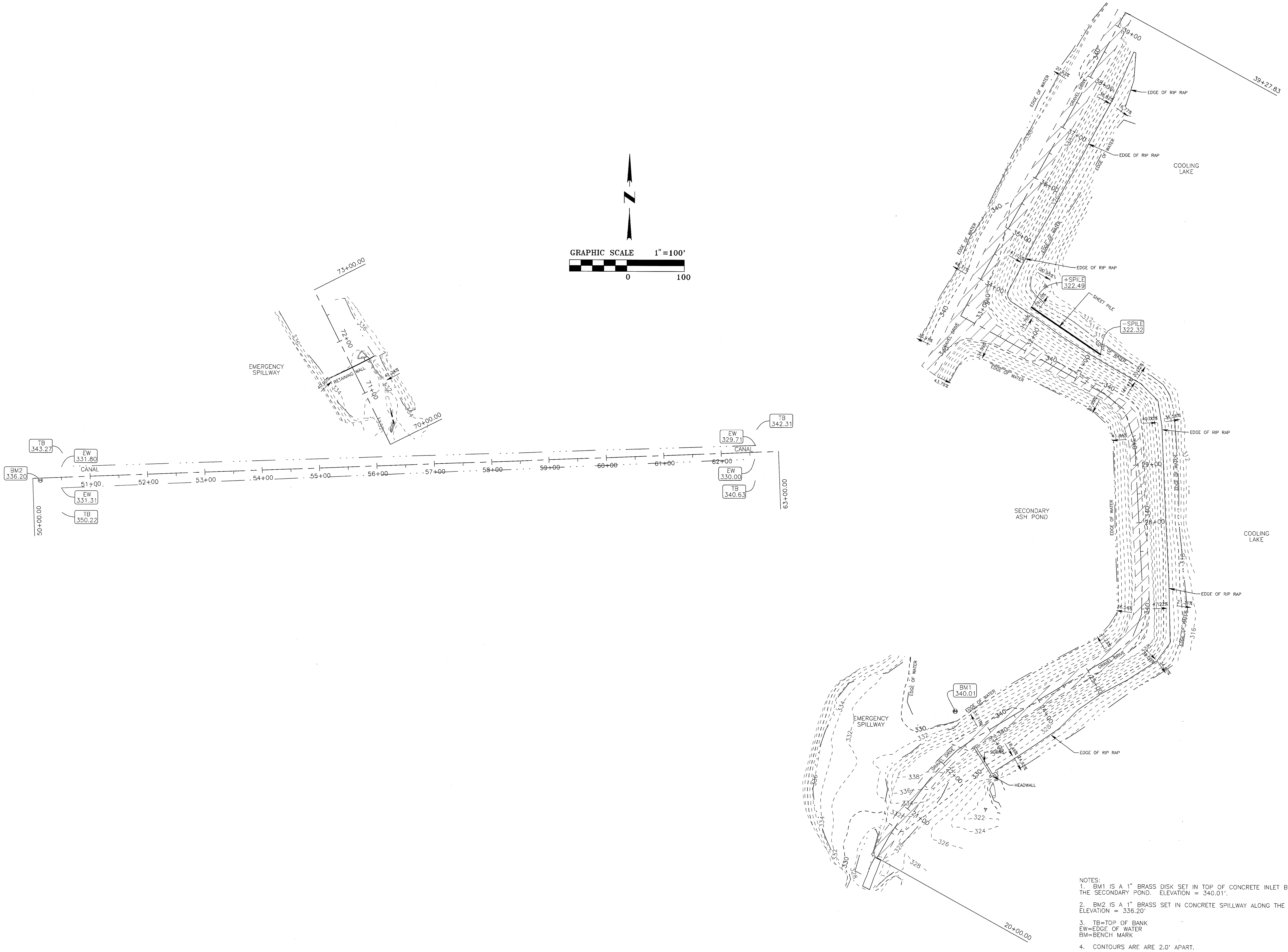
ka = 4.30E-05 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	4.12E-05	cm/sec	4.2	%
k2 =	4.23E-05	cm/sec	1.7	%
k3 =	4.57E-05	cm/sec	6.3	%
k4 =	4.28E-05	cm/sec	0.4	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**4.30E-05**	cm/sec	**1.22E-01**	ft/day
Void Ratio	e =	**0.60**			
Porosity	n =	**0.37**			
Bulk Density	γ =	**2.00**	g/cm^3	**124.8**	pcf
Water Content	W =	**0.40**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**4.41E-10**	cm^2	(at 20 deg C)	

Robert Duke, P.E.



SURVEYOR CERTIFICATE:

I HEREBY CERTIFY THAT THIS TOPOGRAPHICAL SURVEY WAS MADE ON THE GROUND UNDER MY SUPERVISION ON NOVEMBER 18, 2010, THAT THIS PLAT (MAP OR DRAWING) REPRESENTS THE FACTS FOUND AT THE TIME.

MIKE GARDNER
REGISTERED PROFESSIONAL LAND SURVEYOR
NO. 5760, STATE OF TEXAS
FIRM CERTIFICATE NO. 101011-00
DATE: NOVEMBER 23, 2010
REVISED: DECEMBER 6, 2010

MIKE GARDNER
#5760

NOTES:
1. BM1 IS A 1" BRASS DISK SET IN TOP OF CONCRETE INLET BOX FOR THE SECONDARY POND. ELEVATION = 340.01'.

2. BM2 IS A 1" BRASS SET IN CONCRETE SPILLWAY ALONG THE CANAL. ELEVATION = 336.20'

3. TB=TOP OF BANK
EW=EDGE OF WATER
BM=BENCH MARK

4. CONTOURS ARE ARE 2.0' APART.

5. LAKE ELEVATION PER WELSH POWER PLANT ON NOVEMBER 18, 2010 WAS 317.57 FEET MSL.

TOPOGRAPHIC SURVEY

DIKE'S AT WELSH POWER PLANT
FOR: GREG CARTER

Date	Revision/Description
12/6/10	ADDED LAKE LEVEL NOTE
12/6/10	ADDED CROSS SECTION SHEETS

Drawn By	Checked By	Project No.	Dwg. Date
MG	DW	104021	11/19/10

MTG engineers & surveyors

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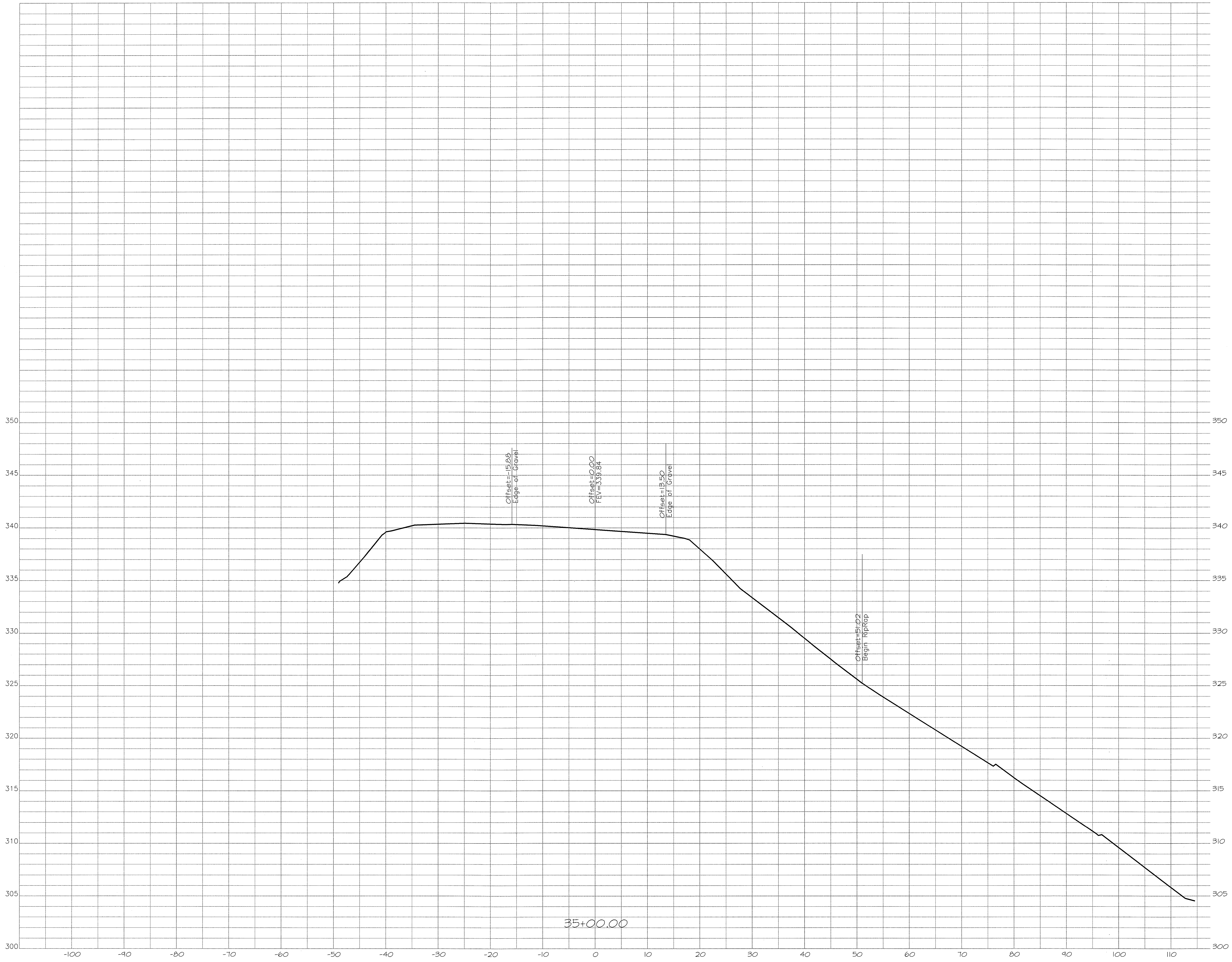
TBPE NO. 354

File No.
Sheet No. 1

X:\2010 Projects\104021 TOPO AT WELSH POWER PLANT DAMS\104021 REVISED 12-3-10 G.pro
Mon Dec 6, 2010 11:13AM

HORIZONTAL SCALE - 1"=10'
VERTICAL SCALE - 1"=5'



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Mon. Dec 6, 2010 11:24AM

SURVEYOR CERTIFICATE:

I HEREBY CERTIFY THAT THIS TOPOGRAPHICAL SURVEY WAS MADE ON THE GROUND UNDER MY SUPERVISION ON NOVEMBER 18, 2010, THAT THIS PLAT (MAP OR DRAWING) REPRESENTS THE FACTS FOUND AT THE TIME.

MIKE GARDNER
REGISTERED PROFESSIONAL LAND SURVEYOR
NO. 5760, STATE OF TEXAS
FIRM CERTIFICATE NO. 101011-00
DATE: NOVEMBER 23, 2010
REVISED: DECEMBER 6, 2010

MIKE GARDNER
#5760

CROSS SECTIONS
ASH POND BERM

DIKE'S AT WELSH POWER PLANT
FOR: GREG CARTER

Date	Revision/Description

Drawn By	Checked By	Project No.	Dwg. Date
J.B.D.	M.G.	104021	12/6/2010

MTG engineers & surveyors

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TBPE NO. 354

File No.	Sheet No.
	5

Initial Safety Factor Assessment – Bottom Ash Pond
Welsh Power Plant
Pittsburg, Texas

Auckland Project No. 2016-007
August 30, 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 2/29/2017

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 Bottom Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Welsh Power Plant near Pittsburg, 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 Bottom Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the Bottom Ash Pond.

1.2 Referenced Information and Data

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Freese and Nichols titled *Hydraulic Analysis of Welsh Power Plant Ash Ponds* dated December 29, 2010 (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. This information is included in the Appendix of this report.

1.3 Embankment Evaluation Criteria

Based on information provided and collected, the existing embankment is primarily lean clay (CL) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of approximately 34 feet (downstream) and top of dam elevation of 360.0 feet MSL. The downstream slope of the embankment is constructed with a 12-foot wide bench (vertical position on the slope varies along the embankment) that supports a 30-inch HDPE decant pipe. To account for the potential loading of the decant pipe, a surcharge load of 150 psf was applied to the bench. The crest width of the embankment is approximately 12 feet. The impoundment's storage area (side slopes and bottom) is lined with a 60-mil HDPE liner. The critical section for the embankment was determined to occur in the vicinity of Boring No. 4, as depicted on the Plan of Borings.

It is our understanding that the maximum storage elevation of impounded CCR material 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 Bottom Ash Pond is not adjacent to other water bodies that may inundate the downstream slope (or toe) 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 Bottom Ash Pond as determined by the 25-year, 24-hour storm event is 355.62 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 356.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.76 feet (MSL), for this evaluation a maximum surcharge loading elevation of 356.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

2.0 Field and Laboratory Testing

2.1 Field Activities

The subsurface exploration of the embankment consisted of advancing a total of seven (7) borings located in potentially critical areas of the embankment. Four (4) borings (Boring Nos. 2 through 5) were completed along the embankment crest with termination depths ranging from approximately 40 to 50 feet. Three (3) borings (Boring Nos. 6 through 8) were completed along the embankment toe and were advanced to termination depths of approximately 40 feet. Boring No. 1 was not accessible by drilling equipment and therefore not completed. Borings were located in the field as shown on the Plan of Borings included in the Appendix of this report.

Drilling Methods. Field operations were performed in general accordance with ASTM procedures or similar accepted practices. Soil borings were drilled using a track mounted Geoprobe drilling rig equipped with a rotary head and continuous augers. The use of mud rotary or rotary wash was not necessary.

Soil Sampling. Sample intervals were semi-continuous in the upper 10 feet of each boring and five (5) foot intervals thereafter, unless otherwise directed by the onsite engineer. Split-spoon (Standard Penetration Test, SPT) or disturbed samples were collected in general accordance with ASTM Standard Method D 1586. Relatively undisturbed soil samples were collected in general accordance with ASTM D 1587 and extruded in the field and sealed in plastic to protect against moisture loss. Soil shear strengths were determined by using a calibrated hand penetrometer on undisturbed samples.

The collected samples were subsequently examined and selected for laboratory testing by a geotechnical engineer.

Boring Logs. The general subsurface soil and groundwater conditions encountered during field activities are presented on boring logs attached in the Appendix of this report. Information on the boring logs includes groundwater levels, laboratory test data, penetration resistance and soil classifications based on the Unified Soil Classification System (USCS).

Groundwater Level Measurements. Groundwater level observations completed during field activities are noted on the boring logs attached in the Appendix of this report.

2.2 Laboratory Testing Program

Laboratory testing was conducted on selected samples to assist in the classification of the soils encountered and to evaluate the physical and engineering properties of subsurface soils. Laboratory test results are presented on the boring logs included in the Appendix. Laboratory tests were performed in general accordance with ASTM procedures cited in the table below.

Laboratory Test	Test Designation
Atterberg Liquid Limit and Plastic Limit Determination	ASTM D 4318
Percentage Soil Passing No. 200 Sieve	ASTM D 1140
Moisture Content Determination	ASTM D 2216
Particle Size Analysis of Soils	ASTM D 422
Unconsolidated Undrained (UU) Triaxial Compression	ASTM D 2850
Hydraulic Conductivity	ASTM D 5084
Consolidated Undrained (CU) Triaxial Compression	ASTM D 4767
Direct Shear of Soils Under Consolidated Drain Conditions	ASTM D 3080

Soil samples not utilized in laboratory testing will be retained for approximately 30 days from the report issuance date and then disposed, unless specifically requested in writing from the client.

3.0 Slope Stability Analyses

3.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of the completed laboratory and field testing programs and previous assessments completed as the Welsh Power Plant. 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.

3.2 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 coarse grained (or sandy) material underlying the Bottom Ash Pond generally consist of medium dense to very dense silty sand (SM), clayey sand (SC) and silt (ML) and fine grained (or clayey) material consist of medium stiff to hard lean clay and fat clay (CL and CH) soils. Based on these soil characteristics and that the Bottom Ash Pond is located in

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[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

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)].

3.3 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. Selection of the critical slope section 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:

Material Type	Unit Weight (pcf)	Consolidated-Undrained Cohesion (psf)	Consolidated-Undrained Angle of Internal Friction (degrees)
Embankment Fill	125	250	28
Silty, Clayey Sand (SM_SC)	120	225	20
Silty Sand (SM)	120	0	30
Native Fat and Lean Clay (CH_CL)	125	450	14
Ash	100	0	30

NOTE: Properties used for Steady State Seepage with Seismic analyses.

Summary of Long Term, Effective Stress Soil Parameters

Material Type	Unit Weight (pcf)	Consolidated-Drained Cohesion (psf)	Consolidated-Drained Angle of Internal Friction (degrees)
Embankment Fill	125	150	32
Silty, Clayey Sand (SM_SC)	120	0	34
Silty Sand (SM)	120	0	36
Native Fat and Lean Clay (CH_CL)	125	300	22
Ash	100	0	30

NOTE: Properties used for Steady State Seepage analyses. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.

The HDPE liner was modeled at the interface of the slope and the ash pond, a nominal strength of 50 psf was assumed for the liner material.

3.4 Seepage Analysis Parameters

The observed groundwater levels while drilling through the embankment (approximate groundwater elevation of 30 to 34 feet, below the crest) correspond with those groundwater elevations encountered while drilling adjacent to the embankment toe (approximately groundwater elevation six [6] feet, below existing grade). No elevated groundwater seepage or groundwater levels were observed in boreholes completed in the embankment that would indicate a prolific and defined phreatic surface in the embankment.

Therefore, based on the available information it appears that the existing impermeable liner has precluded the development of a phreatic surface (internal groundwater elevation) within the embankment. Though the probability of a phreatic surface developing in the embankment is considered low, it is however possible, and therefore was modeled as part of the structural assessment.

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	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-8}
Silty, Clayey Sand (SM_SC)	1×10^{-5}
Silty Sand (SM)	1×10^{-5}
Native Fat and Lean Clay (CH_CL)	1×10^{-8}
Ash	1×10^{-4}

The HDPE liner is assumed to be impermeable; therefore a very low permeability value of $1\text{x}10^{-20}$ ft/sec was utilized.

3.5 Stability Analysis Results

The following table 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

Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	2.60	1.50
Steady State Seepage – Surcharge Pool	2.60	1.40
Steady State Seepage with Seismic – Maximum Pool	1.60	1.00

Summary of Stability Analyses– Safety Factors
(Potential Phreatic Surface)

Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	1.78	1.50
Steady State Seepage – Surcharge Pool	1.78	1.40
Steady State Seepage with Seismic – Maximum Pool	1.31	1.00

Based on the findings of this analysis, the evaluated embankment appears to be stable under both modeled conditions (existing conditions and potential phreatic surface) and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

4.0 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 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.

5.0 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 Bottom Ash Pond (Welsh Power Plant) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

By: ______________________________

Dated: August 30, 2016

STATE OF TEXAS
JOHN J. TAYNTOR
99202
LICENSED PROFESSIONAL ENGINEER

TBPE Firm Registration No. F-16721
Expires 2/28/2017

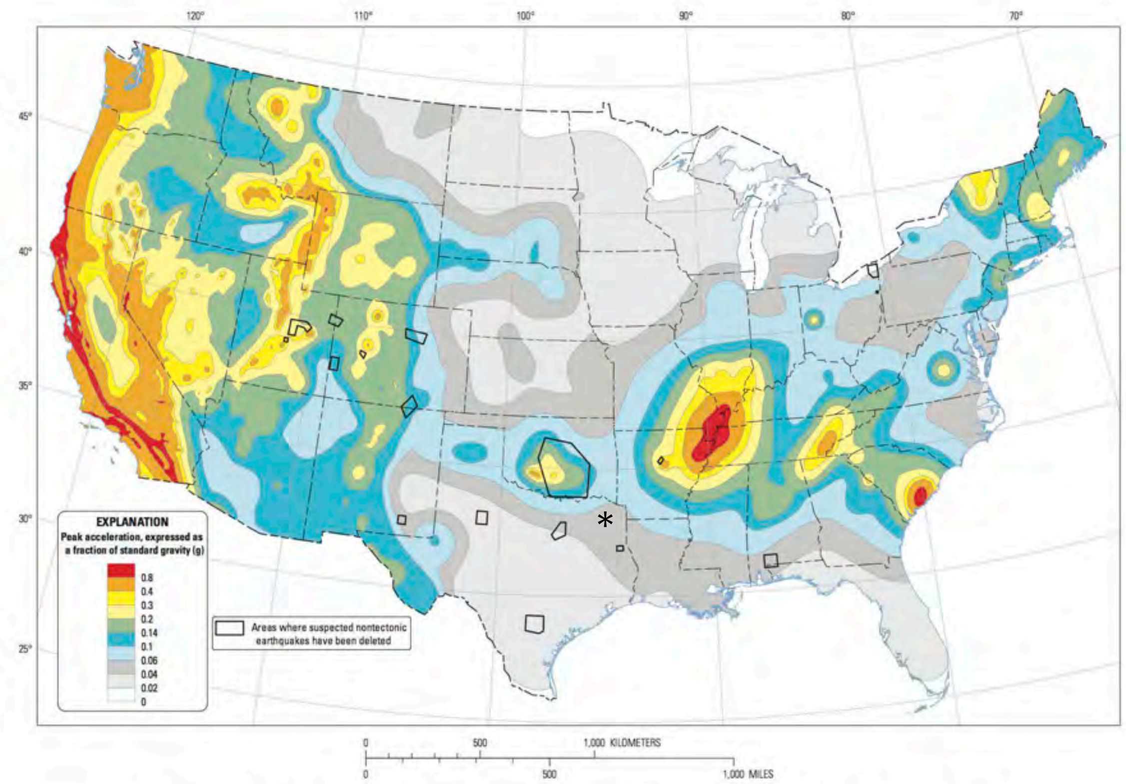
Appendix

Stability Analyses
Reference Data

Aerial image provided by Google Earth.

Soil Boring Location Plan

Scale: N/A	**Welsh Power Plant** **Initial Safety Factor Assessment - Bottom Ash Pond** **Pittsburg, Texas**
Auckland Project No. 2016-007	



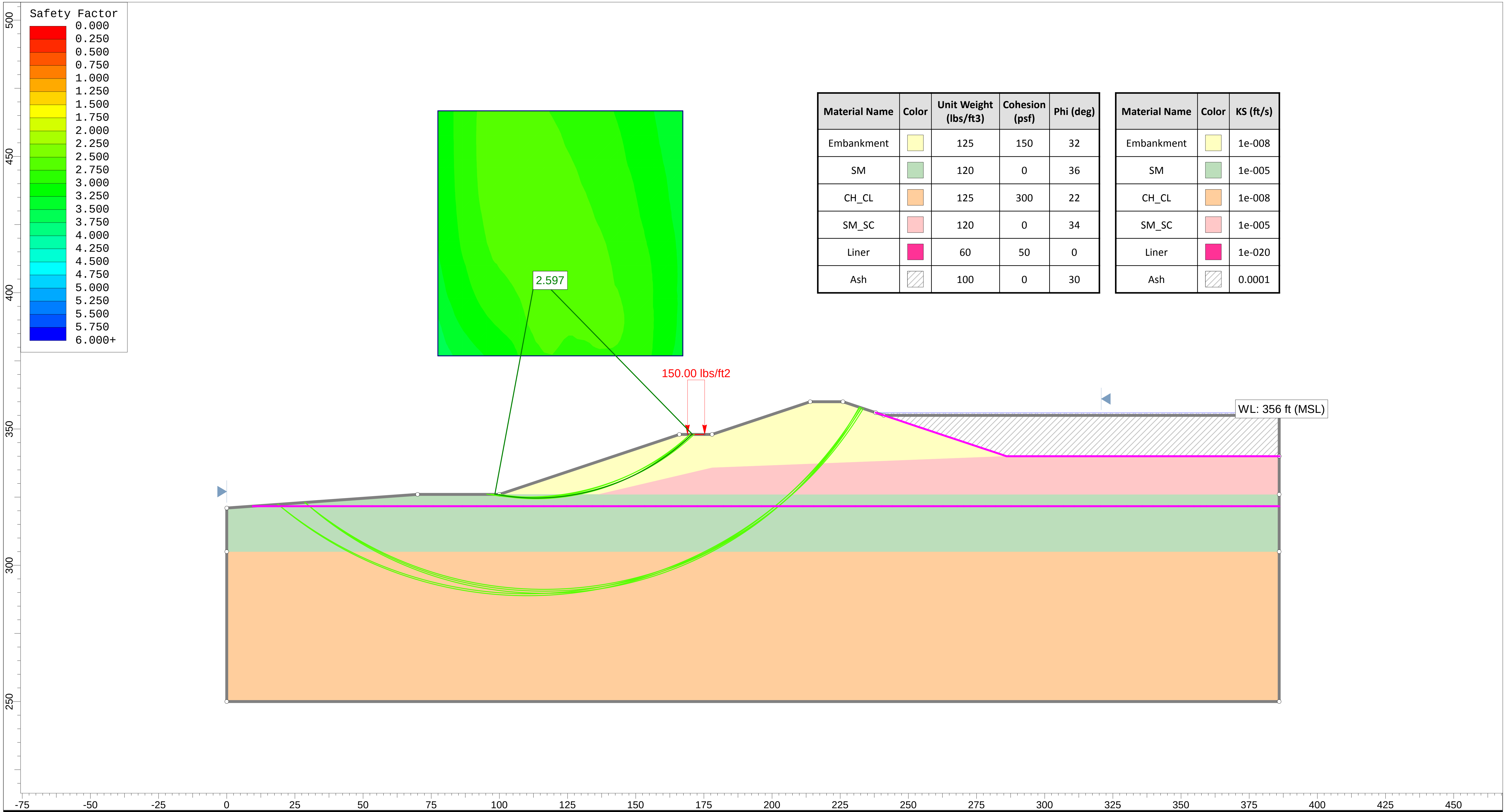
Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Welsh Power Plant

Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map

Scale: N/A	**Welsh Power Plant** **Initial Safety Factor Assessment - Bottom Ash Pond** **Pittsburg, Texas**
Auckland Project No. 2016-007	



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	150	32
SM	🟩	120	0	36
CH_CL	🟧	125	300	22
SM_SC	🟥	120	0	34
Liner	🟪	60	50	0
Ash	▨	100	0	30

Material Name	Color	KS (ft/s)
Embankment	🟨	1e-008
SM	🟩	1e-005
CH_CL	🟧	1e-008
SM_SC	🟥	1e-005
Liner	🟪	1e-020
Ash	▨	0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond		
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool		
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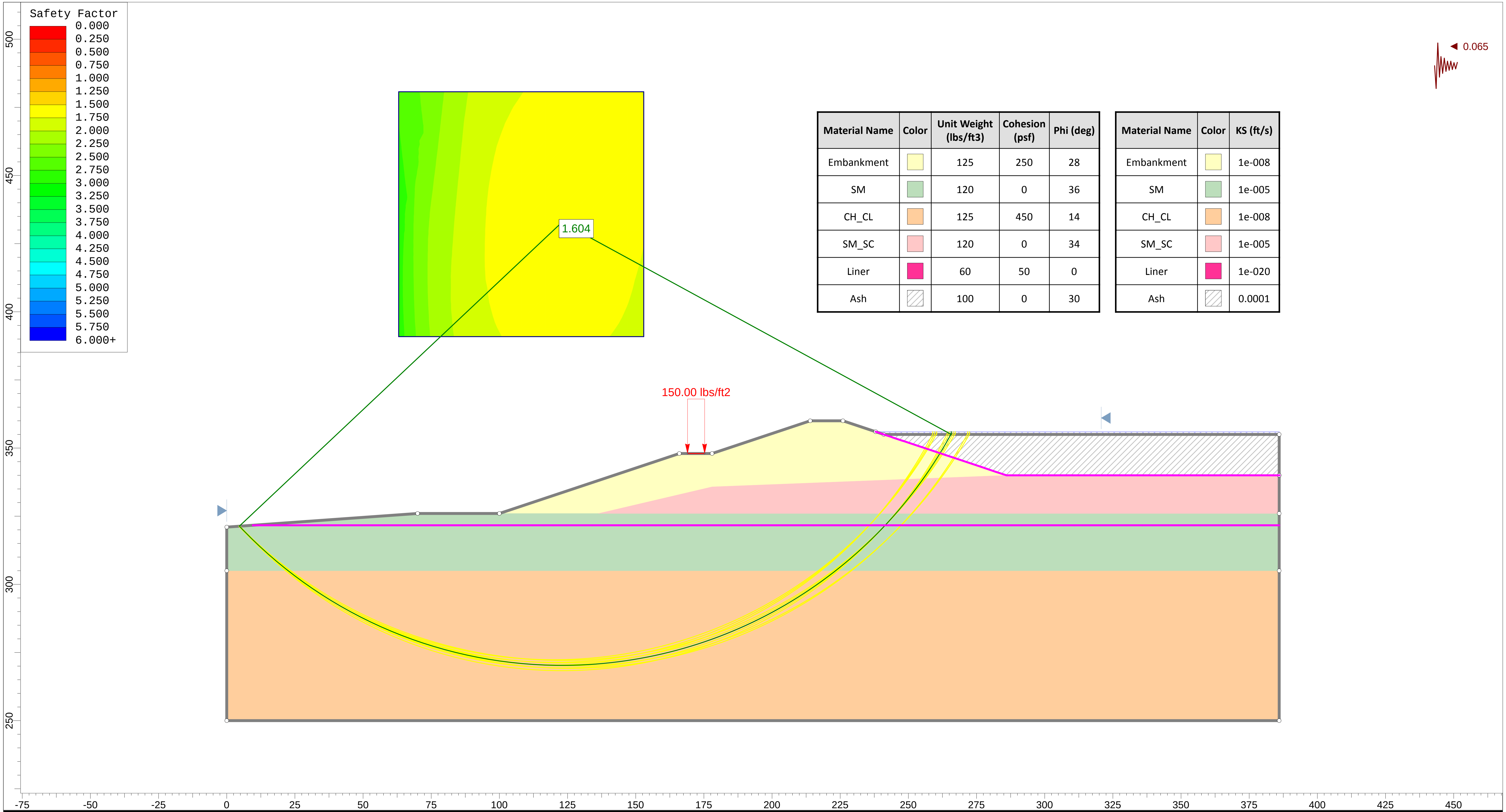
Date	7/11/2016, 3:30:13 PM	*File Name*	Winston_SS.slim



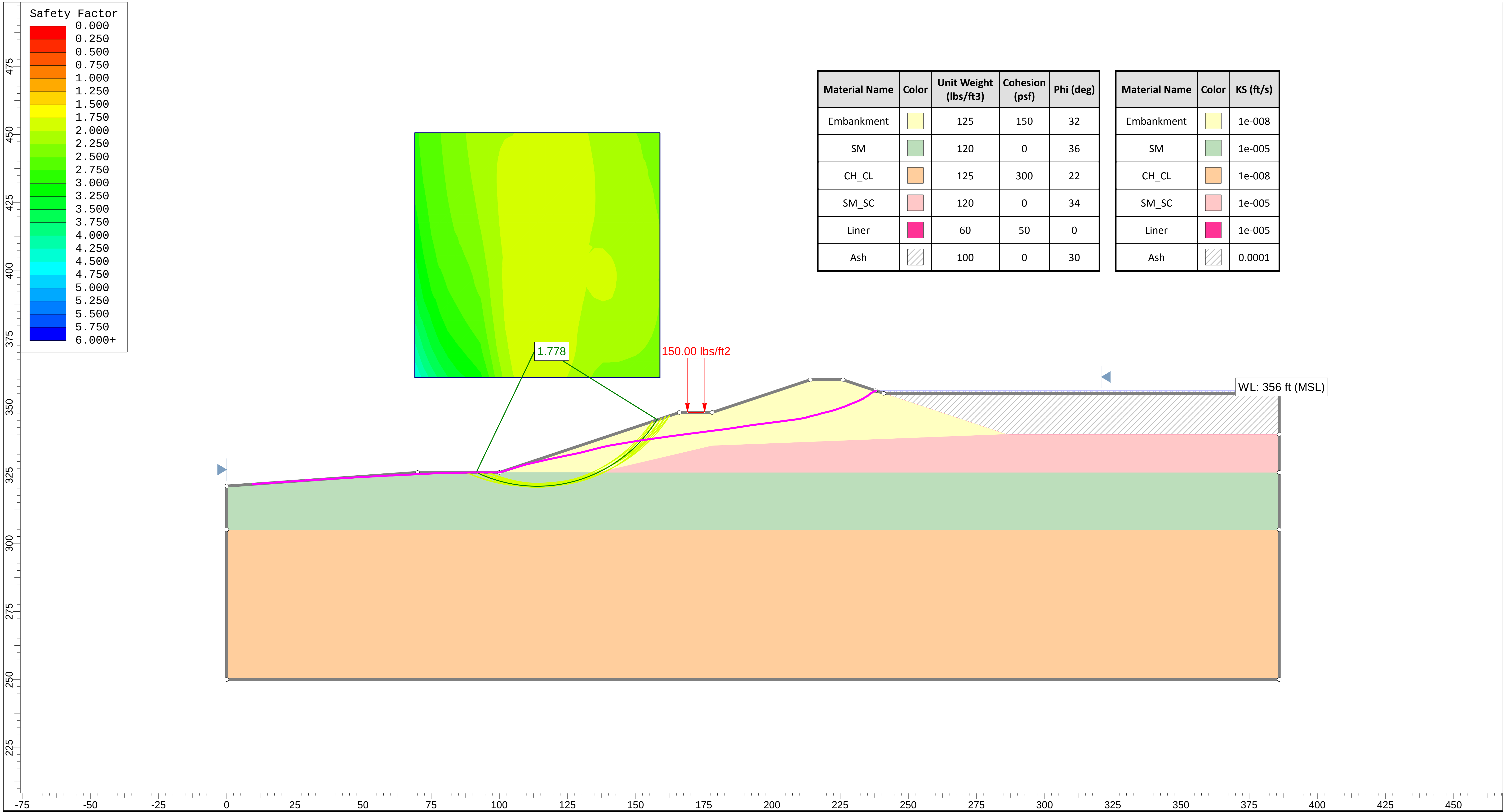
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	250	28
SM	🟩	120	0	36
CH_CL	🟧	125	450	14
SM_SC	🟥	120	0	34
Liner	🟪	60	50	0
Ash	▨	100	0	30

Material Name	Color	KS (ft/s)
Embankment	🟨	1e-008
SM	🟩	1e-005
CH_CL	🟧	1e-008
SM_SC	🟥	1e-005
Liner	🟪	1e-020
Ash	▨	0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool, Seismic Analysis
Drawn By	JJT
Company	Auckland
Date	7/11/2016, 3:30:13 PM
File Name	Winston_SSS.slim



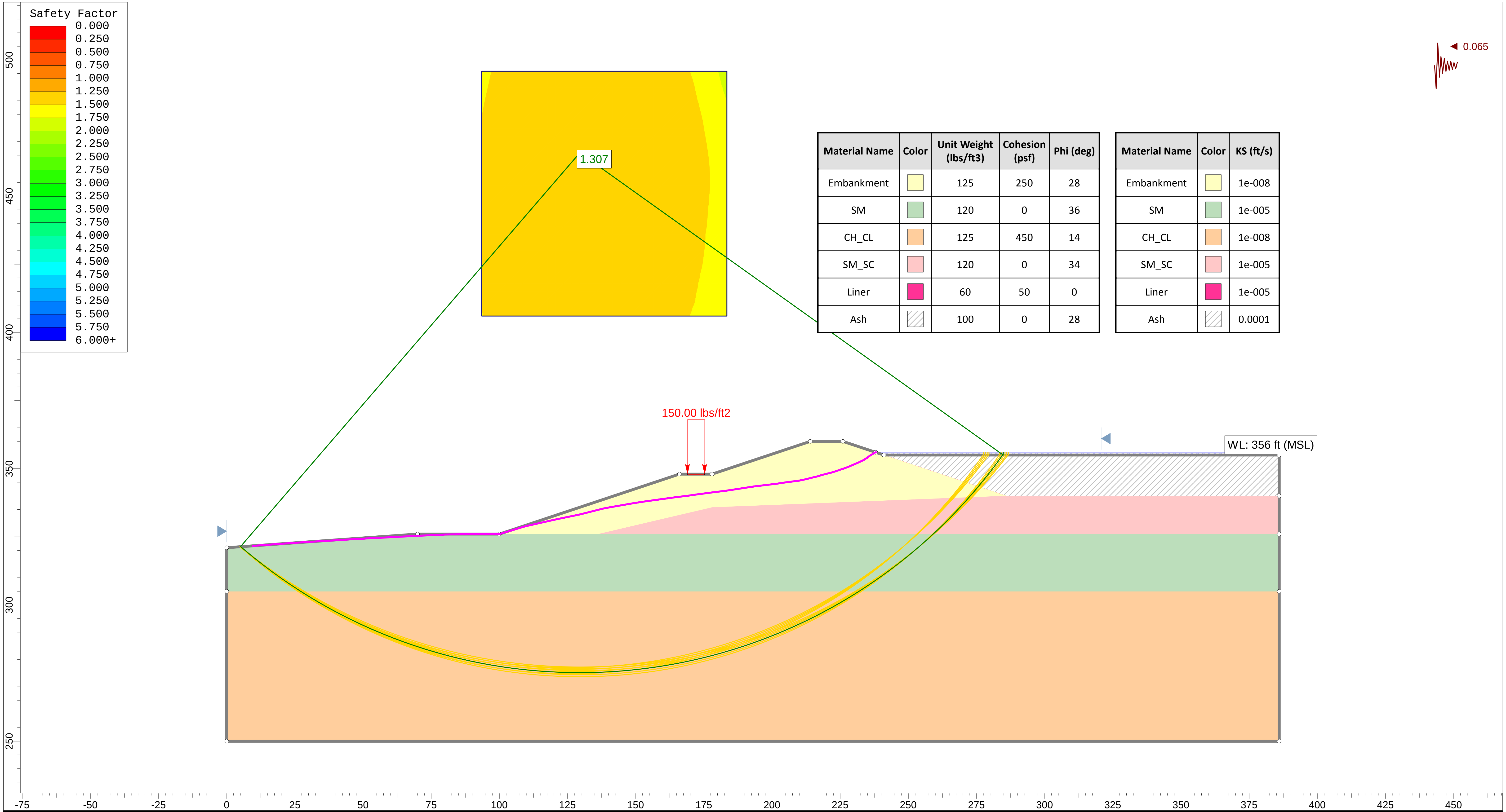
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	150	32
SM	🟩	120	0	36
CH_CL	🟧	125	300	22
SM_SC	🟥	120	0	34
Liner	🟥	60	50	0
Ash	▨	100	0	30

Material Name	Color	KS (ft/s)
Embankment	🟨	1e-008
SM	🟩	1e-005
CH_CL	🟧	1e-008
SM_SC	🟥	1e-005
Liner	🟥	1e-005
Ash	▨	0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool (assumed phreatic surface)
Drawn By	JJT
Company	Auckland
Date	7/11/2016, 3:30:13 PM
File Name	Winston_SS_L.slim



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	250	28
SM	🟩	120	0	36
CH_CL	🟧	125	450	14
SM_SC	🟥	120	0	34
Liner	🟥	60	50	0
Ash	▨	100	0	28

Material Name	Color	KS (ft/s)
Embankment	🟨	1e-008
SM	🟩	1e-005
CH_CL	🟧	1e-008
SM_SC	🟥	1e-005
Liner	🟥	1e-005
Ash	▨	0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

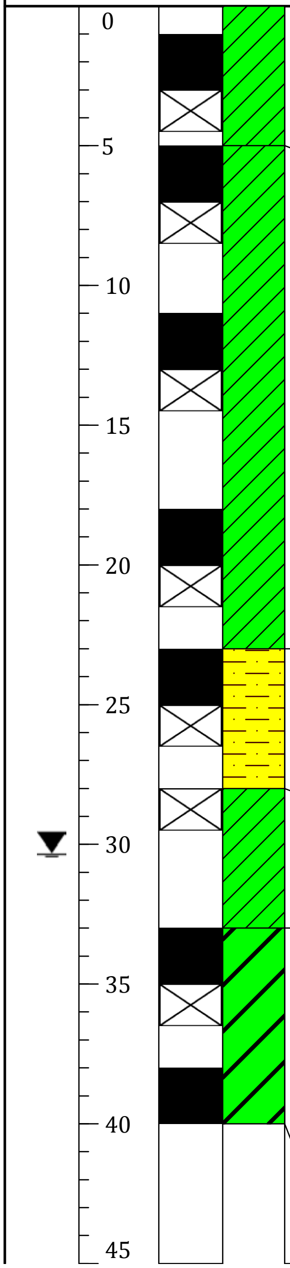
Project	Welsh Power Station - Bottom Ash Pond
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool, Seismic Analysis (assumed phreatic surface)
Drawn By	JJT
Company	Auckland
Date	7/11/2016, 3:30:13 PM
File Name	Winston_SSS_L.slim

Auckland Consulting LLC

LOG OF BORING B2

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-007
Drill Date(s): 05/19/2016

GPS Coordinates: N33° 02' 38.1" W94° 50' 42.3"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger



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)
Very Stiff, light gray, red and tan, Sandy Lean Clay (CL), mottled, interbedded sand seams		4.0		57	23	35	18	17	
- medium stiff, mottled	8								
Stiff, tan with gray and red, Sandy Lean Clay (CL), mottled		N/A							
	14			64	23	34	22	12	
- very stiff, between 11 to 18 ft		3.0	2.5	61	16	36	17	19	114
	15								
- hard, between 18 to 20 ft		4.5+							114
- stiff, below 20 ft	15			66	18	38	19	19	
Medium Dense, light gray with tan, Silt with Sand (ML), with few clay		N/A							
	19			73	17				
- medium stiff									
	40								
Hard, light gray with tan, Lean Clay (CL), interbedded sand seams									
Very Stiff, light gray with tan, Fat Clay (CH), interbedded sand seams		3.0		98	30	63	31	32	92
	18								
- dark gray, tan and red, with sand inclusions and ferrous partings below 38 ft		3.0							
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 30 ft during drilling. Water level at 30 feet upon completion. Boring caved to 32 feet. N/A: Not Attempted

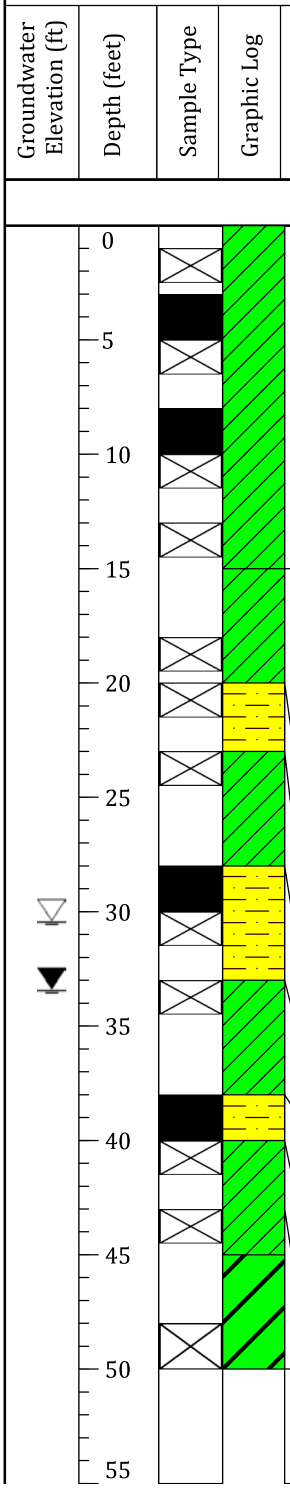
Auckland Consulting LLC

LOG OF BORING B3

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/18/2016

GPS Coordinates: N33° 02' 39.2" W94° 50' 38.1"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger



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)
Stiff, red, tan and gray, Sandy Lean Clay (CL), mottled	9								
		3.0		59	17	33	16	17	113
- with interbedded sand seams	13								
		1.5		67	18	39	21	18	111
- very stiff, tan, gray with red below 10 ft	18								
	16								
Very Stiff, red, brown, tan with gray, Lean Clay with Sand (CL), mottled, with interbedded sand seams		4.0	2.2	71	18	42	20	22	109
- clay with silt and organics (wood debris) at 18 ft	26			61	13				
	30			70	19				
Medium Dense, gray, Sandy Silt (ML), few organics (wood debris), few clay inclusions									
Very Stiff, tan, red and gray, Sandy Lean Clay (CL), mottled with silt		N/A		52	12	29	21	8	
	16								
Medium Dense, light gray and red, Sandy Silt (ML), mottled, few clay inclusions	19			91	29	36	24	12	
Very Stiff, tan, orange and red, Lean Clay (CL), mottled, laminated		N/A							
Light gray, tan and red, Sandy Silt (ML), mottled, few clay inclusions	35			70	24				
Hard, tan, gray with orange, Sandy Lean Clay (CL) with trace silt, mottled, laminated	34								
Very Stiff, gray, Fat Clay (CH), laminated	29			98	27	53	25	28	
Boring terminated at 50 feet.									

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 30 ft during drilling. Water level at 33 feet upon completion.
Boring caved to 40 feet. N/A: Not Attempted

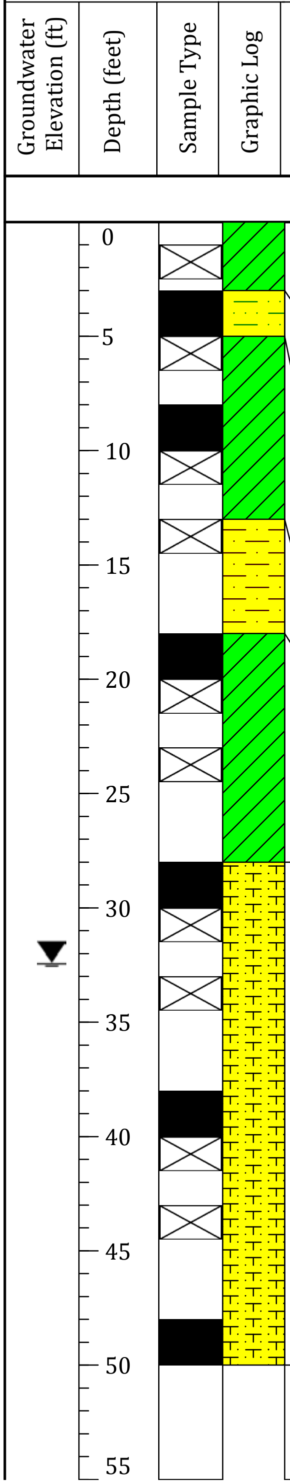
Auckland Consulting LLC

LOG OF BORING B4

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 06/08/2016

GPS Coordinates: N33° 02' 43.1" W94° 50' 37.1"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger



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)
Stiff, red, brown with gray, Sandy Lean Clay (CL), mottled	9			63	14	38	18	20	
		3.5		44	19	42	25	17	109
Medium Dense, light gray, red and brown, Clayey Sand (SC), mottled, laminated	15								
Very Stiff, light gray, tan and brown, Sandy Lean Clay (CL), mottled, slickensided		3.5		66	16	33	20	13	
	12								
- stiff, light gray, red and tan, with silt and sand seams below 10 ft	13			62	18				
Medium Dense, light gray and brown, Sandy Silt (ML), mottled, few clay inclusions									
		3.0		55	17	38	20	18	
Very Stiff, brown, gray and red, Sandy Lean Clay (CL), mottled	18								
	10								
- stiff below 23 ft									
Dense, brown, light gray and red, Silty Sand (SM)		N/A		43	16	NP	NP	NP	
	37								
- brown with red, some clay between 30 to 33 ft	46			30	30	NP	NP	NP	
- very dense, light gray with tan below 33 ft									
		N/A							116
	48								
	48								
		N/A		26	19	NP	NP	NP	
Boring terminated at 50 feet.									

Additional Information/Comments:

Logger: R. Pierson

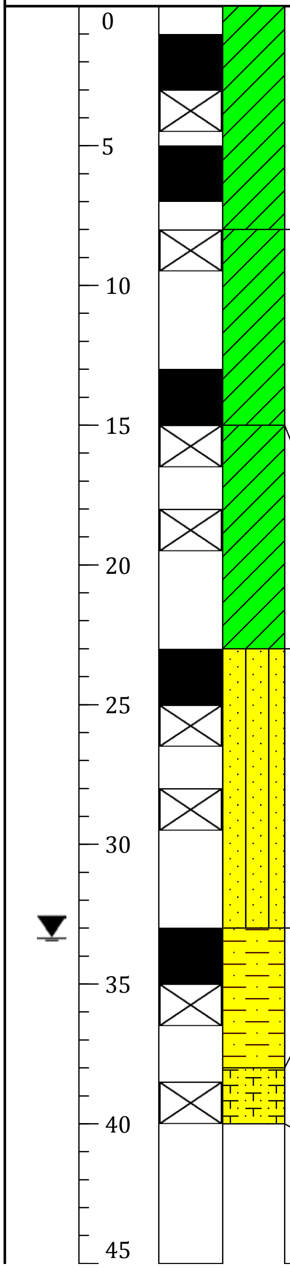
Notes/Comments: Seepage encountered at 32 ft during drilling. Water level at 32 feet upon completion.
Boring caved to 40 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B5

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-007
Drill Date(s): 06/08/2016

GPS Coordinates: N33° 02' 45.0" W94° 50' 33.4"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger



Groundwater Elevation (ft)	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)
	Stiff, red, gray and brown, Sandy Lean Clay (CL), mottled		2.0		54	20	40	18	22	
		11								
	- very stiff with sand lenses below 5 ft		2.5		60	17	44	20	24	119
	Very Stiff, light gray and brown, Lean Clay with Sand (CL), mottled	16								
	- stiff with sand and organics (root and wood debris) below 13 ft		2.0		79	18	35	17	18	110
		23			62	12	30	16	14	
	Very Stiff, light brown with gray, Sandy Lean Clay (CL), with few organics (root debris)	6								
	- medium stiff, silt with sand below 18 ft									
	Medium Dense, light brown, tan with gray, Silty Clayey Sand (SC-SM), mottled, with organics (root debris) between 23 to 25 ft		N/A		47	10	31	23	8	
		26								
	- very dense below 28 ft	34			44	20				
▼	Very Dense, light gray with tan, Silt (ML)		N/A		91	27	NP	NP	NP	96
	- sandy silt below 35 ft	68								
	Very Dense, light gray with tan, Silty Sand (SM)	96			21	28				
	Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: R. Pierson

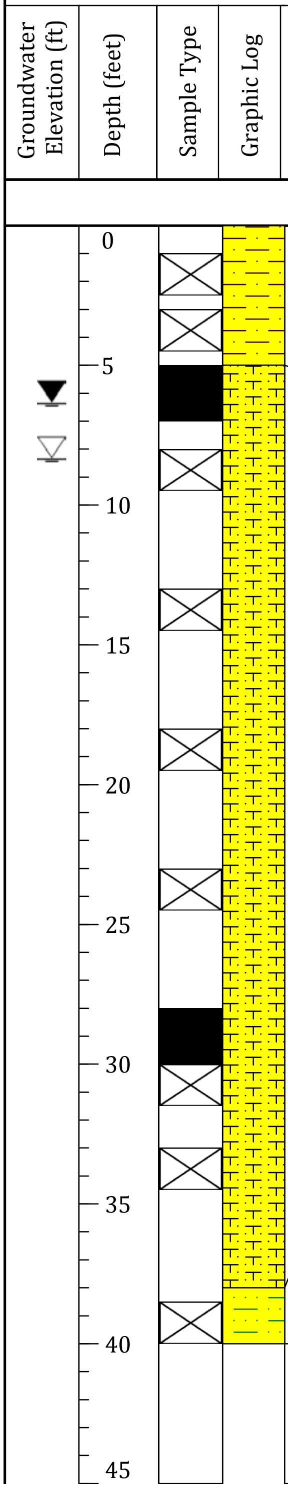
Notes/Comments: Seepage encountered at 33 ft during drilling. Water level at 33 feet upon completion.
Boring caved to 38 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B6

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-007
Drill Date(s): 05/17/2016

GPS Coordinates: N33° 02' 43.0" W94° 50' 34.1"
Surface Elevation: 332 ft, MSL (approx)
Drilling Method: Dry Auger



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)
Medium Dense, red, tan and brown, Silt with Sand (ML), mottled	16								
- with gray	23			73	19	NP	NP	NP	
Medium Dense, tan, gray and brown, Silty Sand (SM), mottled		N/A							
- tan and gray below 8 ft	24			45	26	NP	NP	NP	
- very dense between 13 and 30 ft	57								
	51			47	27				
- few clay inclusions below 23 ft	73								
		N/A		36	29	NP	NP	NP	122
- dense with few clay inclusions between 30 and 33 ft	34								
- very dense below 33 ft	79								
Medium Dense, dark gray, tan and red, Clayey Sand (SC), few silt, trace gypsum	27			39	25	47	21	26	
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 6 feet upon completion.
Boring caved to 15 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B7

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/17/2016

GPS Coordinates: N33° 02' 40.8" W94° 50' 36.5"
Surface Elevation: 328 ft, MSL (approx)
Drilling Method: Dry Auger

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, brown and tan, Clayey Sand (SC), few organics	8								
		☒	🟨	- medium dense, gray and tan below 3 ft	26			40	22				
▼ ▽	5	☒	🟨	Dense, tan, gray and red, Silty Sand (SM)	32			31	24	NP	NP	NP	
		☒	🟨		47								
	10		🟨										
	15	■	🟨	- light gray with tan, with few clay inclusions between 13 and 18 ft		N/A		31	26	NP	NP	NP	100
	20	☒	🟨	- medium dense below 18 ft	30								
	25	☒	🟩	Medium Stiff, tan, orange and brown, Fat Clay (CH), laminated with gypsum	5			92	31	55	22	33	
		■	🟩			N/A							
	30	☒	🟩	- very stiff below 30 ft	29								
	35	☒	🟩	Hard, dark gray and gray, Lean Clay with Sand (CL), laminated with gypsum	57			73	23	33	18	15	
	40	☒	🟩		36								
				Boring terminated at 40 feet.									
	45												

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 7 ft during drilling. Water level at 6 feet upon completion.
Boring caved to 35 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B8

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-007
Drill Date(s): 05/18/2016

GPS Coordinates: N33° 02' 37.8" W94° 50' 38.0"
Surface Elevation: 338 ft, MSL (approx)
Drilling Method: Dry Auger

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, gray, red and tan, Sandy Lean Clay (CL), mottled	12								
		■	▨			4.5+	1.8	51	18	33	18	15	115
	5	☒	▨	- very stiff between 5 and 8 ft	22								
▽		☒	▨	- stiff, gray and light brown, mottled with interbedded sand seams below 8 ft	11			57	23				
	10		▨										
		☒	▨	Stiff, light brown and gray, Fat Clay (CH), laminated, few ferrous partings	13								
▼	15		▨										
		☒	▨	- very stiff, dark gray with brown, gypsum below 18 ft	28			60	25	58	32	26	
	20		▨										
		■	▨	- laminated with gypsum, interbedded sand seams below 23 ft		2.5							
	25	☒	▨		22								
		☒	▨		30			88	19	63	32	31	
	30		▨										
		☒	▨	- hard below 33 ft	38								
	35		▨										
		☒	▨		34			85	29				
	40			Boring terminated at 40 feet.									
	45												

Additional Information/Comments:

Logger: R. Pierson
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 16 feet upon completion.
Boring caved to 26 feet. N/A: Not Attempted

Boring Log Terms and Symbols

Symbols and Sampler Types

■	Thin-walled Tube (Shelby Tube)
☒	Standard Penetration Test (SPT)
◩	Auger Sample
⧗	Texas Cone Penetration Test (TCP)
▼	Observed Static-Water Level
▽	Observed Free Water (Seepage)

Soil Consistency and Structure

Strength of Fine Grained Soils		
Consistency	**SPT (Blows/ft)**	**UCS (tsf)**
Very Soft	< 2	< 0.25
Soft	2 – 4	0.25 – 0.5
Medium Stiff	4 – 8	0.5 – 1.0
Stiff	8 – 15	1.0 – 2.0
Very Stiff	15 – 30	2.0 – 4.0
Hard	> 30	> 4.0

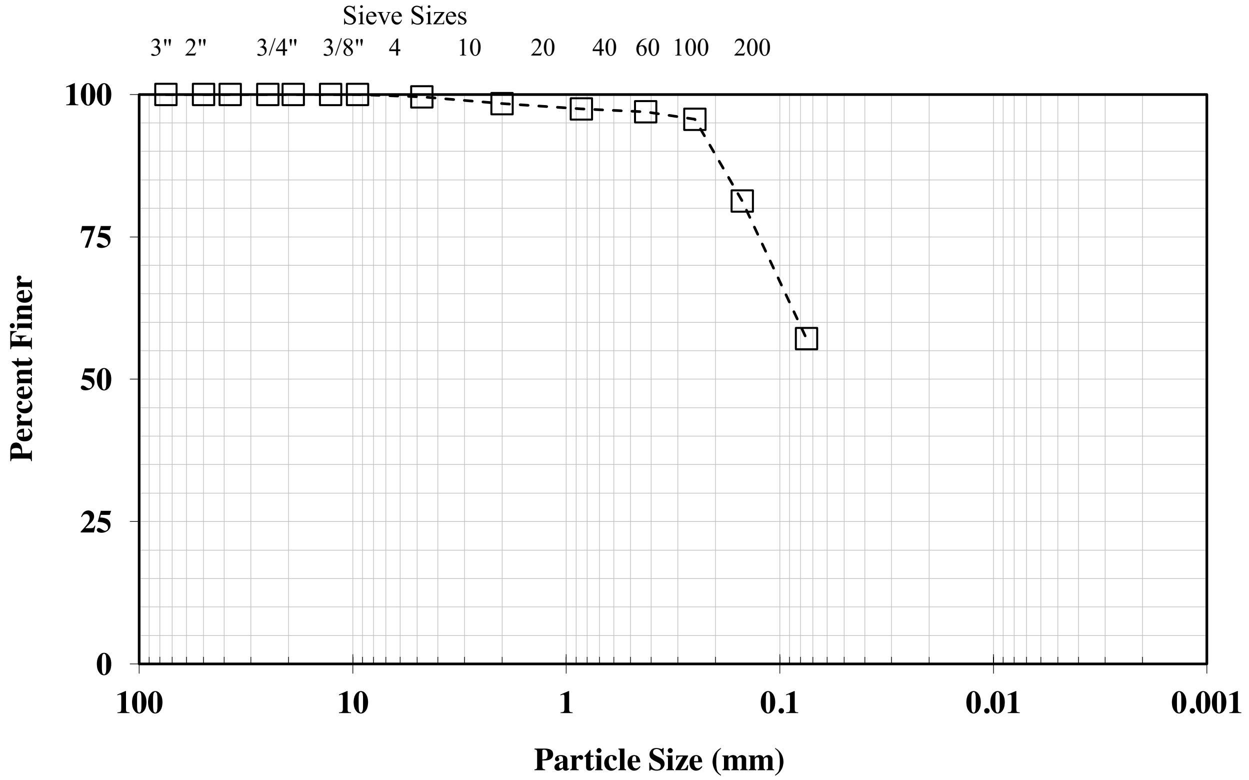
Density of Coarse Grained Soils		
Consistency	**SPT (Blows/ft)**	**TCP (Blows/ft)**
Very Loose	0 – 4	< 8
Loose	5 – 10	9 – 20
Medium Dense	11 – 30	21 – 60
Dense	31 – 50	61 -100
Very Dense	> 50	> 100

Soil Structure - Description	
Description	**Explanation**
Laminated	Alternating layers of varying material or color.
Slickensided	Fractured polished planes, little resistance to fracturing
Blocky	Cohesive soil that can be broken into small angular pieces.
Lensed	Inclusion of small pockets of different soils
Homogeneous	Same appearance and color throughout

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2 1-3

TRI Log#: 20888.1
Test Method: ASTM D422



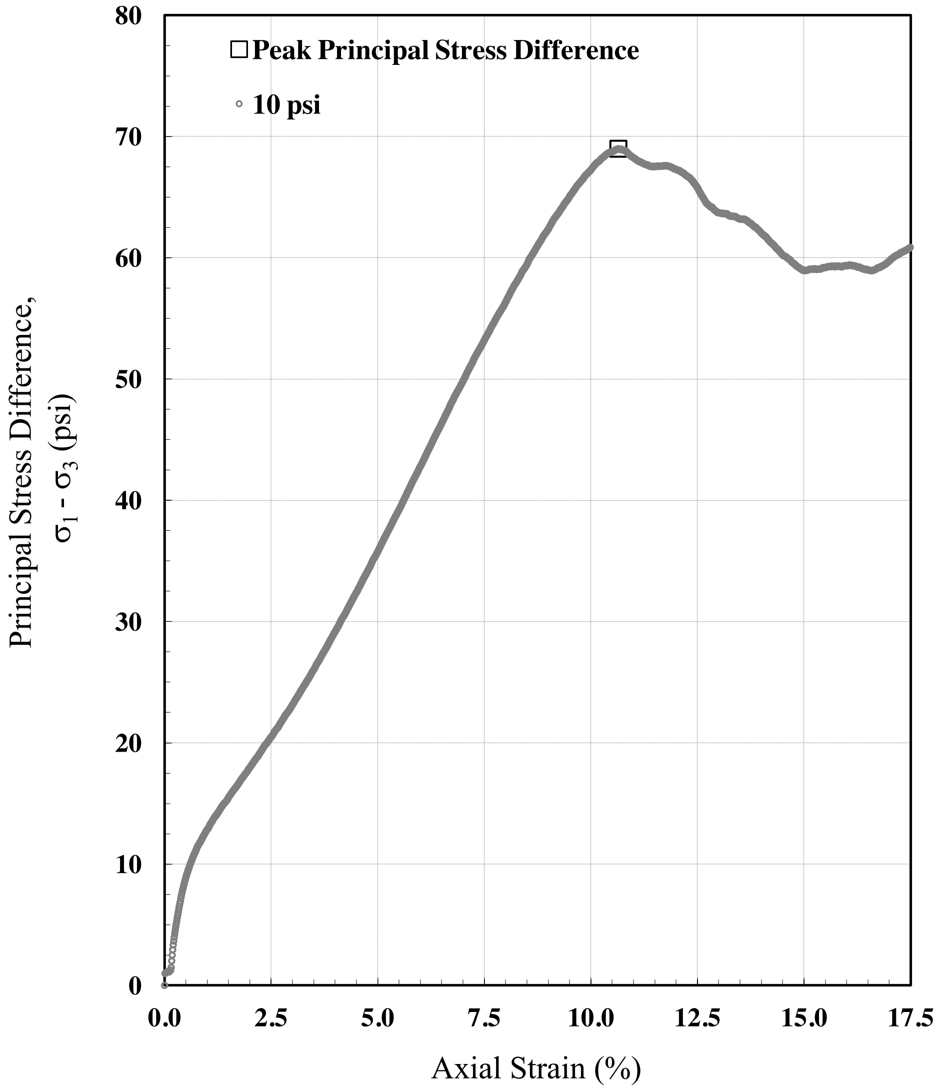
Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	99.6
No. 10 (2.00 mm)	98.4
No. 20 (0.841 mm)	97.5
No. 40 (0.420 mm)	97.0
No. 60 (0.250 mm)	95.6
No. 100 (0.149 mm)	81.3
No. 200 (0.074 mm)	57.1
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	Sandy lean clay (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	23.0
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	35
	Plastic Limit	18
	Plastic Index	17
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Unconsolidated-Undrained (Q) Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D2850
Sample:	B2: 11-13		



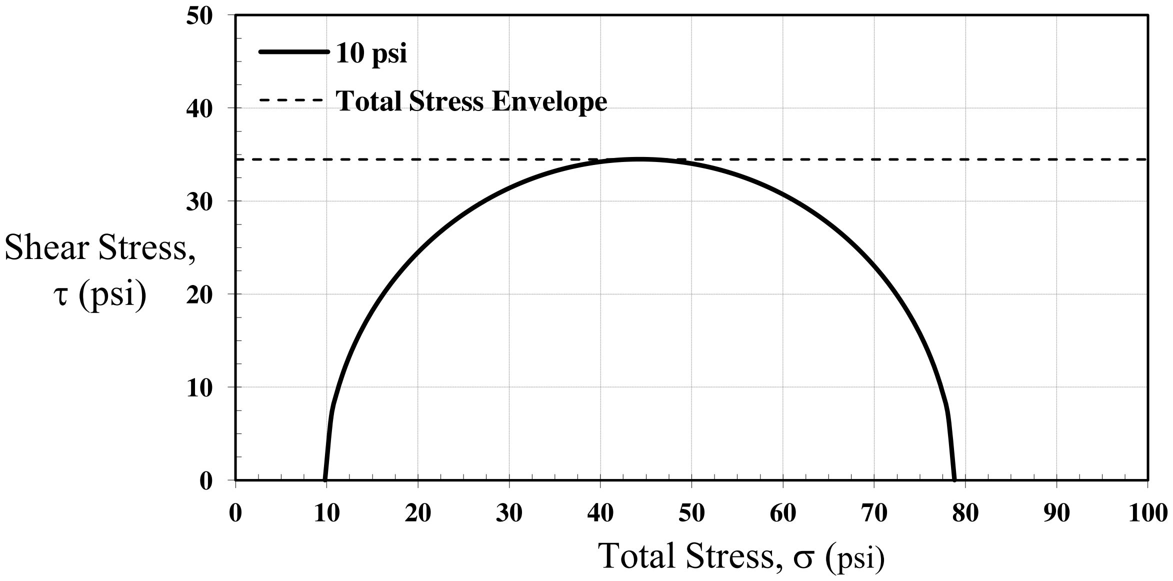
Test Parameters	
Minor Principal Stress (psi)	10.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.84
Avg. Height (in)	5.61
Avg. Water Content (%)	15.5
Bulk Density (pcf)	132.1
Dry Density (pcf)	114.4
Saturation (%)	92.0
Void Ratio	0.45
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	10.6
Minor Total Stress (psi)	10.0
Major Total Stress (psi)	79.0
Principal Stress Diff. (psi)	69.0

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	34.5
S_u / σ_3	3.4

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



Jeffrey A. Kuhn , Ph.D., P.E., 6/30/2016

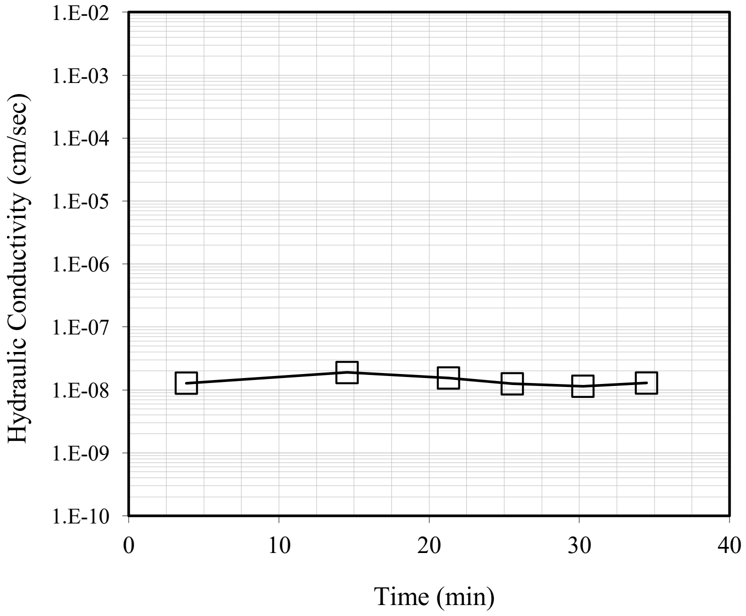
Analysis & Quality Review/Date

Laboratory Staff: LC

Hydraulic Conductivity

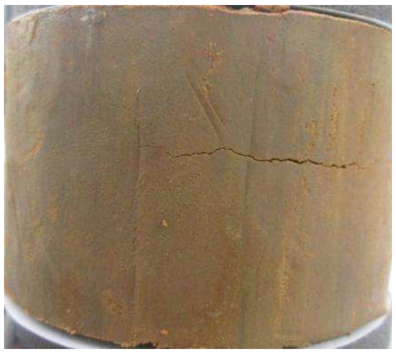
Client: Auckland Consulting LLC
Project: Winston Pond
Sample ID: B2: 18-20

TRI Log #: 20888
Test Method: ASTM D5084 Method F



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.82
Height (in)	1.81
Initial Mass (g)	389.6
Sample Area (in^2)	6.25
Water Content (%)	15.5
Total Unit Weight (pcf)	131.4
Dry Unit Weight (pcf)	113.8
Specific Gravity (Assumed)	2.65
Degree of Saturation	90.4
Void Ratio	0.45
Porosity	0.31
1 Pore Volume (cc)	57.7
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.96

Specimen Image



Note: Permeation measurements were made with a mercury U-tube.

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
21.3	1.5E-08
25.5	1.3E-08
30.2	1.1E-08
34.5	1.3E-08
Average, Last 2 Readings	**1.2E-08**

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Testing Performed By: SOC & LC

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
AUSTIN, TX - USA | ANAHEIM, CA - USA | ANDERSON, SC - USA | GOLD COAST - AUSTRALIA | SUZHOU - CHINA

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

TRI Log #: 20888
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	14.2	28.3	42.5
Initial Specimen Properties			
Avg. Diameter (in)	2.05	2.05	2.05
Avg. Height (in)	4.33	4.33	4.33
Avg. Water Content (%)	30.8	-	-
Bulk Density (pcf)	119.7	119.7	119.7
Dry Density (pcf)	91.5	-	-
Saturation (%)	98.8	-	-
Void Ratio, n	0.84	0.84	0.84
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	79.7	80.0	80.2
B-Value, End of Saturation	0.96	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.82	0.82	0.82
Area (in^2)	3.28	3.28	3.28

Shear / Post-Shear			
Avg. Water Content (%)	-	-	29.7
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	1.0	1.5	1.9
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	5.6	11.9	20.5
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	15.8	25.5	34.0
Pore Water Pressure, Δu_f (psi)	-	-	-	9.8	17.2	22.6
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	21.4	37.4	54.5
Effective Friction Angle (degrees)	-			22.1		
Effective Cohesion (psi)	-			3.3		

R-Envelope, "Total" Stress		
Friction Angle (deg)	-	14.3
Cohesion (psi)	-	2.3

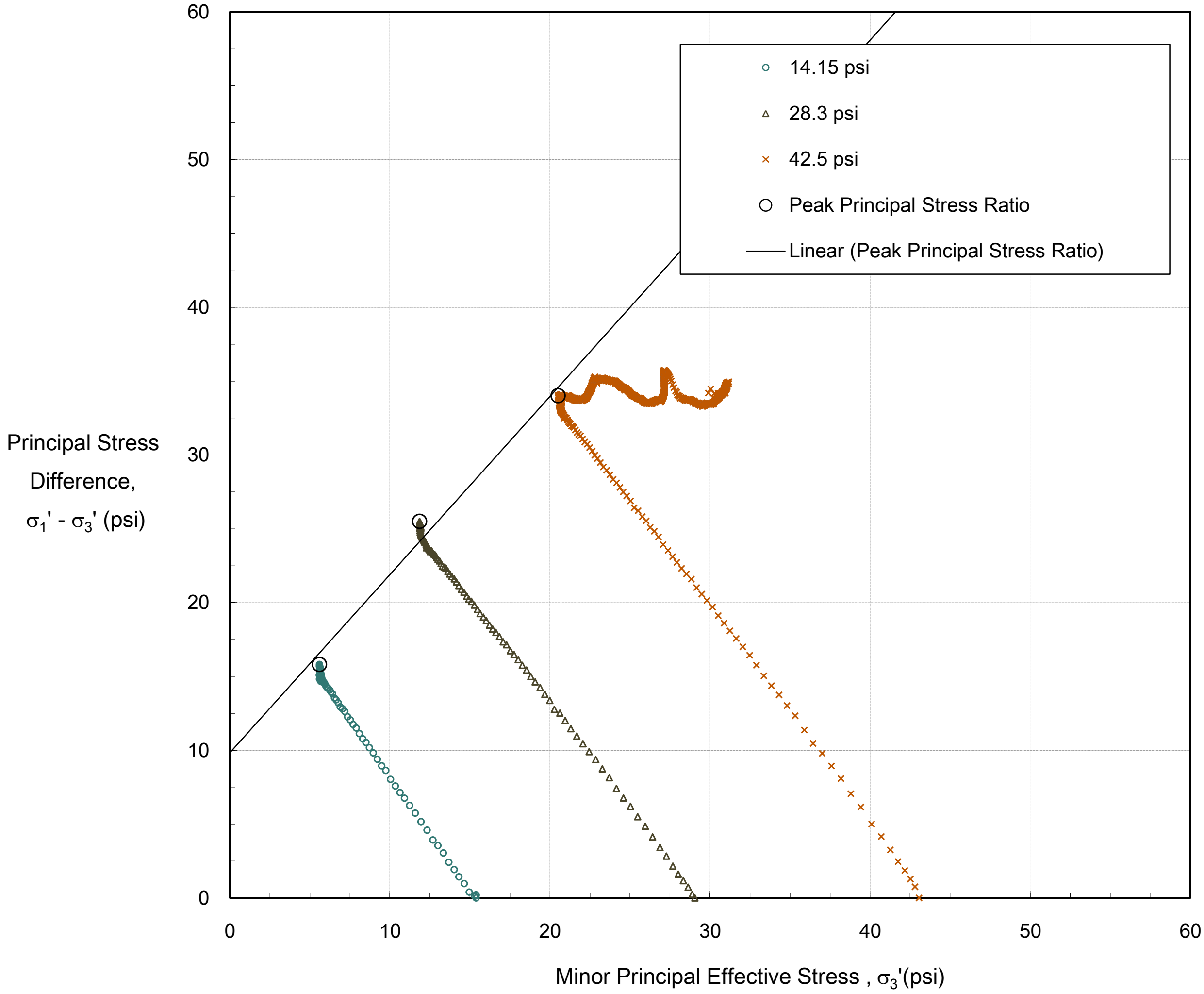
Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

Jeffrey A. Kuhn , Ph.D., P.E., 7/12/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B2: 33-35		

Modified Mohr-Coulomb

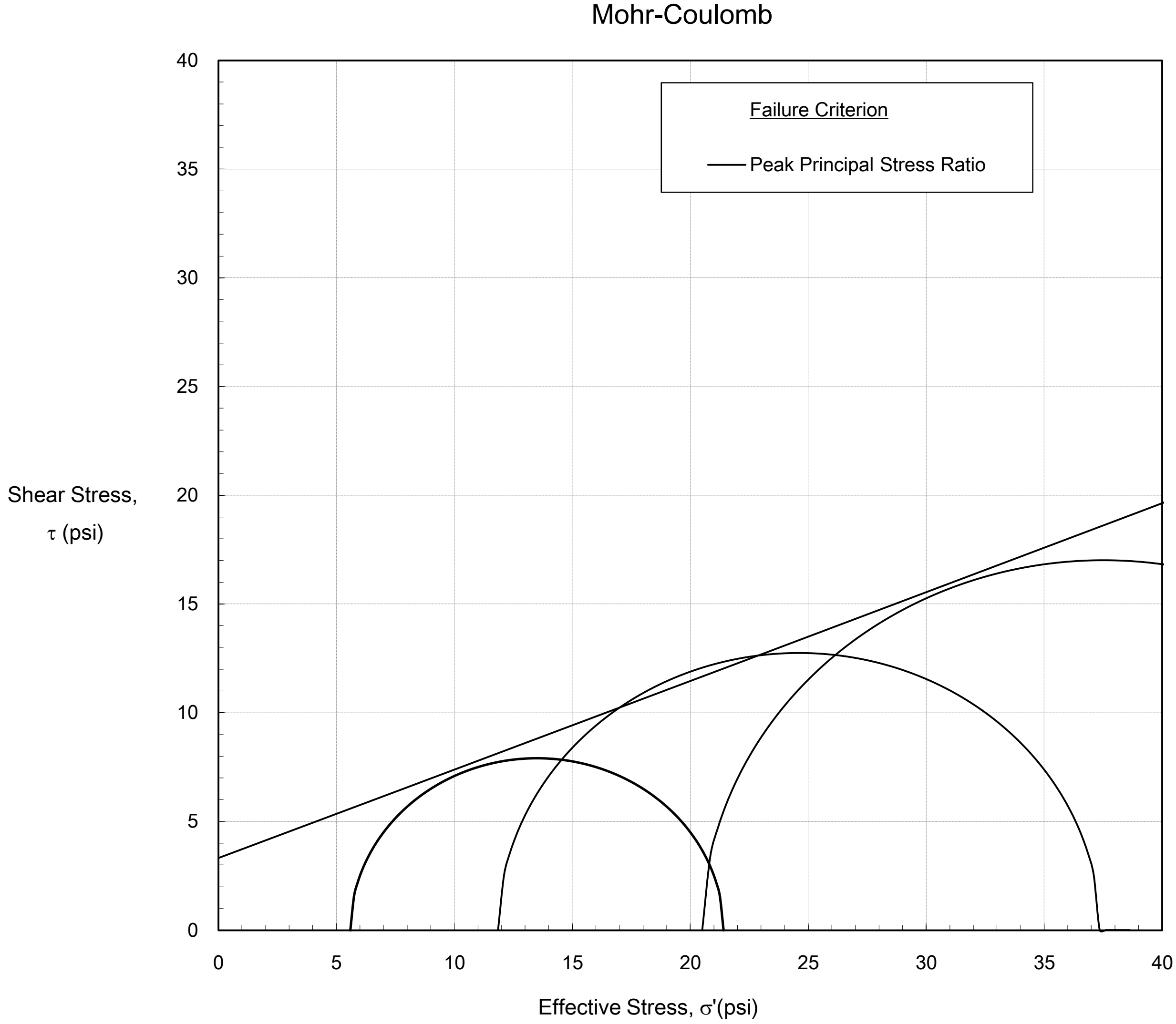


Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	22.1
Effective Cohesion (psi)	-	3.3

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

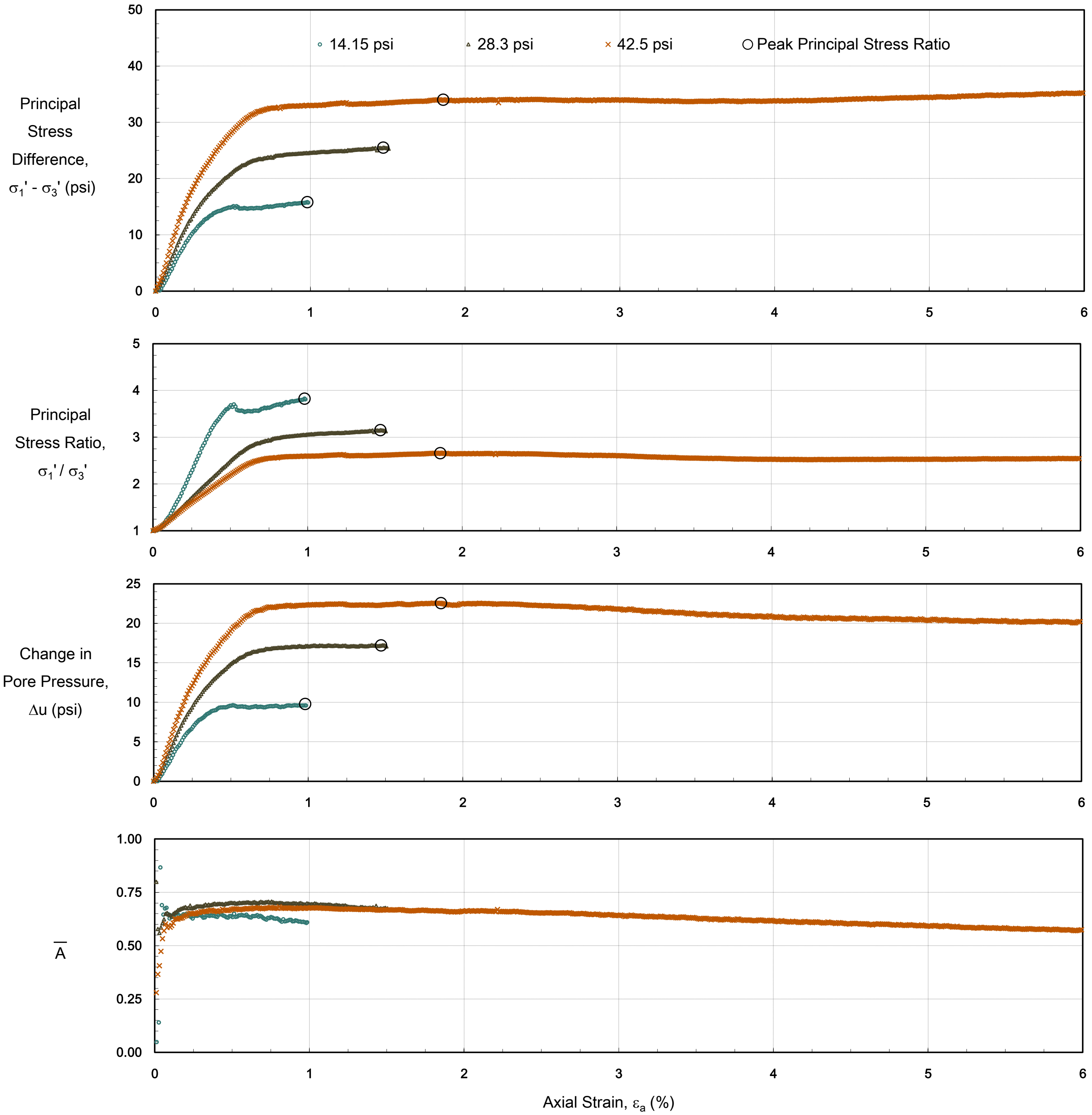
TRI Log #: 20888
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	22.1
Effective Cohesion (psi)	-	3.3

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B2: 33-35		



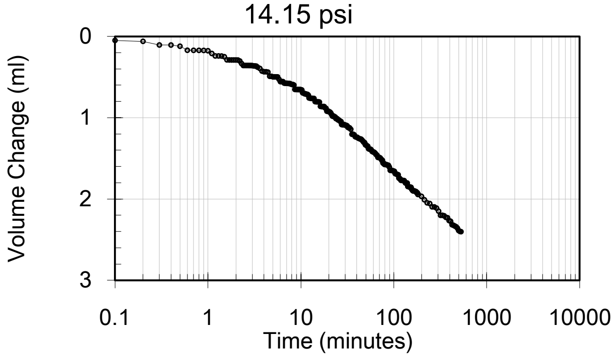
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

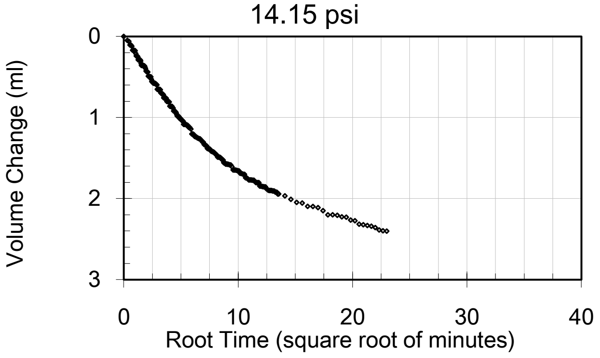
TRI Log #: 20888
Test Method: ASTM D4767 Mod

Consolidation

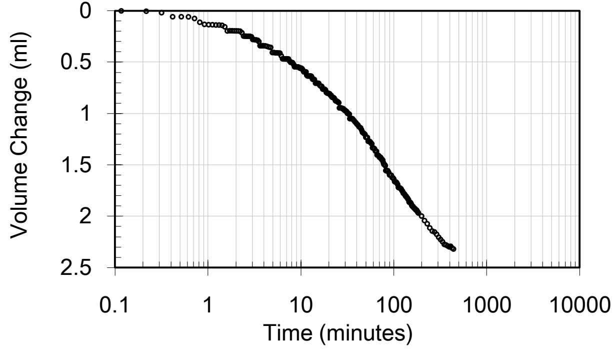
14.15 psi



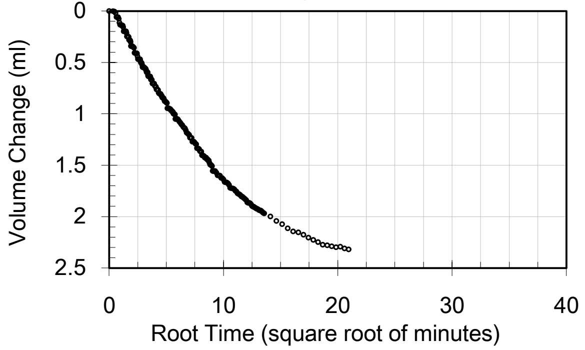
14.15 psi



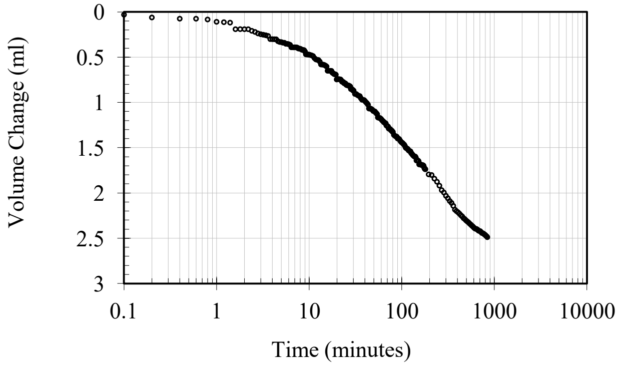
28.3 psi



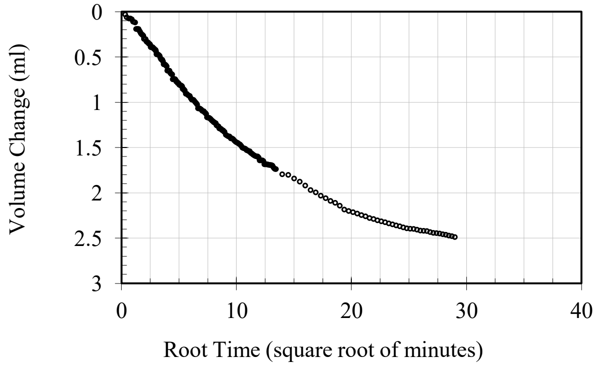
28.3 psi



42.5 psi

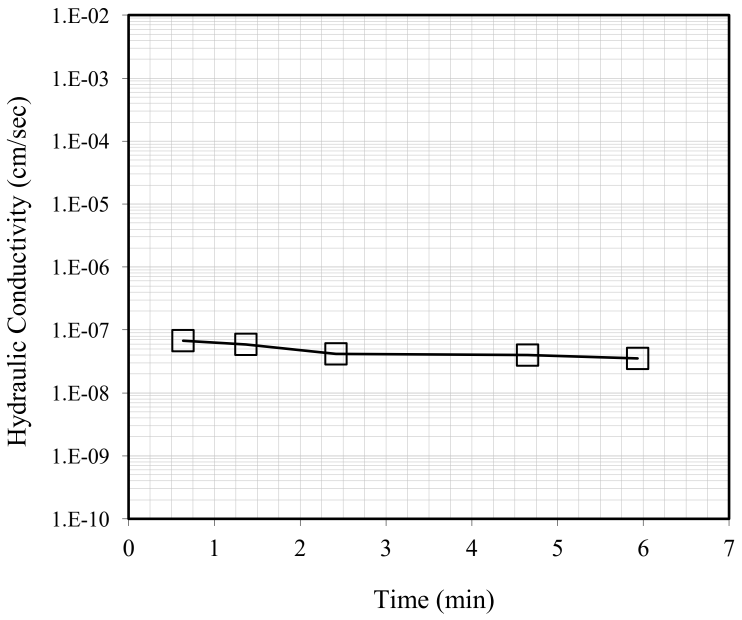


42.5 psi



Hydraulic Conductivity

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D5084 Method F
Sample ID:	B3: 3-5		



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.83
Height (in)	1.59
Initial Mass (g)	341.8
Sample Area (in^2)	6.28
Water Content (%)	15.9
Total Unit Weight (pcf)	130.4
Dry Unit Weight (pcf)	112.6
Specific Gravity (Assumed)	2.65
Degree of Saturation	89.6
Void Ratio	0.47
Porosity	0.32
1 Pore Volume (cc)	52.2
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.96

Specimen Image

Note: Permeation measurements were made with a mercury U-tube.

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
1.4	5.9E-08
2.4	4.2E-08
4.6	4.0E-08
5.9	3.5E-08
Average, Last 2 Readings	**3.8E-08**

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Testing Performed By: SOC & LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B3: 8-10		

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	3.8	7.5	15.0
Initial Specimen Properties			
Avg. Diameter (in)	2.05	2.05	2.05
Avg. Height (in)	4.46	4.46	4.46
Avg. Water Content (%)	17.8	-	-
Bulk Density (pcf)	130.1	130.1	130.1
Dry Density (pcf)	110.5	-	-
Saturation (%)	91.3	-	-
Void Ratio, n	0.53	0.53	0.53
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	81.1	81.1	81.1
B-Value, End of Saturation	1.00	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.51	0.51	0.51
Area (in^2)	3.27	3.27	3.26

Shear / Post-Shear			
Avg. Water Content (%)	-	-	19.9
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	1.0	0.8	2.7
Minor Effective Stress (psi), $\sigma_3'{}_f$	-	-	-	2.2	4.4	10.1
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	7.0	11.6	28.5
Pore Water Pressure, Δu_f (psi)	-	-	-	1.6	3.1	4.9
Major Effective Stress (psi), $\sigma_1'{}_f$	-	-	-	9.2	16.0	38.6
Effective Friction Angle (degrees)	-			35.1		
Effective Cohesion (psi)	-			0.1		

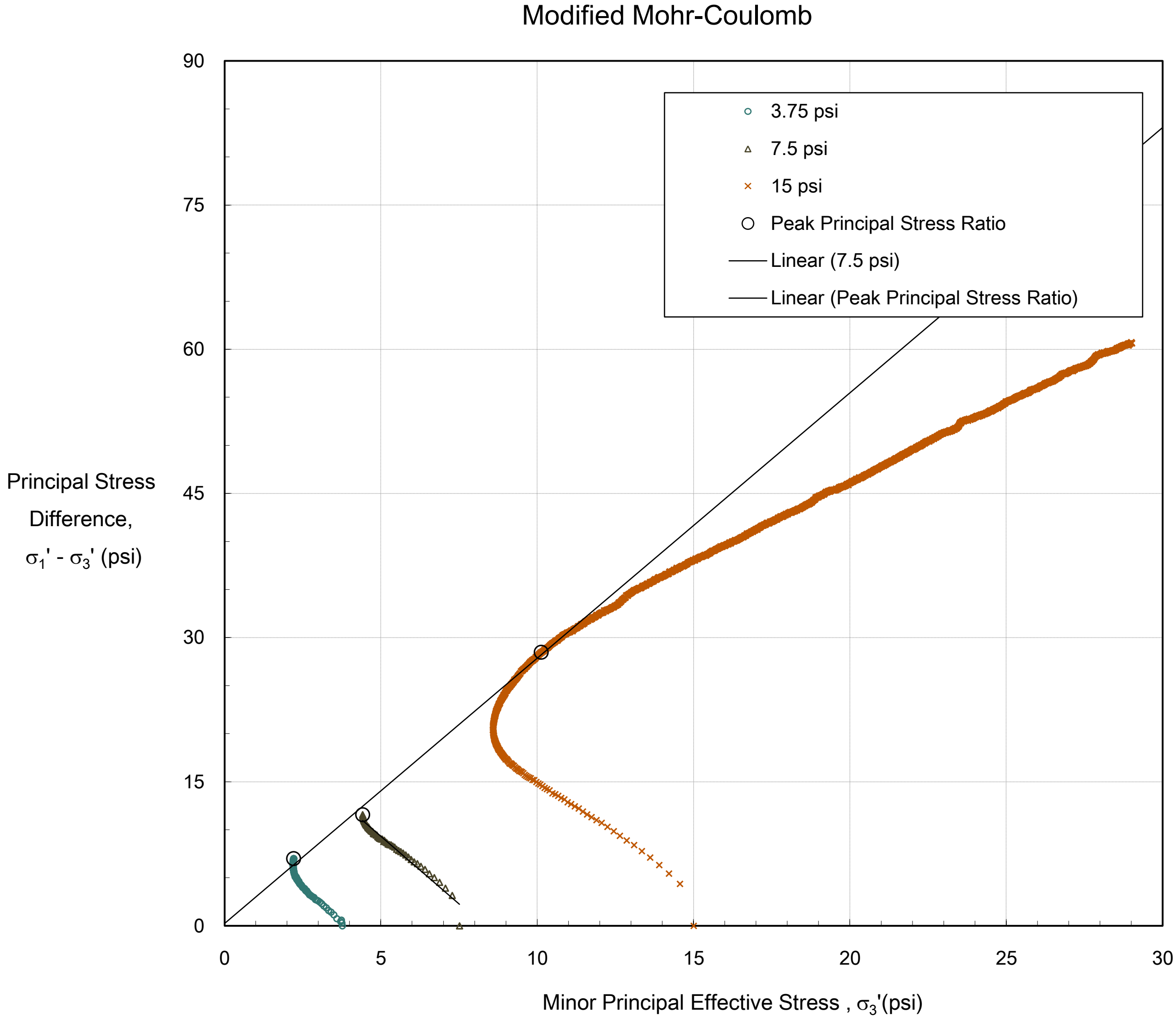
R-Envelope, "Total" Stress		
Friction Angle (deg)	-	28.5
Cohesion (psi)	-	0 (Forced)

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

Jeffrey A. Kuhn , Ph.D., P.E., 7/13/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B3: 8-10		

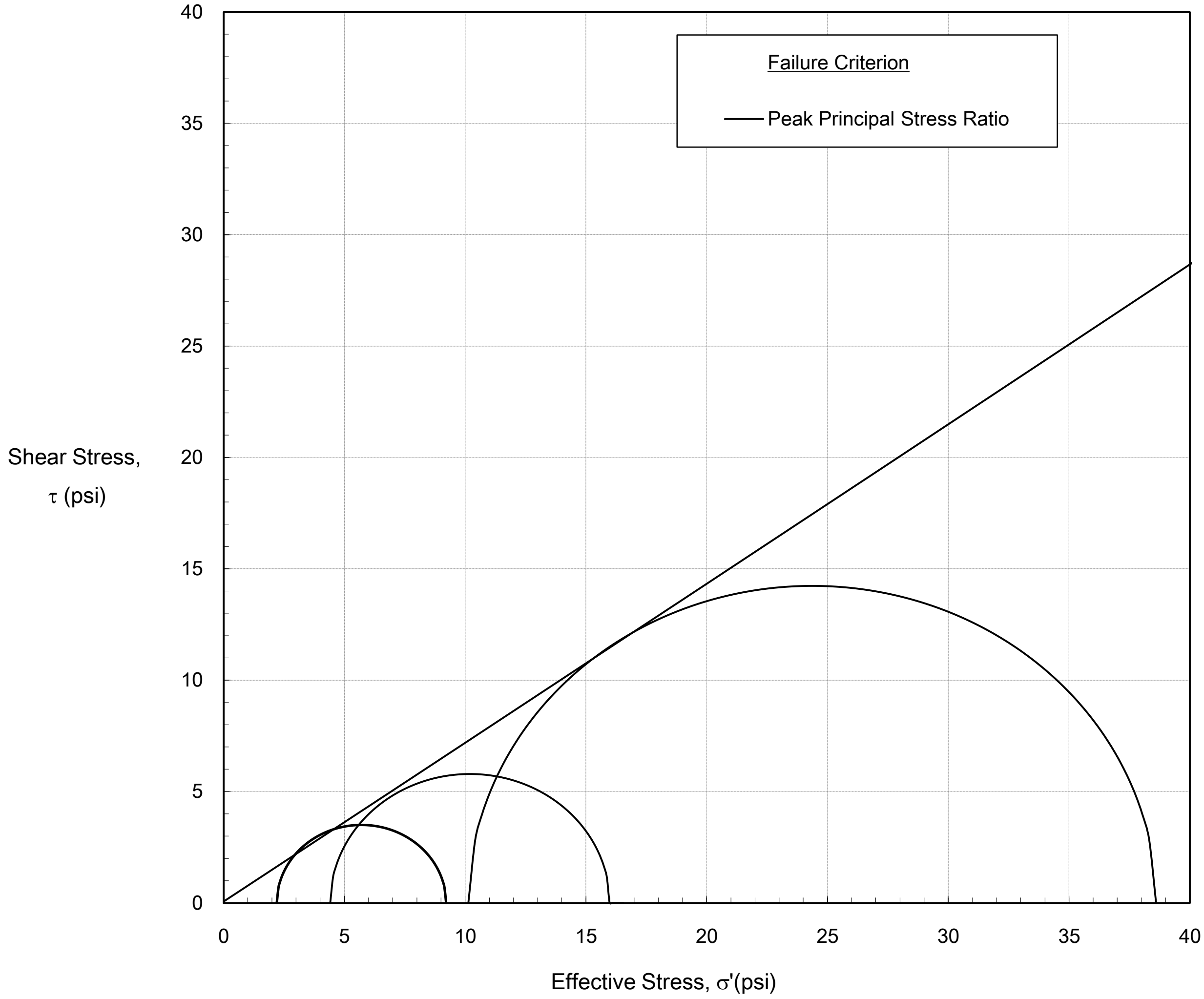


Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	35.1
Effective Cohesion (psi)	-	0.1

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B3: 8-10		

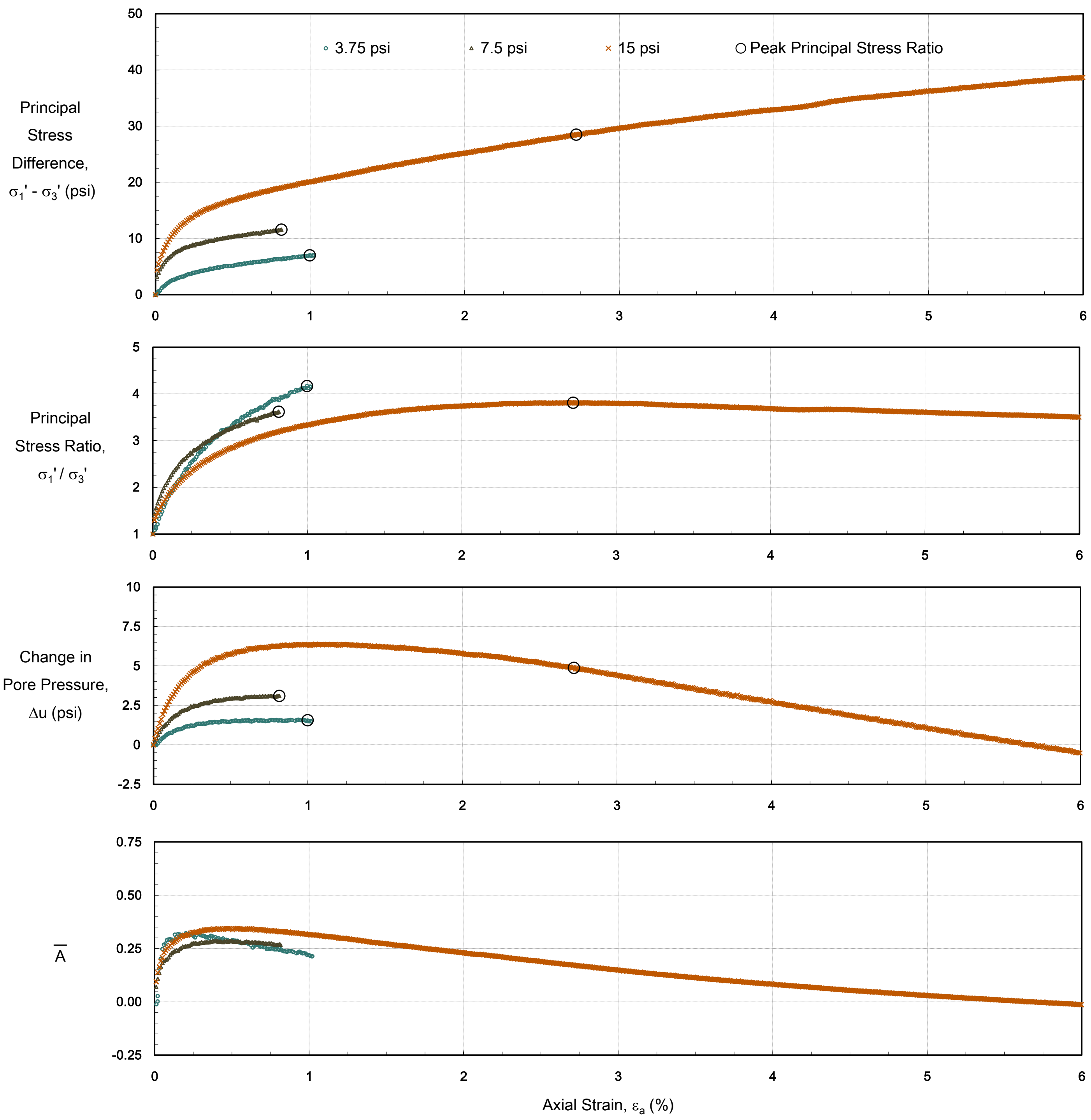
Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	35.1
Effective Cohesion (psi)	-	0.1

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B3: 8-10		

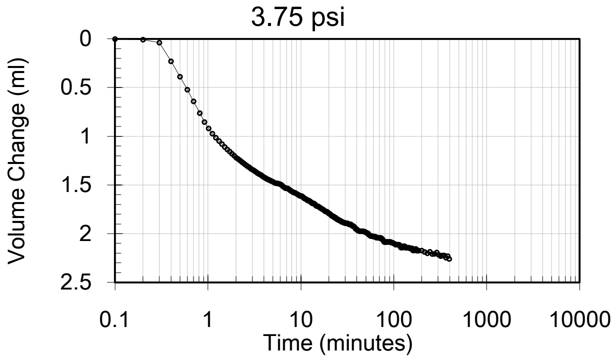


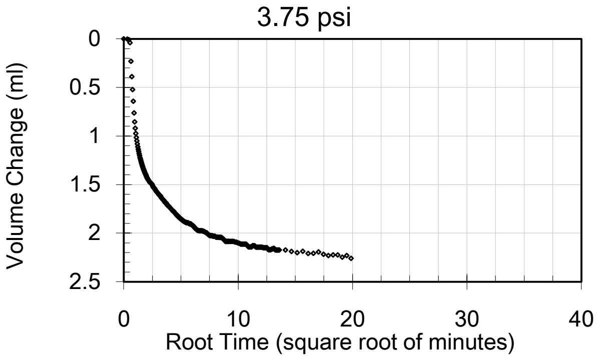
Multi-Stage Consolidated-Undrained Triaxial Compression

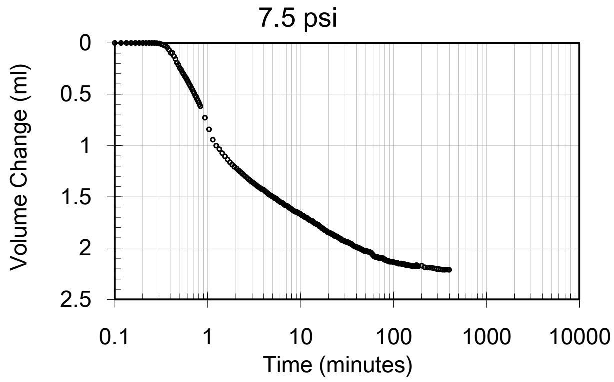
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 8-10

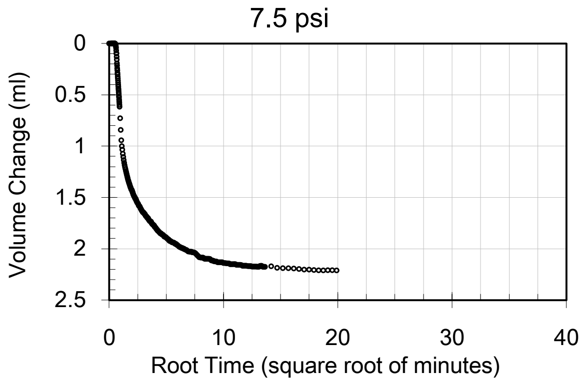
TRI Log #: 20888
Test Method: ASTM D4767 Mod

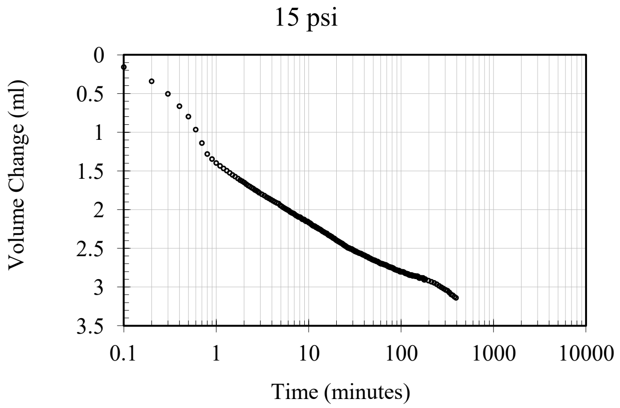
Consolidation

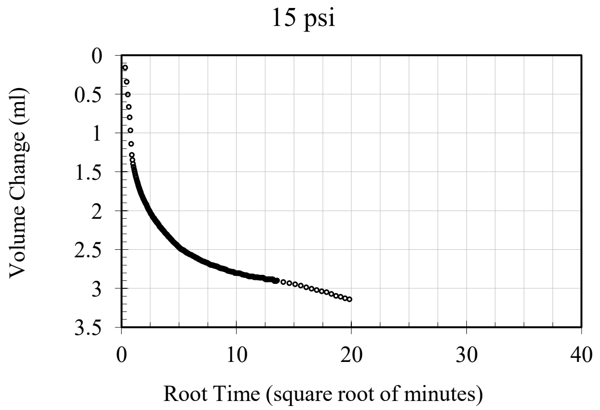












TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
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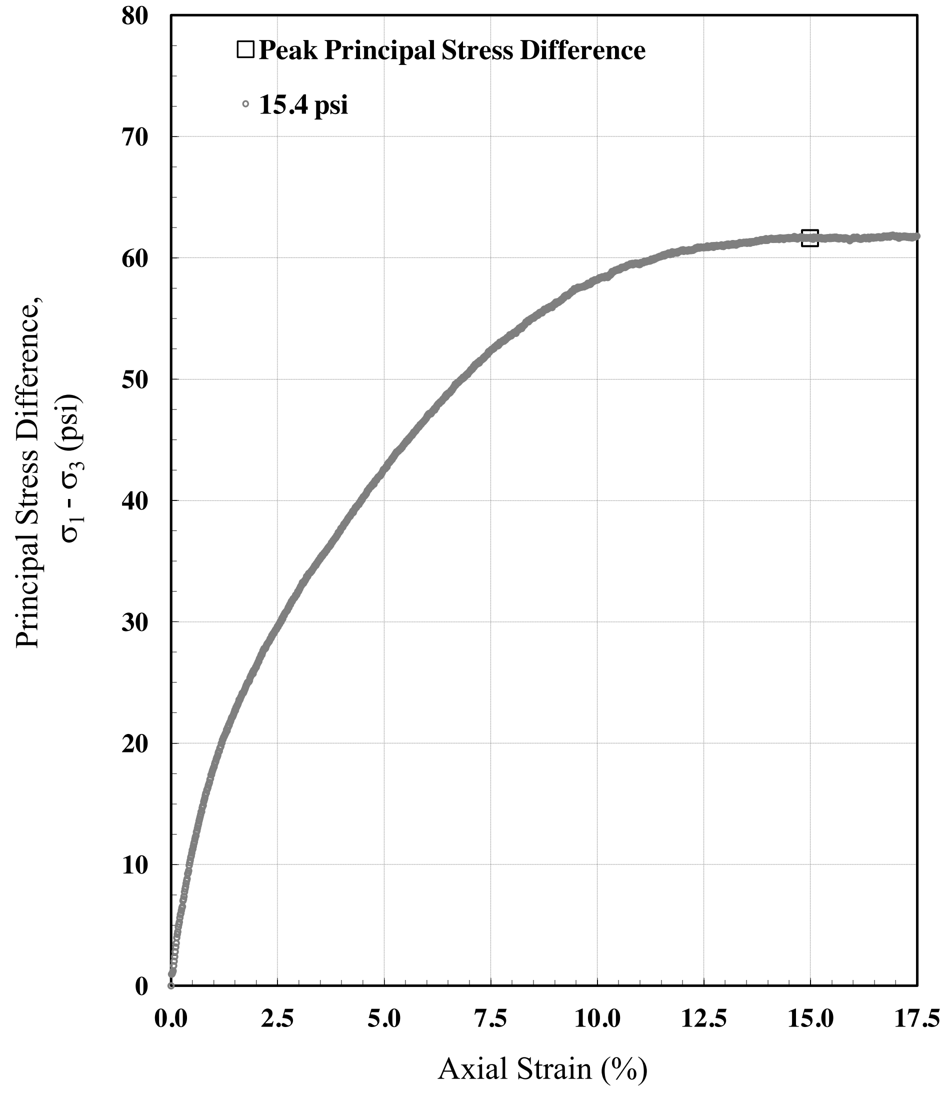
Unconsolidated-Undrained (Q) Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D2850
Sample:	B3: 18-19		



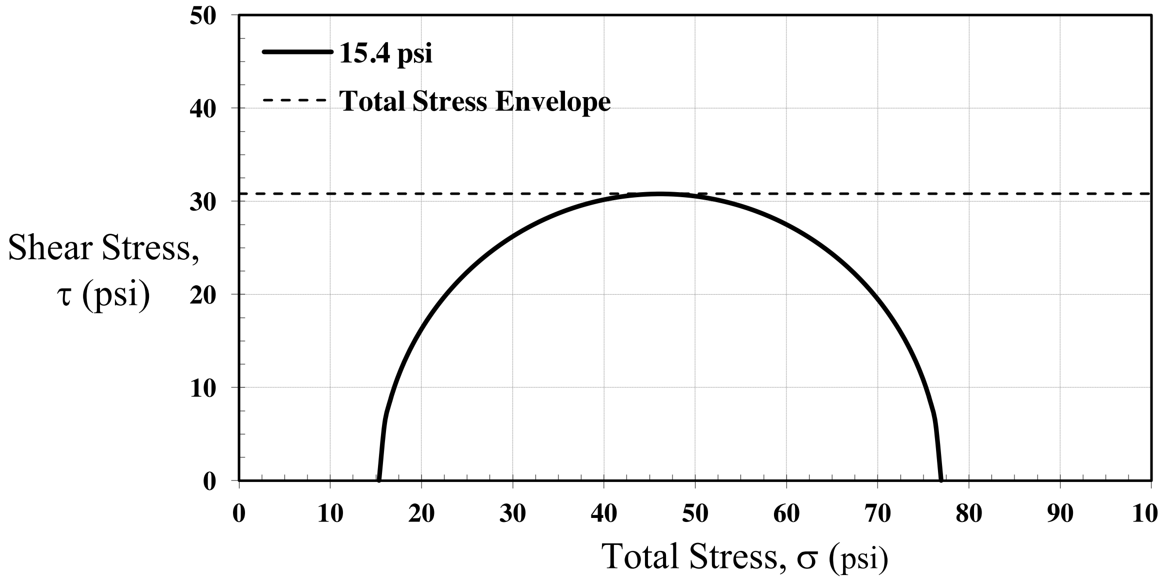
Test Parameters	
Minor Principal Stress (psi)	15.4
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	1.31
Avg. Height (in)	2.55
Avg. Water Content (%)	18.6
Bulk Density (pcf)	129.6
Dry Density (pcf)	109.2
Saturation (%)	95.9
Void Ratio	0.51
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	15.0
Minor Total Stress (psi)	15.4
Major Total Stress (psi)	77.0
Principal Stress Diff. (psi)	61.6

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	30.8
S_u / σ_3	2.0

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



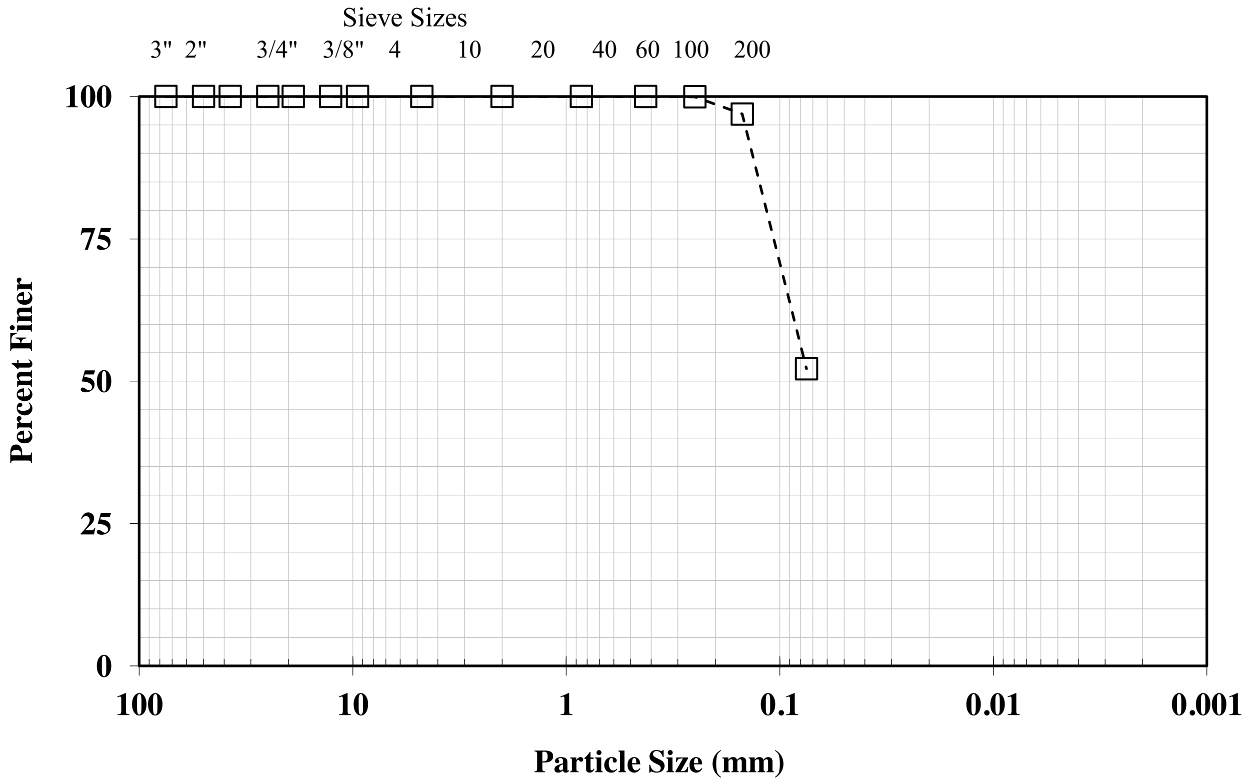
Jeffrey A. Kuhn , Ph.D., P.E., 6/30/2016

Analysis & Quality Review/Date

Laboratory Staff: LC

Particle Size Analysis for Soils

Client:	Auckland Consulting LLC	TRI Log#: 20888.13
Project:	Winston Pond	Test Method: ASTM D422
Sample:	B3 28-30	



Sieve Analysis		
Sieve Size		Percent Passing
3 in.	(76.2 mm)	100.0
2 in.	(50.8 mm)	100.0
1.5 in.	(38.1 mm)	100.0
1 in.	(25.4 mm)	100.0
3/4 in.	(19.0 mm)	100.0
1/2 in.	(12.7 mm)	100.0
3/8 in.	(9.51 mm)	100.0
No. 4	(4.76 mm)	100.0
No. 10	(2.00 mm)	100.0
No. 20	(0.841 mm)	100.0
No. 40	(0.420 mm)	100.0
No. 60	(0.250 mm)	99.9
No. 100	(0.149 mm)	96.9
No. 200	(0.074 mm)	52.2

Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	Sandy lean clay (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	11.9
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	29
	Plastic Limit	21
	Plastic Index	8
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
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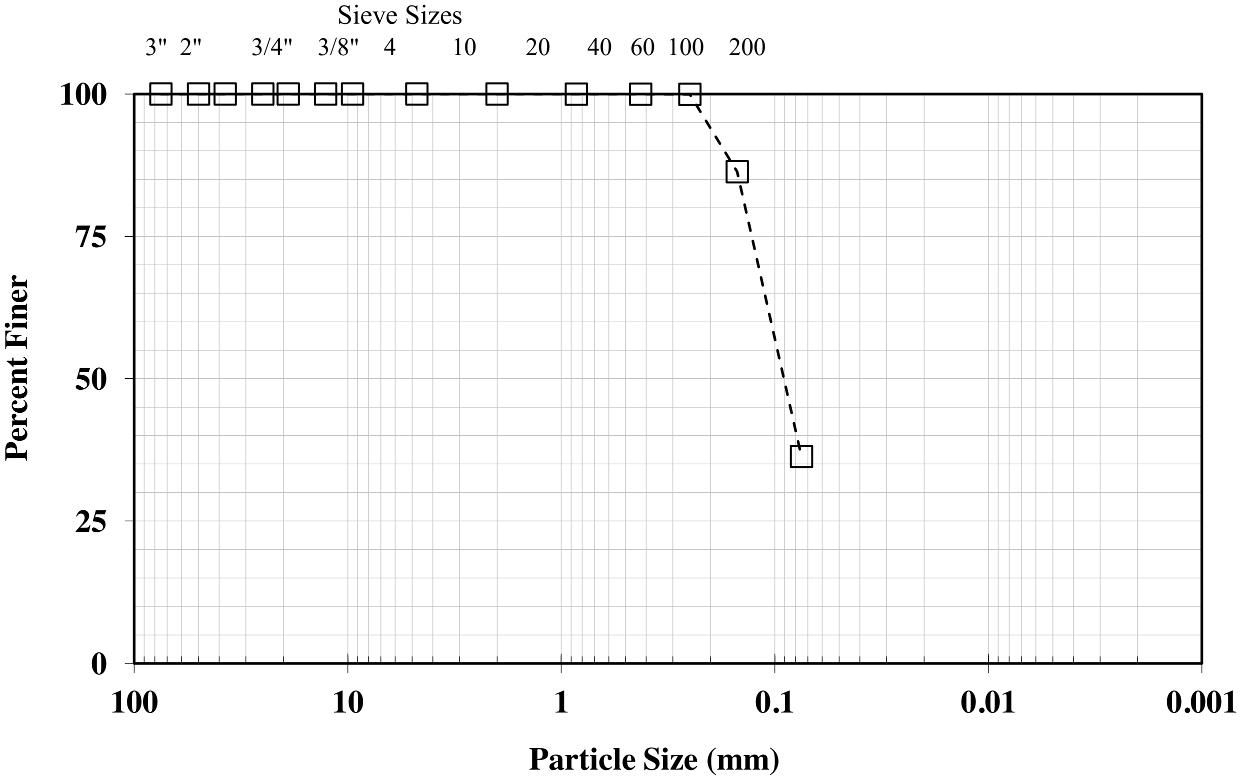
Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B6: 28-30

TRI Log#: 20888.20
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	100.0
No. 20 (0.841 mm)	100.0
No. 40 (0.420 mm)	100.0
No. 60 (0.250 mm)	99.9
No. 100 (0.149 mm)	86.3
No. 200 (0.074 mm)	36.3
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	Silty sand (SM)	
As-Received Moisture Content (%)	(ASTM D2216)	28.9
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	25
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
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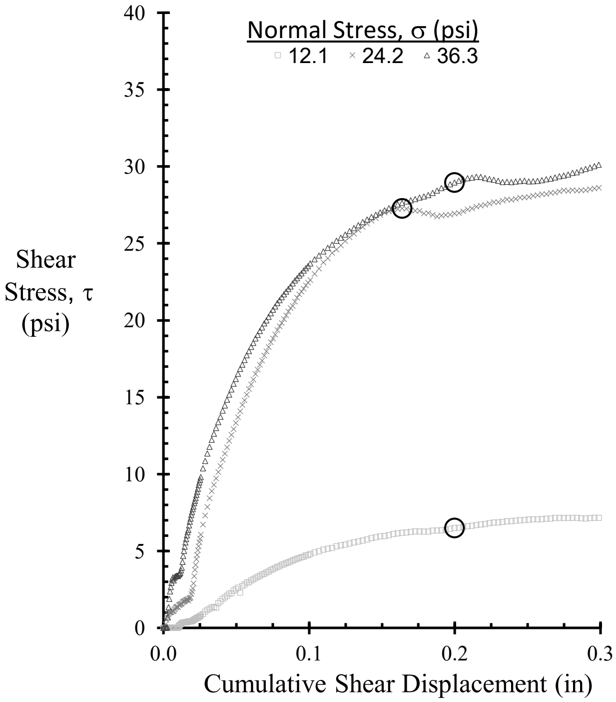
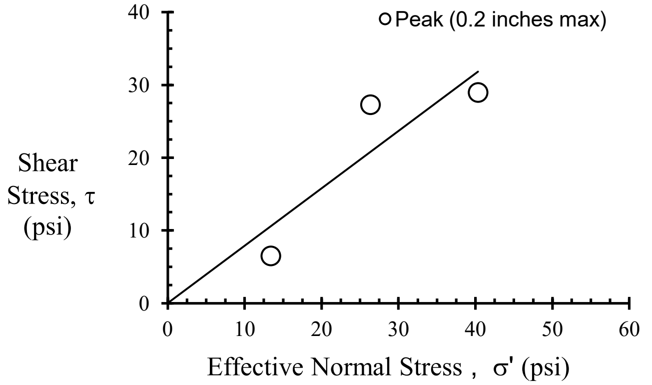
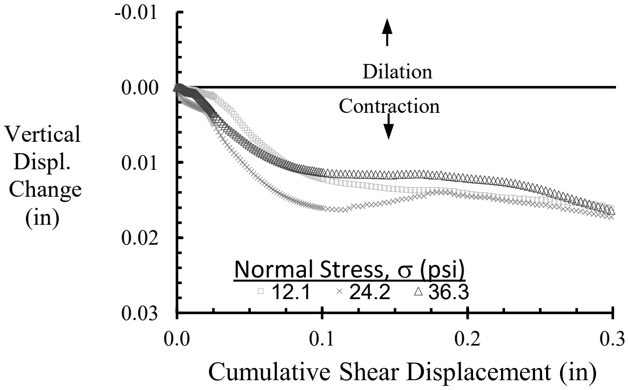
Direct Shear of Soil Under Consolidated-Drained Conditions

Client:	Auckland Consulting LLC	TRI Log#:	20888
Project:	Winston Pond	Test Method:	ASTM D 3080
Sample:	B6: 28-30		





Note: Area Correction Has Been Applied



	Sample Number	1	2	3
Initial Condition	Diameter, in	2.50	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	29.9	27.7	28.8
	Saturation, %	225.9	223.9	225.0
	Dry Density, pcf	122.4	124.5	123.4
	Void Ratio	0.35	0.33	0.34
Post Consol	Height, in (prior to shear)	0.94	0.96	0.97
	Final Water Content, %	25.5	21.5	21.9
	Dry Density, pcf	130.9	129.3	126.6
	Void Ratio	0.26	0.28	0.31
Displacement rate (in/min)		2.0E-03	2.0E-03	2.0E-03
Peak (0.2 inches)	Normal Stress, σ' (psi)	13.40	26.36	40.34
	Shear Stress, τ (psi)	6.50	27.28	28.96
	Displacement (in)	0.20	0.16	0.20
	ϕ'_d, degrees	38.3		
	c'_d, psi	0 (Forced)		

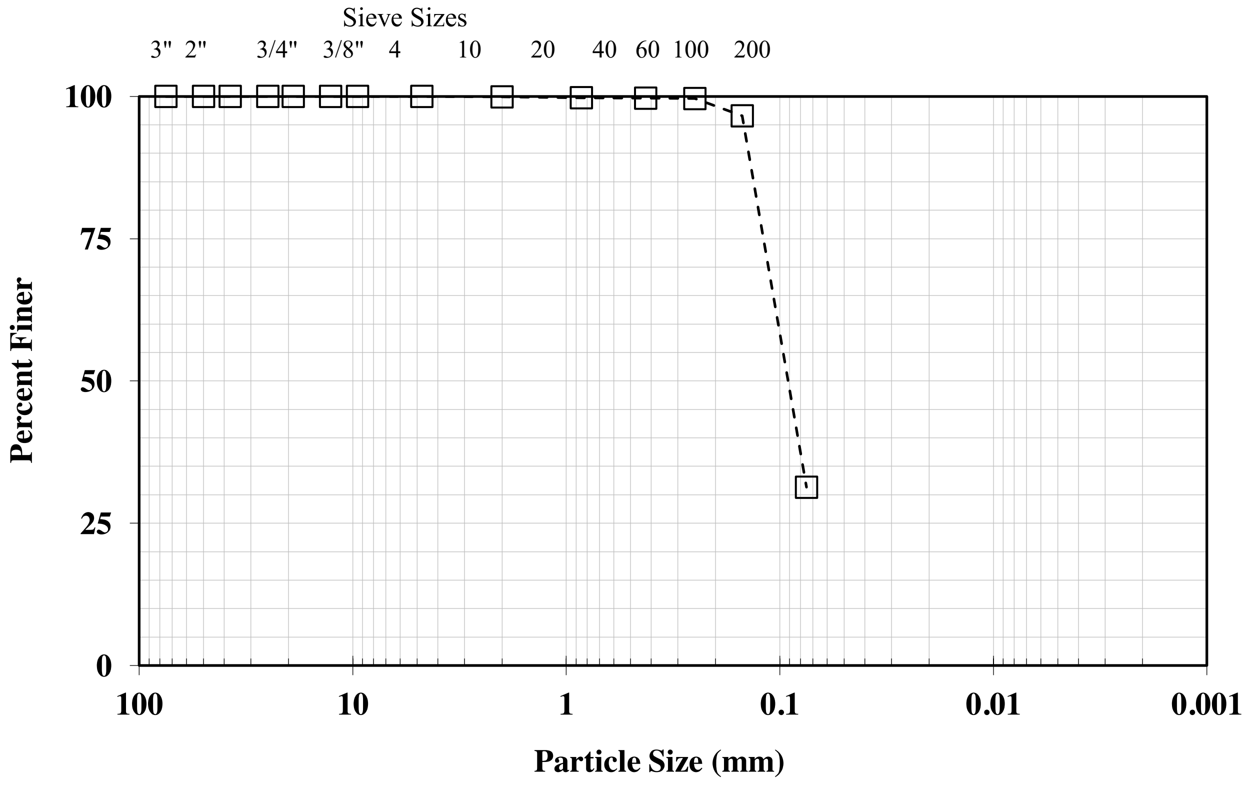
Note: The loose sample was tamped in place. A specific gravity of 2.65 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/16
Analysis & Quality Review/Date
Test Performed By: LC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B7 13-15

TRI Log#: 20888.24
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	99.9
No. 20 (0.841 mm)	99.8
No. 40 (0.420 mm)	99.7
No. 60 (0.250 mm)	99.6
No. 100 (0.149 mm)	96.6
No. 200 (0.074 mm)	31.3
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

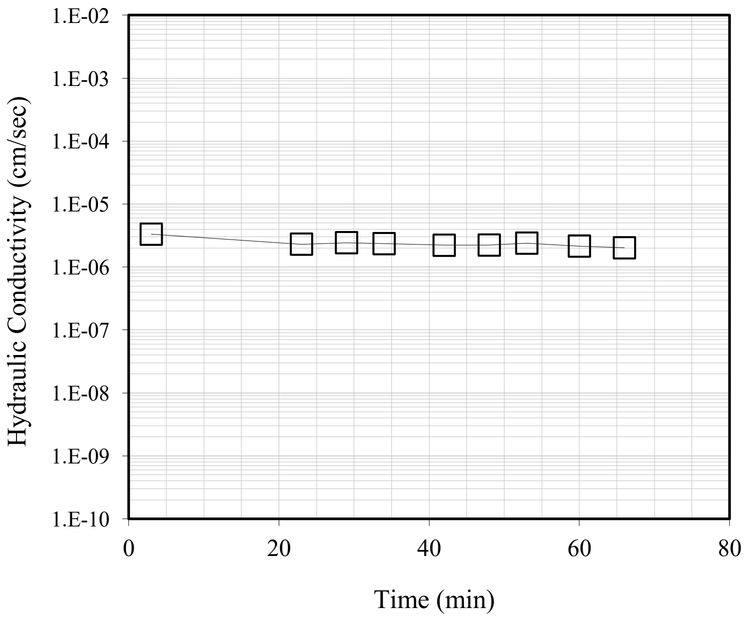
USCS Classification (ASTM D2487)	Silty sand (SM)	
As-Received Moisture Content (%)	(ASTM D2216)	25.6
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	24
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Hydraulic Conductivity

Client:	Auckland Consulting LLC
Project:	Winston Pond
Sample ID:	B7: 13-15

TRI Log #:	20888
Test Method:	ASTM D5084 Method C



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.80
Height (in)	2.21
Initial Mass (g)	444.2
Sample Area (in^2)	6.16
Water Content (%)	24.5
Total Unit Weight (pcf)	124.3
Dry Unit Weight (pcf)	99.9
Specific Gravity (Assumed)	2.65
Degree of Saturation	99.0
Void Ratio	0.66
Porosity	0.40
1 Pore Volume (cc)	88.3
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.99

Specimen Image

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
48.0	2.2E-06
53.0	2.4E-06
60.0	2.2E-06
66.0	2.0E-06
Average, Last 4 Readings	**2.2E-06**

Note: Permeation measurements were made with a mercury U-tube.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016

Analysis & Quality Review/Date

Testing Performed By: SOC & LC

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
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Unconsolidated-Undrained (Q) Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B8: 3-5

TRI Log #: 20888
Test Method: ASTM D2850

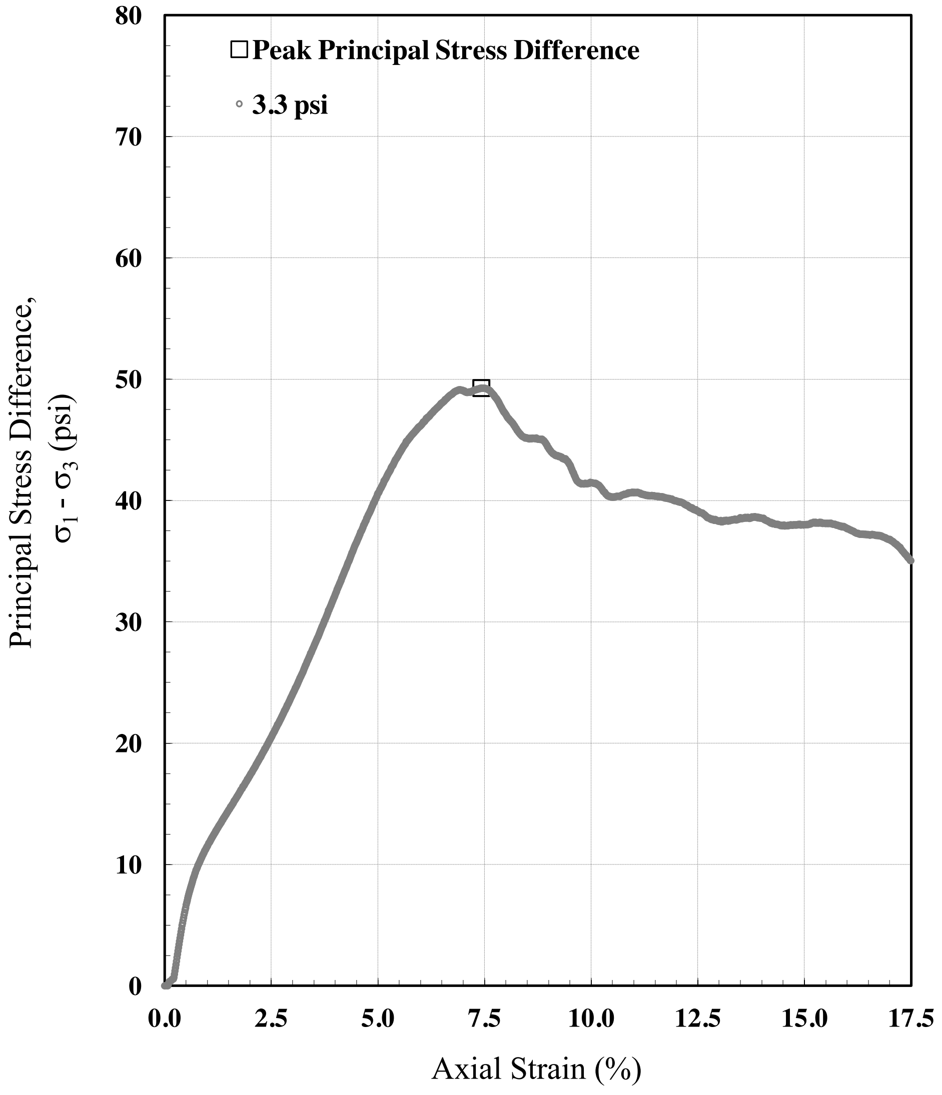
Test Parameters	
Minor Principal Stress (psi)	3.3
Rate of Strain (%/hr)	60

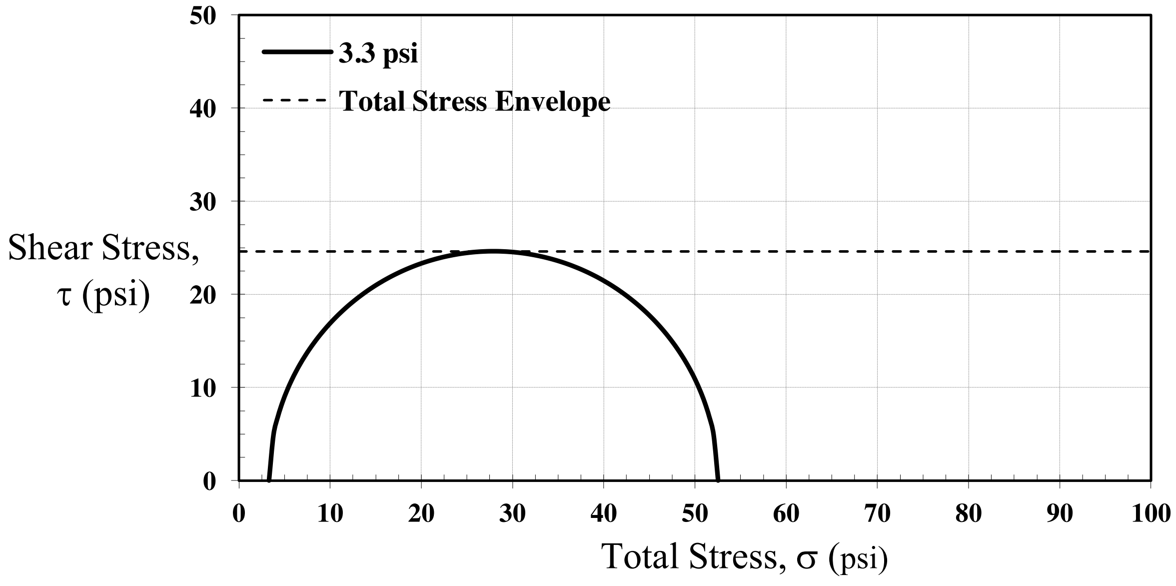
Initial Properties	
Avg. Diameter (in)	2.80
Avg. Height (in)	5.60
Avg. Water Content (%)	15.2
Bulk Density (pcf)	132.9
Dry Density (pcf)	115.4
Saturation (%)	92.8
Void Ratio	0.43
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	7.4
Minor Total Stress (psi)	3.3
Major Total Stress (psi)	52.6
Principal Stress Diff. (psi)	49.3

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	24.6
S_u / σ_3	7.5

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.

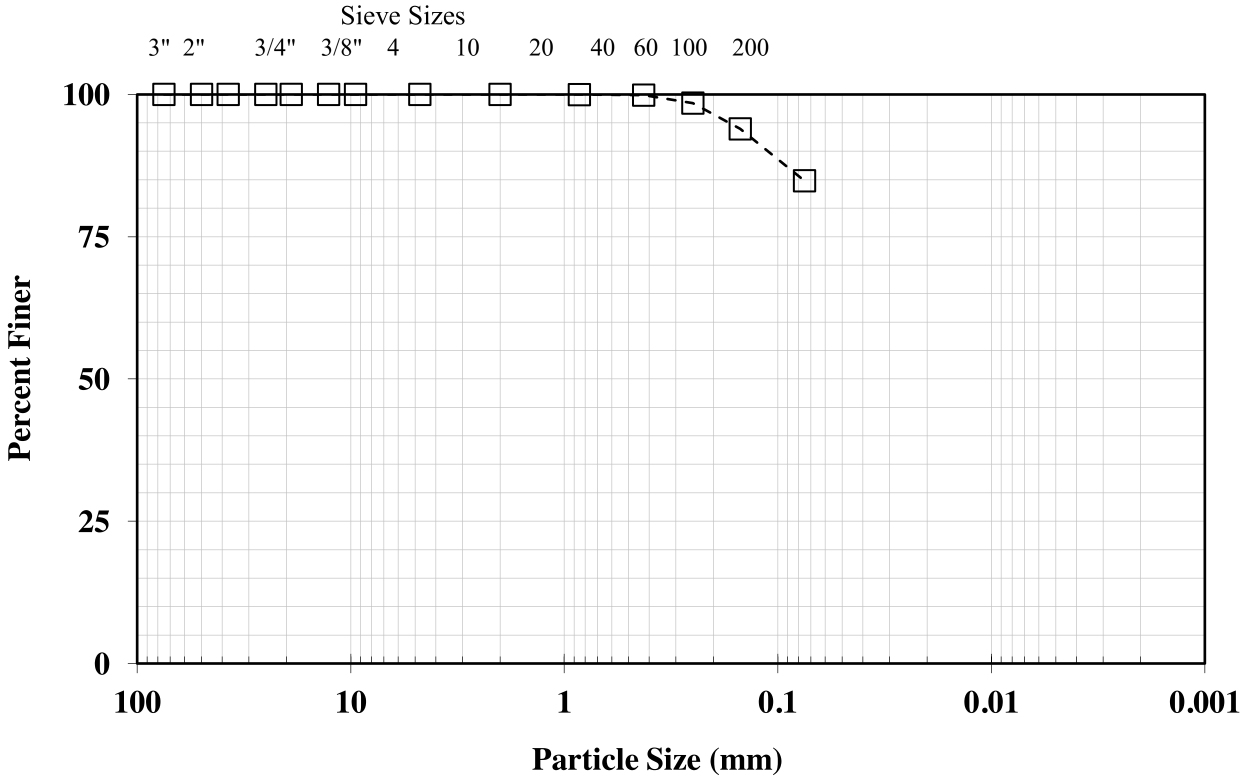




Jeffrey A. Kuhn , Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

Particle Size Analysis for Soils

Client:	Auckland Consulting LLC	TRI Log#:	20888.32
Project:	Winston Pond	Test Method:	ASTM D422
Sample:	B8 38-40		



Sieve Analysis		
Sieve Size		Percent Passing
3 in.	(76.2 mm)	100.0
2 in.	(50.8 mm)	100.0
1.5 in.	(38.1 mm)	100.0
1 in.	(25.4 mm)	100.0
3/4 in.	(19.0 mm)	100.0
1/2 in.	(12.7 mm)	100.0
3/8 in.	(9.51 mm)	100.0
No. 4	(4.76 mm)	100.0
No. 10	(2.00 mm)	100.0
No. 20	(0.841 mm)	100.0
No. 40	(0.420 mm)	99.9
No. 60	(0.250 mm)	98.5
No. 100	(0.149 mm)	93.9
No. 200	(0.074 mm)	84.8
Hydrometer Analysis		
Particle Size		Percent Passing
0.005 mm		- -
0.002 mm		- -

USCS Classification (ASTM D2487)	- -	
As-Received Moisture Content (%)	(ASTM D2216)	28.8
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	- -
	Plastic Limit	- -
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

TRI Log #: 21381
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	5.0	10.0	15.0
Initial Specimen Properties			
Avg. Diameter (in)	1.95	1.96	1.97
Avg. Height (in)	4.39	4.33	4.24
Avg. Water Content (%)	18.1	-	-
Bulk Density (pcf)	128.7	129.5	130.6
Dry Density (pcf)	109.0	-	-
Saturation (%)	89.4	-	-
Void Ratio, n	0.55	0.54	0.52
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	81.0	80.9	80.9
B-Value, End of Saturation	0.97	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.54	0.52	0.51
Area (in^2)	2.98	3.00	3.04

Shear / Post-Shear			
Avg. Water Content (%)	-	-	20.6
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	0.8	1.3	1.6
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	2.7	6.1	11.1
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	9.1	16.6	25.8
Pore Water Pressure, Δu_f (psi)	-	-	-	2.5	4.2	4.2
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	11.8	22.7	36.9
Effective Friction Angle (degrees)	-			29.9		
Effective Cohesion (psi)	-			1.2		

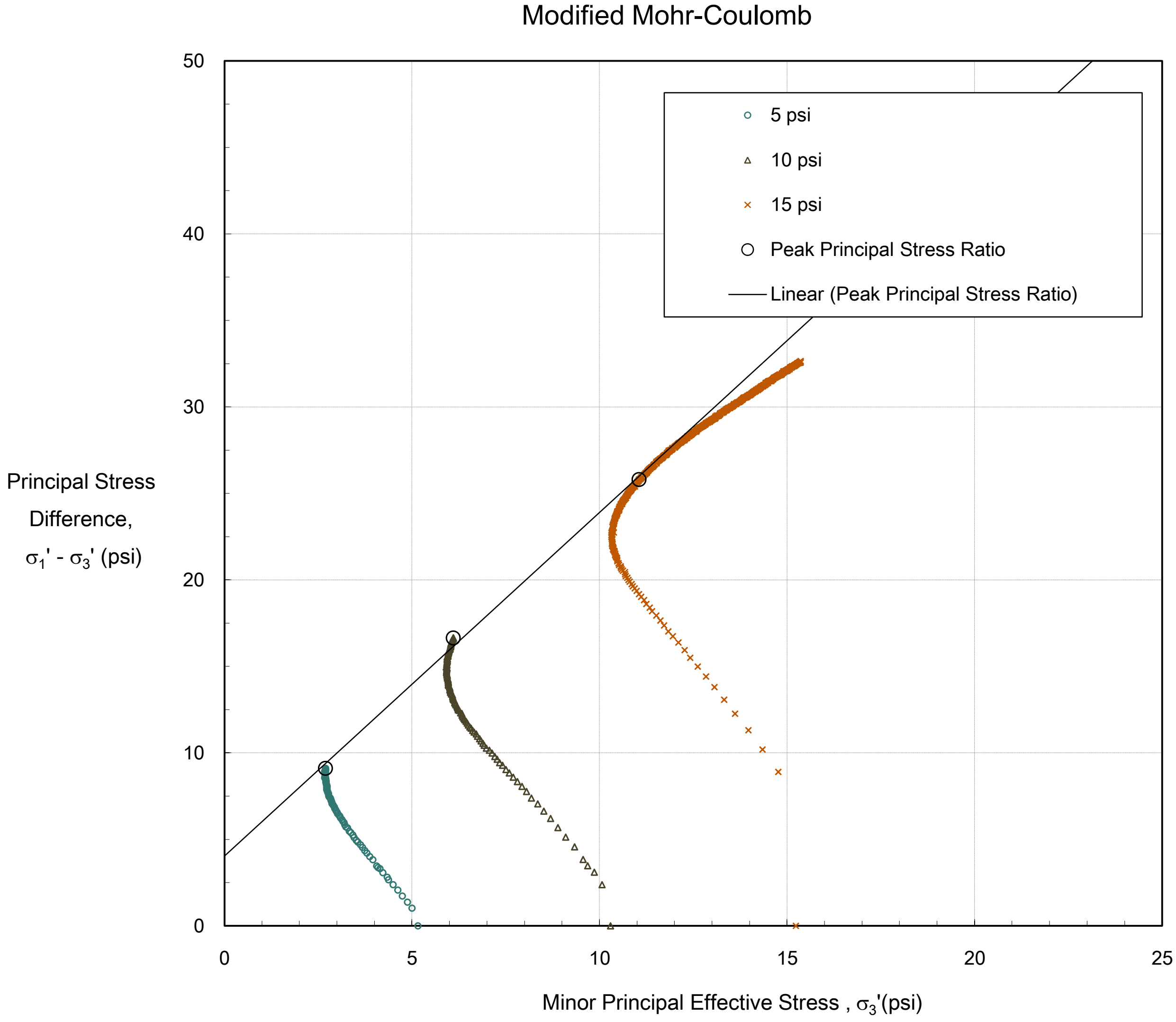
R-Envelope, "Total" Stress		
Friction Angle (deg)	-	26.9
Cohesion (psi)	-	0.1

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

Jeffrey A. Kuhn , Ph.D., P.E., 7/12/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	21381
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B-4 (3-5)		

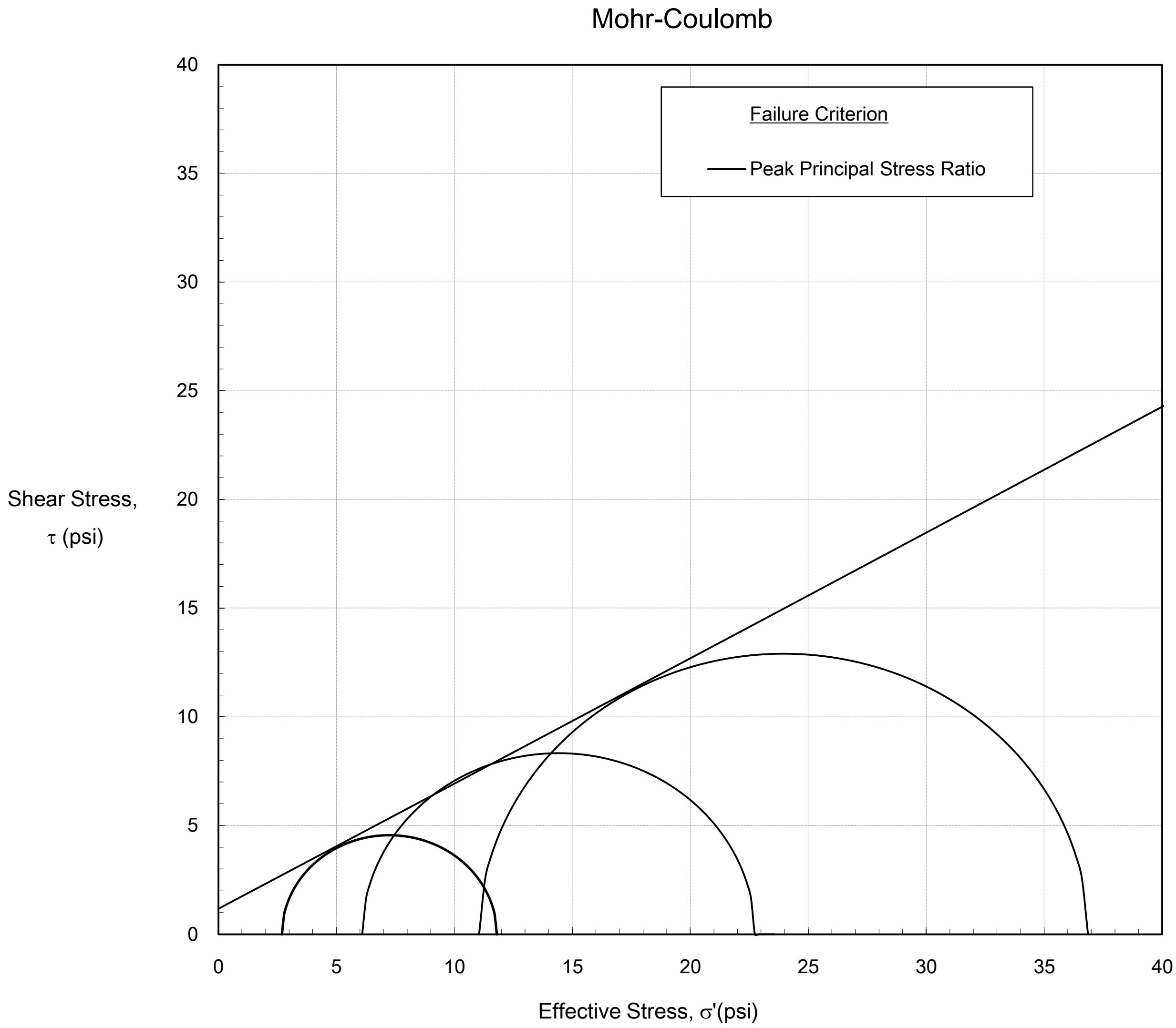


Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	29.9
Effective Cohesion (psi)	-	1.2

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

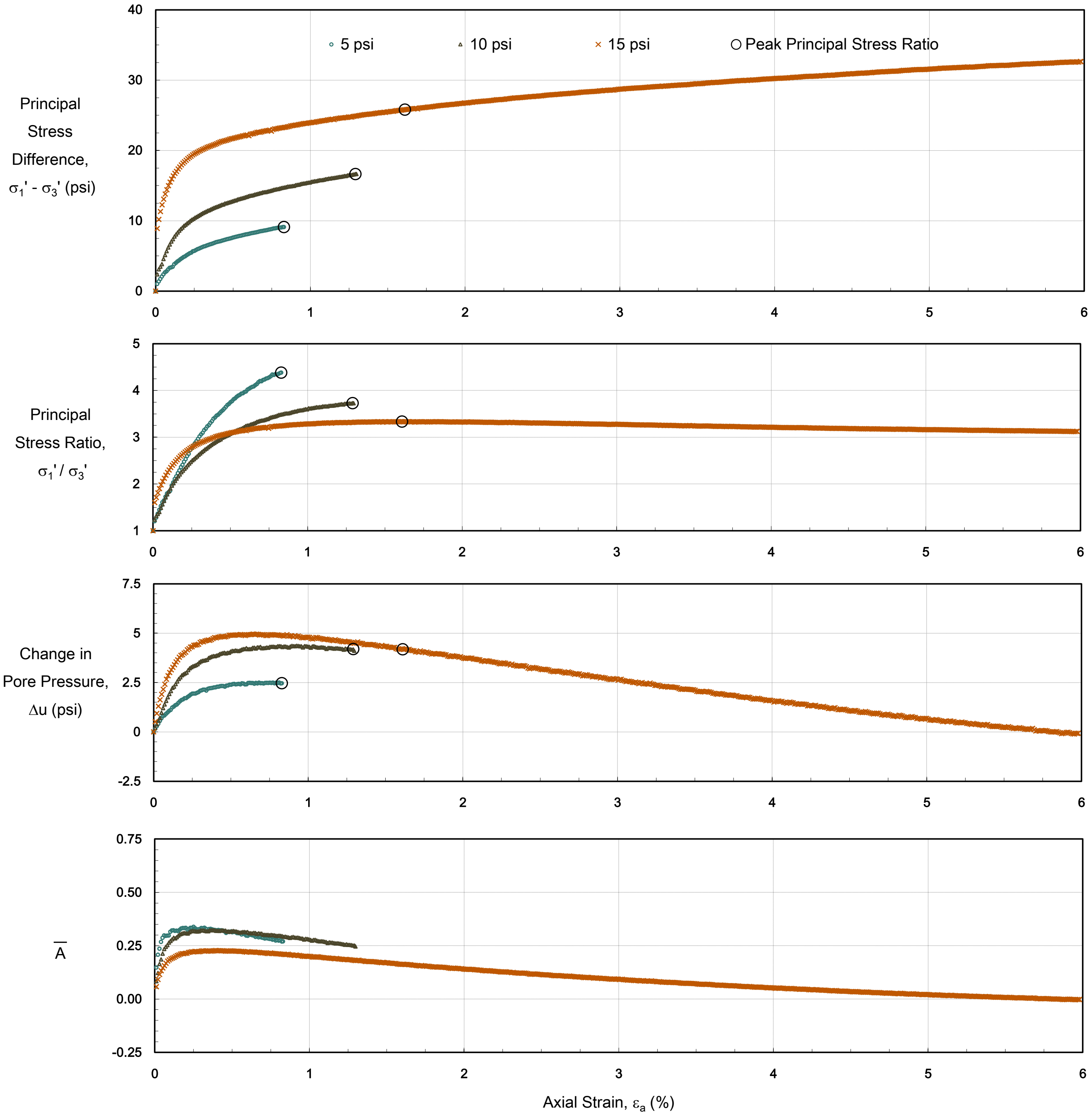
TRI Log #: 21381
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	29.9
Effective Cohesion (psi)	-	1.2

Multi-Stage Consolidated-Undrained Triaxial Compression

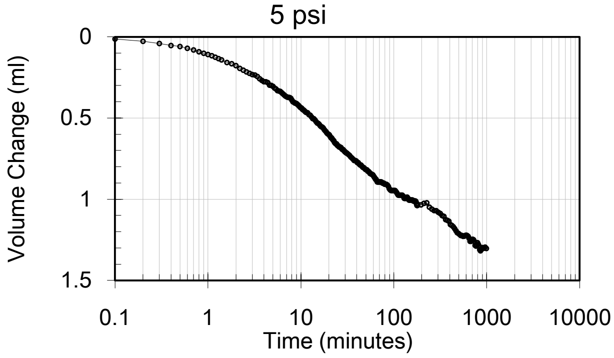
Client:	Auckland Consulting LLC	TRI Log #:	21381
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B-4 (3-5)		

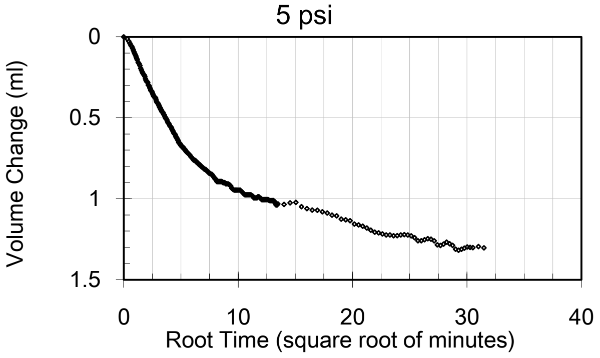


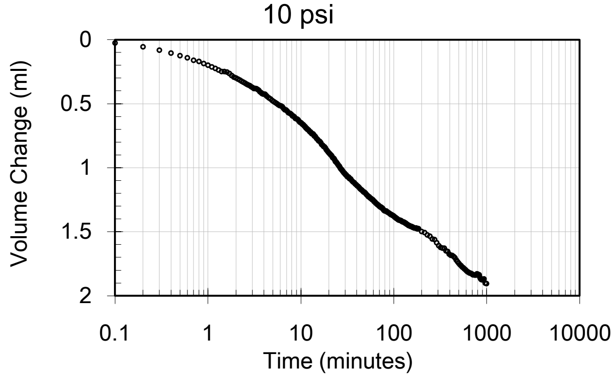
Multi-Stage Consolidated-Undrained Triaxial Compression

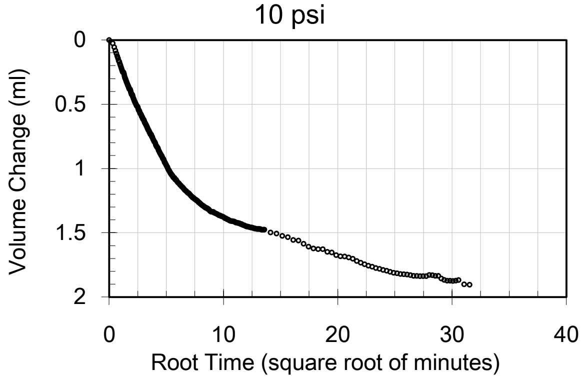
Client:	Auckland Consulting LLC	TRI Log #:	21381
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B-4 (3-5)		

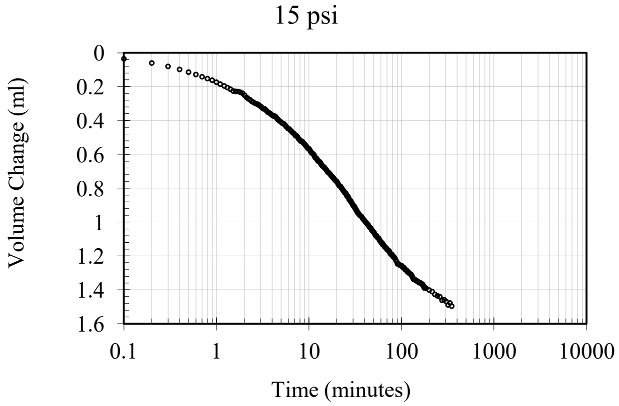
Consolidation

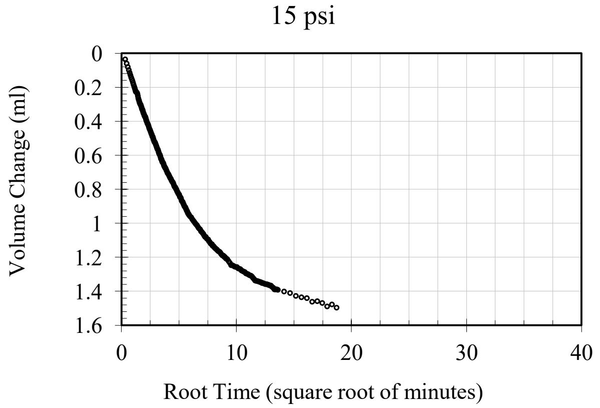












TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
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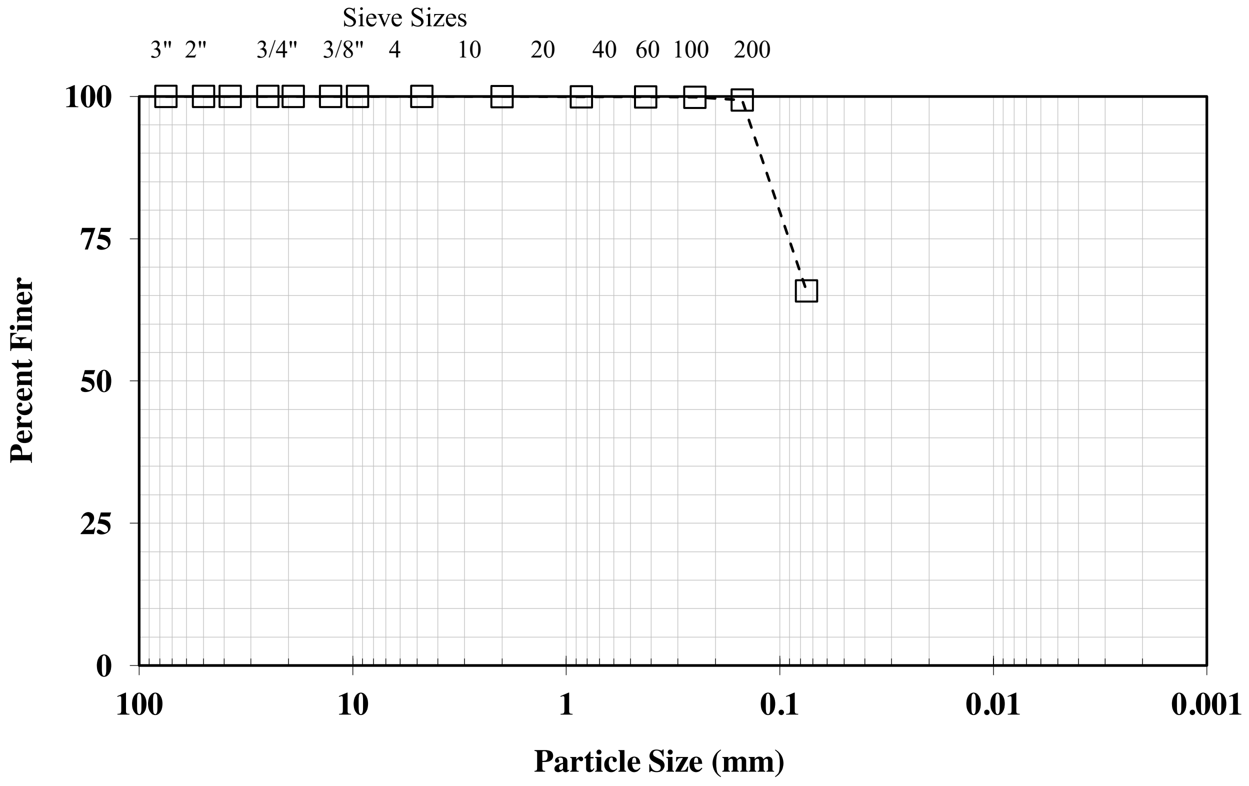
Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (8-10)

TRI Log#: 21381.3
Test Method: ASTM D422



Sieve Analysis		
Sieve Size		Percent Passing
3 in.	(76.2 mm)	100.0
2 in.	(50.8 mm)	100.0
1.5 in.	(38.1 mm)	100.0
1 in.	(25.4 mm)	100.0
3/4 in.	(19.0 mm)	100.0
1/2 in.	(12.7 mm)	100.0
3/8 in.	(9.51 mm)	100.0
No. 4	(4.76 mm)	100.0
No. 10	(2.00 mm)	100.0
No. 20	(0.841 mm)	99.9
No. 40	(0.420 mm)	99.9
No. 60	(0.250 mm)	99.8
No. 100	(0.149 mm)	99.4
No. 200	(0.074 mm)	65.8

Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

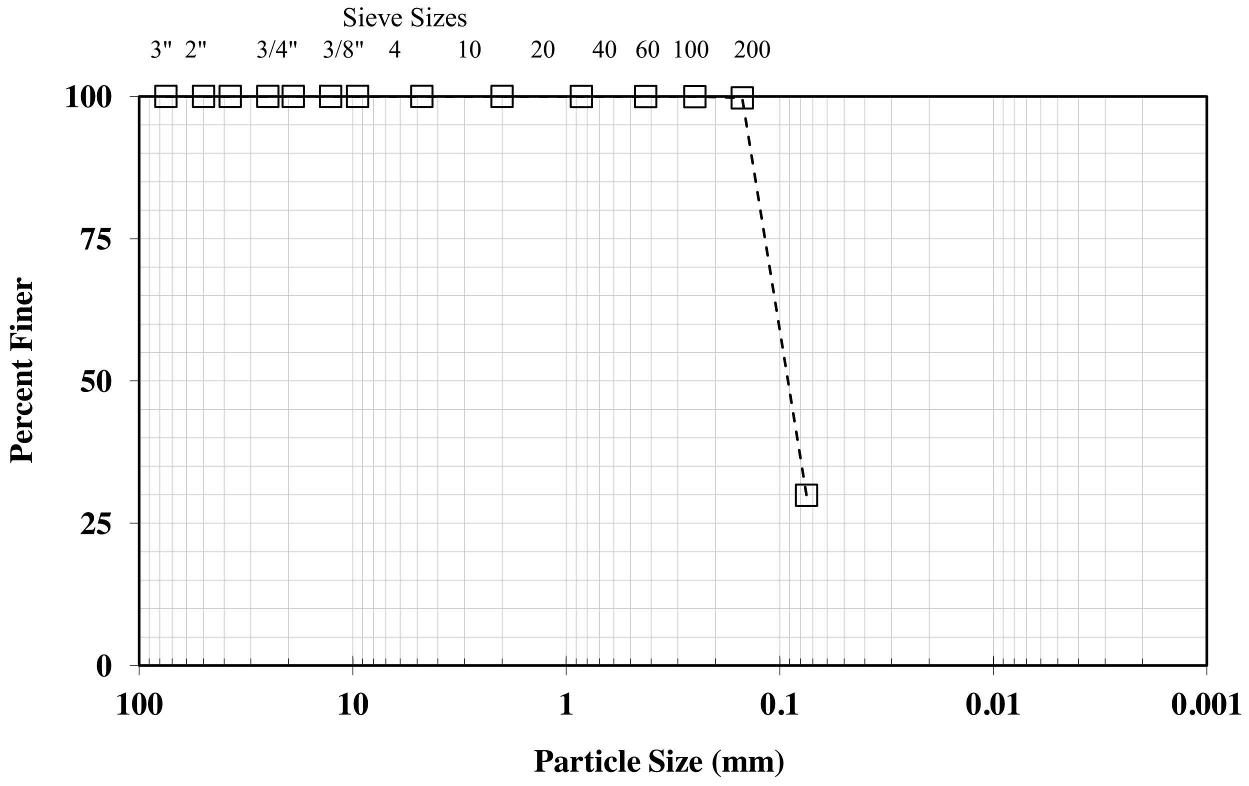
USCS Classification (ASTM D2487)	Sandy lean clay (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	16.3
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	33
	Plastic Limit	20
	Plastic Index	13
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (33-35)

TRI Log#: 21381.7
Test Method: ASTM D422



Sieve Analysis		
Sieve Size		Percent Passing
3 in.	(76.2 mm)	100.0
2 in.	(50.8 mm)	100.0
1.5 in.	(38.1 mm)	100.0
1 in.	(25.4 mm)	100.0
3/4 in.	(19.0 mm)	100.0
1/2 in.	(12.7 mm)	100.0
3/8 in.	(9.51 mm)	100.0
No. 4	(4.76 mm)	100.0
No. 10	(2.00 mm)	100.0
No. 20	(0.841 mm)	100.0
No. 40	(0.420 mm)	100.0
No. 60	(0.250 mm)	100.0
No. 100	(0.149 mm)	99.7
No. 200	(0.074 mm)	29.9

Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	Silty sand (SM)	
As-Received Moisture Content (%)	(ASTM D2216)	29.6
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	26
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES

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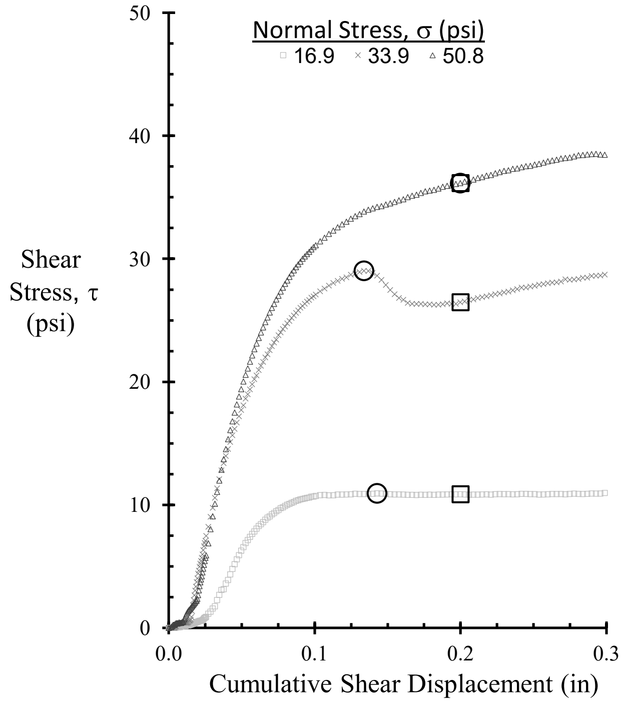
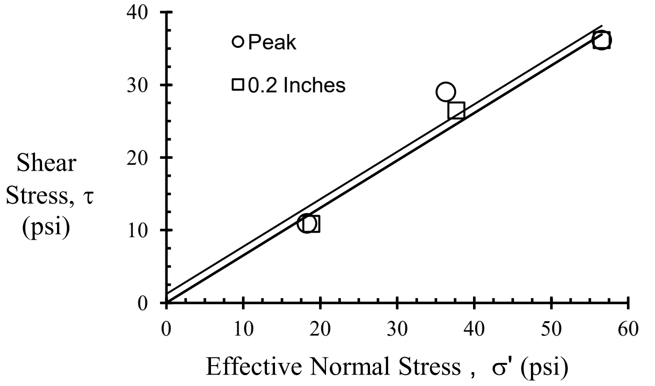
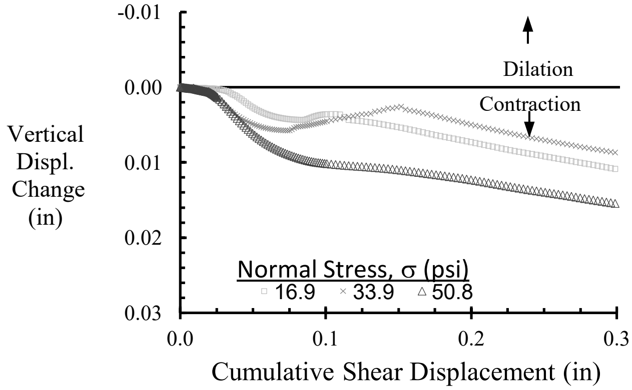
Direct Shear of Soil Under Consolidated-Drained Conditions

Client:	Auckland Consulting LLC	TRI Log#:	21381
Project:	Winston Pond	Test Method:	ASTM D 3080
Sample:	B-4 (38-40)		





Note: Area Correction Has Been Applied



	Sample Number	1	2	3
Initial Condition	Diameter, in	2.50	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	24.7	24.9	24.9
	Saturation, %	155.9	156.2	156.2
	Dry Density, pcf	116.4	116.3	116.3
	Void Ratio	0.42	0.42	0.42
Post Consol	Height, in (prior to shear)	1.00	1.00	0.99
	Final Water Content, %	23.9	25.0	23.6
	Dry Density, pcf	116.9	116.5	117.2
	Void Ratio	0.41	0.42	0.41
	Displacement rate (in/min)	2.0E-03	2.0E-03	2.0E-03
Peak	Normal Stress, σ' (psi)	18.26	36.30	56.54
	Shear Stress, τ (psi)	10.94	29.03	36.15
	Displacement (in)	0.14	0.13	0.20
	ϕ'_d, degrees	33.1		
	c'_d, psi	1.2		
Post-Peak	Normal Stress, σ' (psi)	18.83	37.66	56.54
	Shear Stress, τ (psi)	10.87	26.47	36.15
	Displacement (in)	0.20	0.20	0.20
	ϕ'_d, degrees	33.1		
	c'_d, psi	0 (Forced)		

Note: The loose sample was tamped in place. A specific gravity of 2.65 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/16

Analysis & Quality Review/Date

Test Performed By: LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

TRI Log #: 21381
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	5.0	10.0	15.0
Initial Specimen Properties			
Avg. Diameter (in)	1.85	1.85	1.87
Avg. Height (in)	4.51	4.44	4.35
Avg. Water Content (%)	17.6	-	-
Bulk Density (pcf)	139.6	141.0	142.1
Dry Density (pcf)	118.7	-	-
Saturation (%)	100.0	-	-
Void Ratio, n	0.42	0.41	0.40
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	80.7	80.8	81.5
B-Value, End of Saturation	0.94	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.41	0.40	0.38
Area (in^2)	2.67	2.68	2.72

Shear / Post-Shear			
Avg. Water Content (%)	-	-	19.1
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	0.6	1.3	1.4
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	4.3	5.6	9.9
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	9.2	11.7	23.4
Pore Water Pressure, Δu_f (psi)	-	-	-	0.7	2.8	3.4
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	13.5	17.3	33.3
Effective Friction Angle (degrees)	-			32.3		
Effective Cohesion (psi)	-			0 (Forced)		

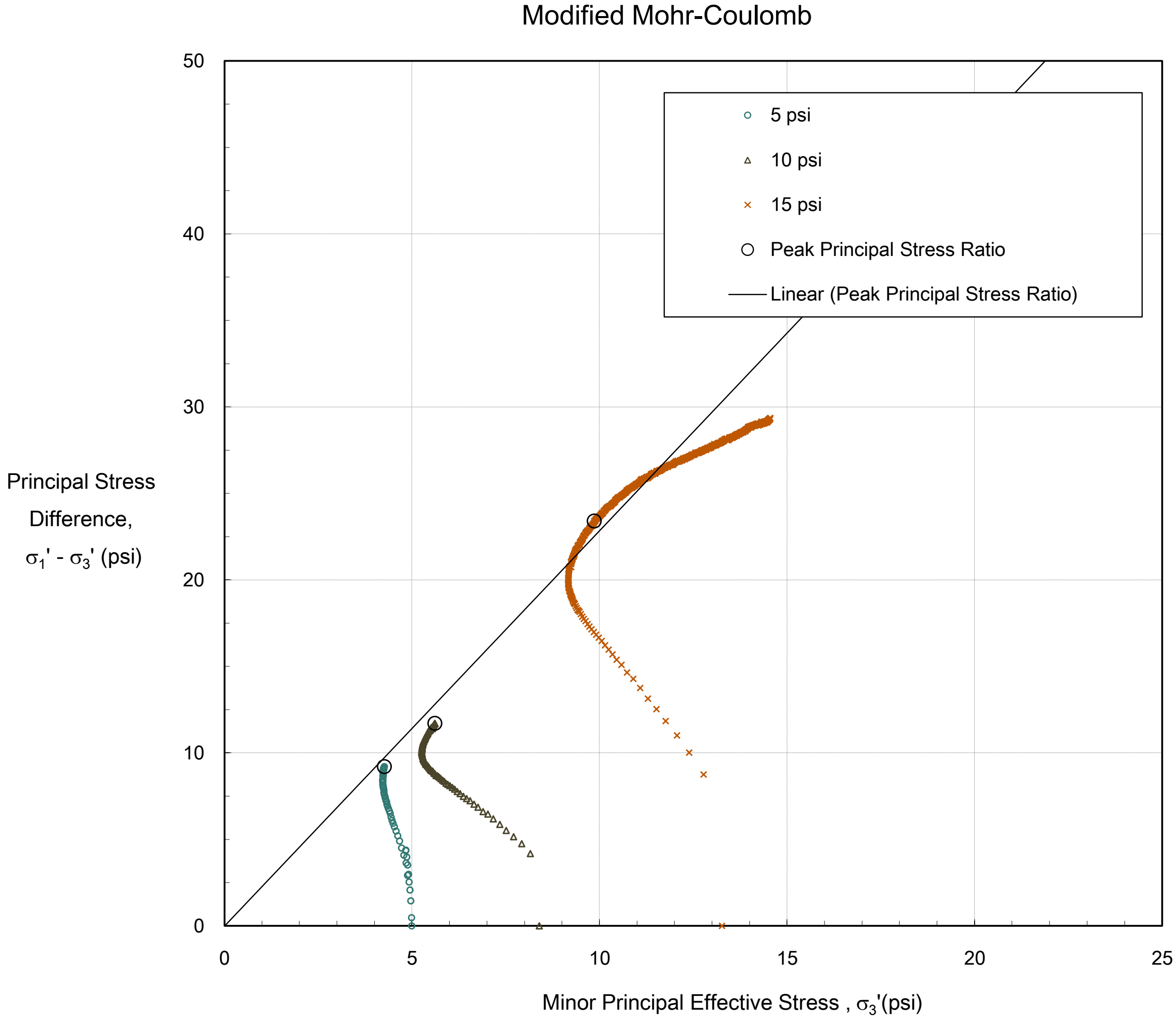
R-Envelope, "Total" Stress		
Friction Angle (deg)	-	27.1
Cohesion (psi)	-	0 (Forced)

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

Jeffrey A. Kuhn , Ph.D., P.E., 7/12/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

Multi-Stage Consolidated-Undrained Triaxial Compression

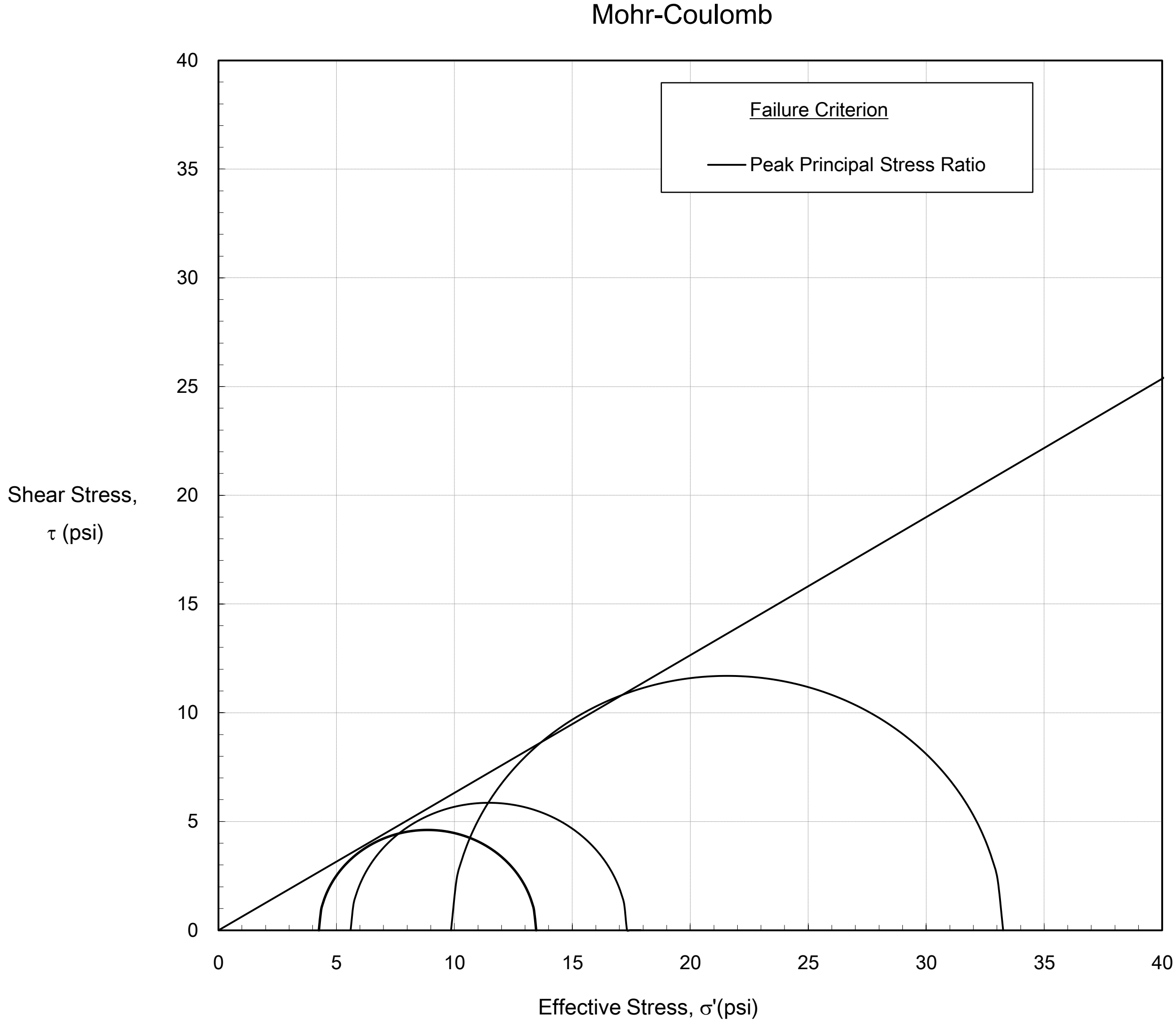
Client:	Auckland Consulting LLC	TRI Log #:	21381
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B-5 (5-7)		



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	32.3
Effective Cohesion (psi)	-	0 (Forced)

Multi-Stage Consolidated-Undrained Triaxial Compression

Client:	Auckland Consulting LLC	TRI Log #:	21381
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B-5 (5-7)		

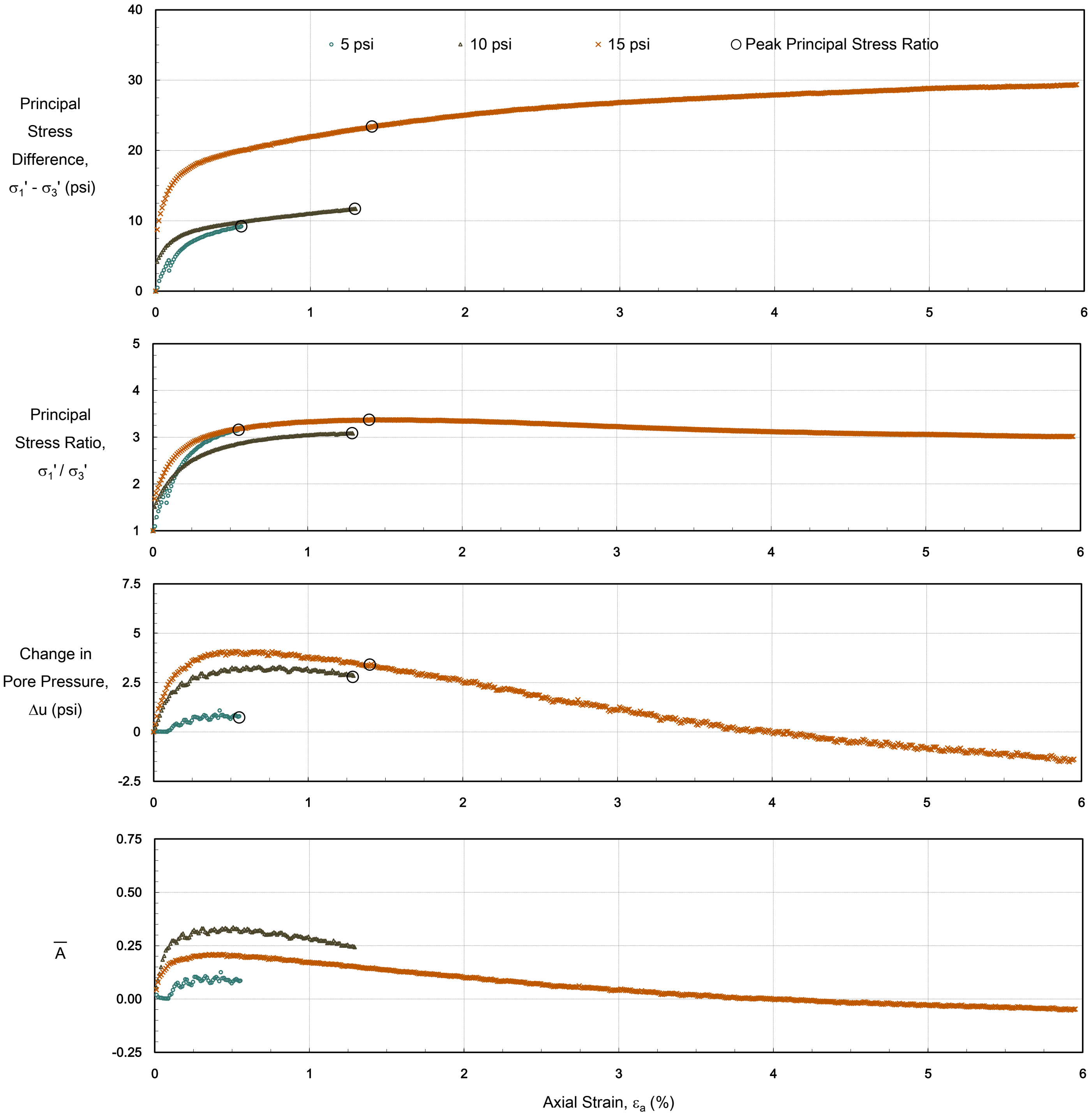


Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	32.3
Effective Cohesion (psi)	-	0 (Forced)

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

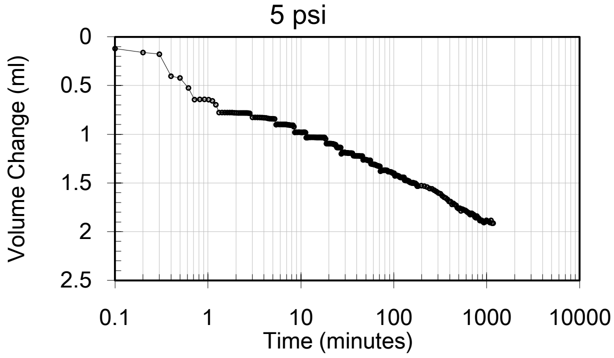
TRI Log #: 21381
Test Method: ASTM D4767 Mod

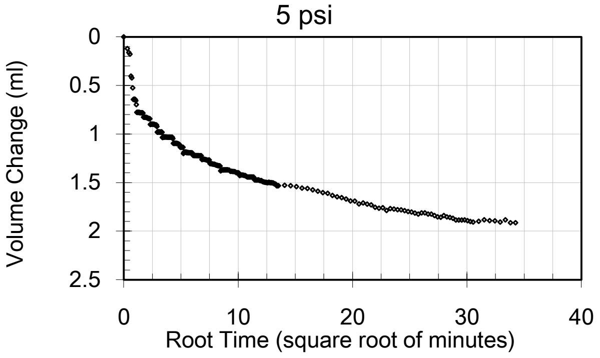


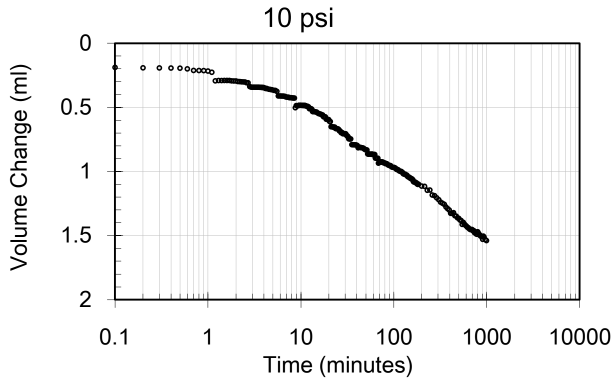
Multi-Stage Consolidated-Undrained Triaxial Compression

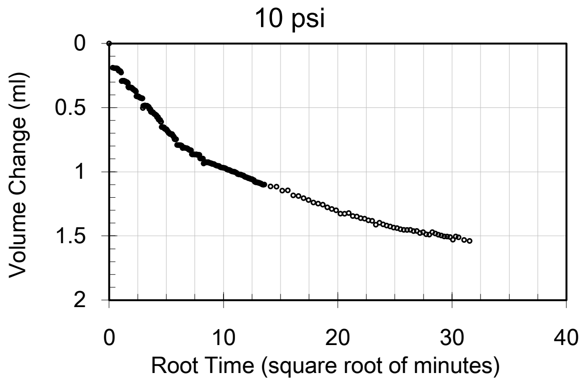
Client:	Auckland Consulting LLC	TRI Log #:	21381
Project:	Winston Pond	Test Method:	ASTM D4767 Mod
Sample:	B-5 (5-7)		

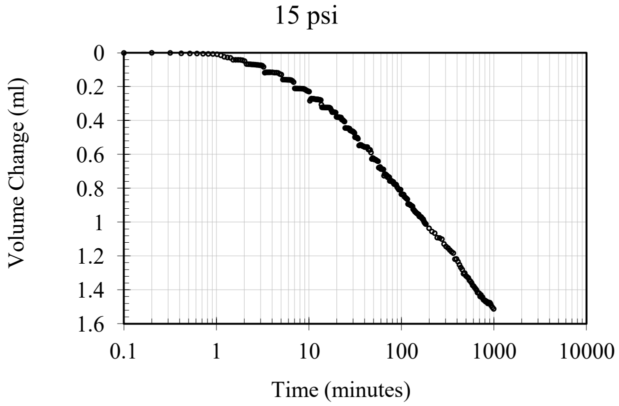
Consolidation

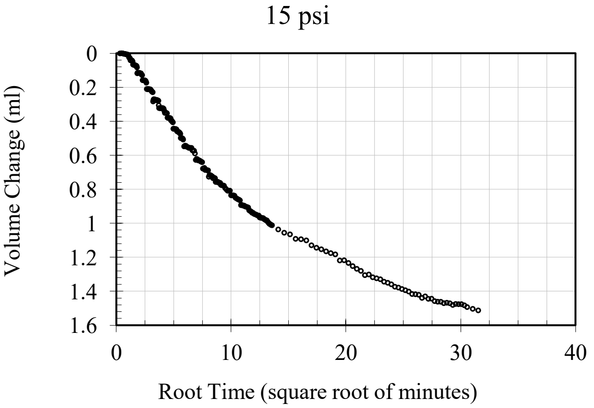








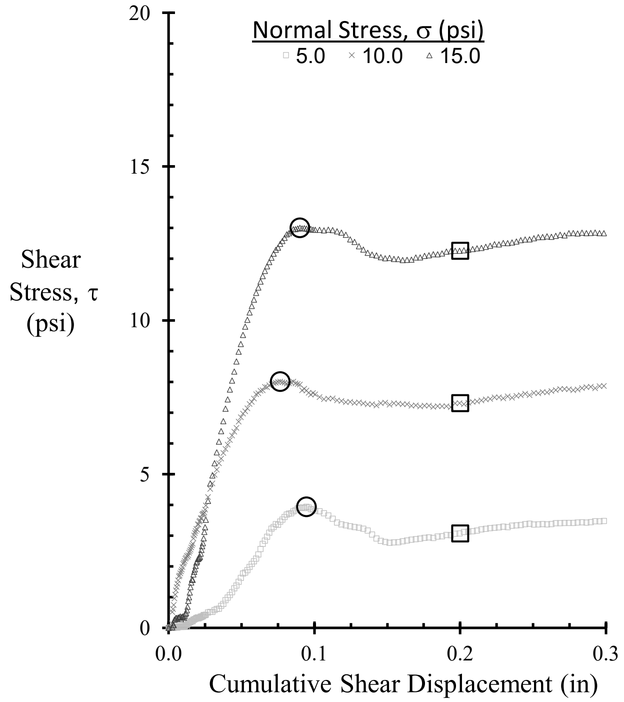


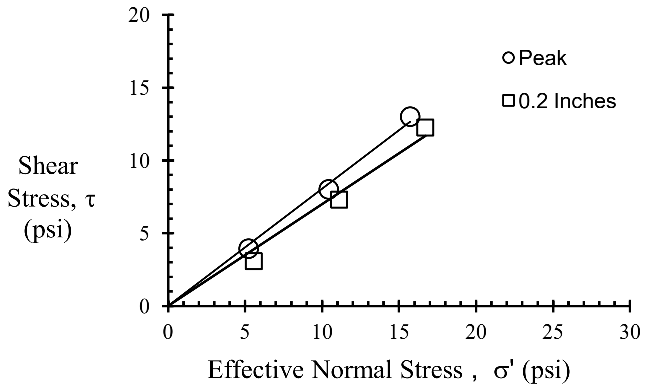


TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
AUSTIN, TX - USA | ANAHEIM, CA - USA | ANDERSON, SC - USA | GOLD COAST - AUSTRALIA | SUZHOU - CHINA

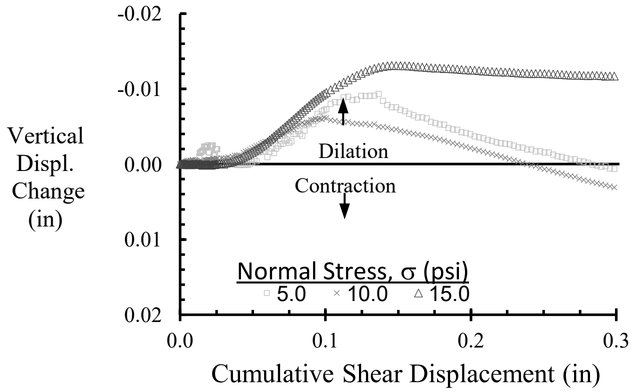
Direct Shear of Soil Under Consolidated-Drained Conditions

Client:	Auckland Consulting LLC	TRI Log#:	21381
Project:	Winston Pond	Test Method:	ASTM D 3080
Sample:	B-5 (13-15)		





Note: Area Correction Has Been Applied



	Sample Number	1	2	3
Initial Condition	Diameter, in	2.50	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	16.9	16.0	15.6
	Saturation, %	83.9	83.6	89.1
	Dry Density, pcf	107.9	109.7	112.9
	Void Ratio	0.53	0.51	0.46
Post Consol	Height, in (prior to shear)	1.00	1.00	1.00
	Final Water Content, %	21.1	20.9	19.2
	Dry Density, pcf	108.0	109.9	113.3
	Void Ratio	0.53	0.50	0.46
Displacement rate (in/min)		6.0E-04	6.0E-04	6.0E-04
Peak	Normal Stress, σ' (psi)	5.23	10.43	15.72
	Shear Stress, τ (psi)	3.94	8.01	13.01
	Displacement (in)	0.09	0.08	0.09
	ϕ'$_d$, degrees	38.8		
	c'$_d$, psi	0 (Forced)		
Post-Peak	Normal Stress, σ' (psi)	5.56	11.12	16.70
	Shear Stress, τ (psi)	3.07	7.31	12.26
	Displacement (in)	0.20	0.20	0.20
	ϕ'$_d$, degrees	35.0		
	c'$_d$, psi	0 (Forced)		

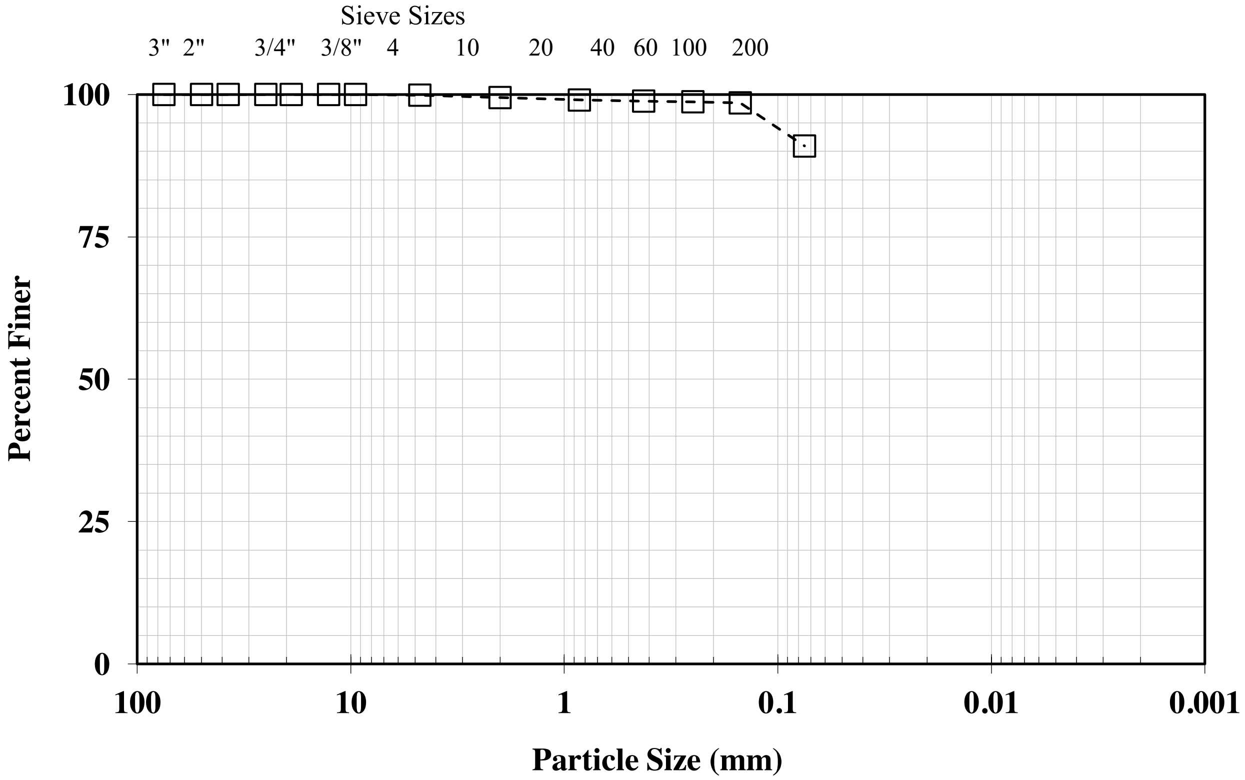
Note: The undisturbed soil samples were extruded and trimmed using a trimming turntable. A specific gravity of 2.65 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/16
Analysis & Quality Review/Date
Test Performed By: LC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (33-35)

TRI Log#: 21381.16
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	99.9
No. 10 (2.00 mm)	99.5
No. 20 (0.841 mm)	99.0
No. 40 (0.420 mm)	98.8
No. 60 (0.250 mm)	98.7
No. 100 (0.149 mm)	98.5
No. 200 (0.074 mm)	90.9
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	Silt (ML)	
As-Received Moisture Content (%)	(ASTM D2216)	27.1
Atterberg Limits	Liquid Limit	28
(ASTM D4318,	Plastic Limit	NP
Method A : Multipoint)	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

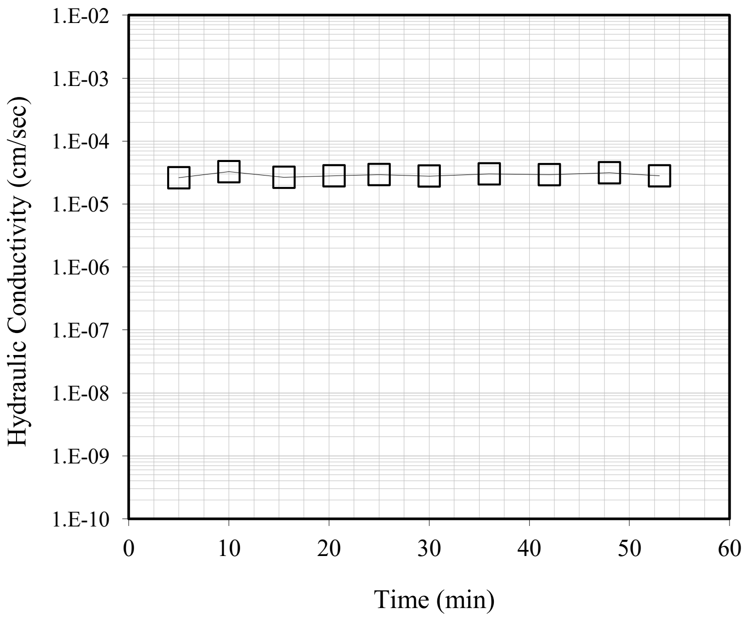
Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
AUSTIN, TX - USA | ANAHEIM, CA - USA | ANDERSON, SC - USA | GOLD COAST - AUSTRALIA | SUZHOU - CHINA

Hydraulic Conductivity

Client: Auckland Consulting LLC
Project: Winston Pond
Sample ID: B-5: (33-35)

TRI Log #: 21381
Test Method: ASTM D5084 Method C



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.80
Height (in)	2.55
Initial Mass (g)	500.5
Sample Area (in^2)	6.16
Water Content (%)	26.4
Total Unit Weight (pcf)	121.4
Dry Unit Weight (pcf)	96.1
Specific Gravity (Assumed)	2.65
Degree of Saturation	96.9
Void Ratio	0.72
Porosity	0.42
1 Pore Volume (cc)	107.8
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.99

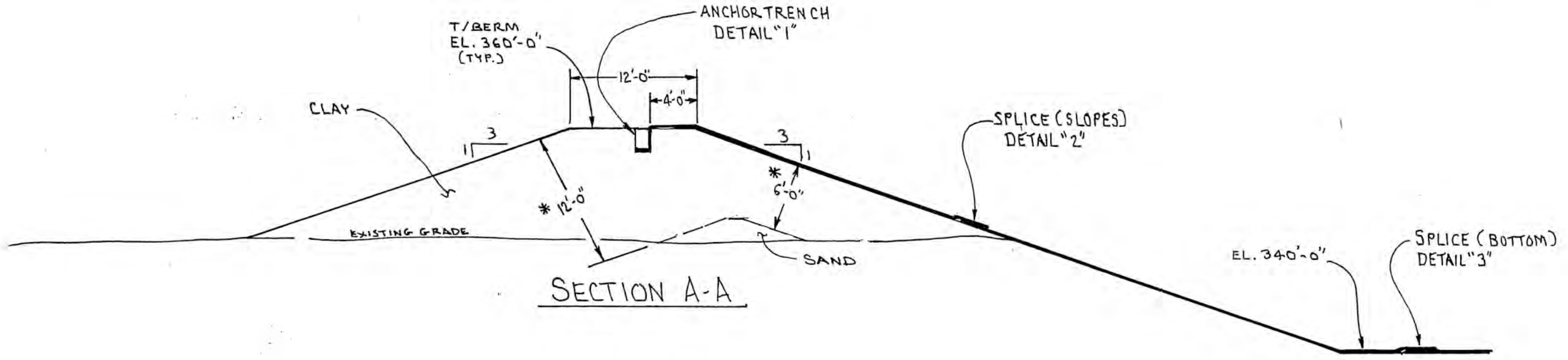
Specimen Image

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
36.0	3.0E-05
42.0	2.9E-05
48.0	3.1E-05
53.0	2.8E-05
Average, Last 4 Readings	**3.0E-05**

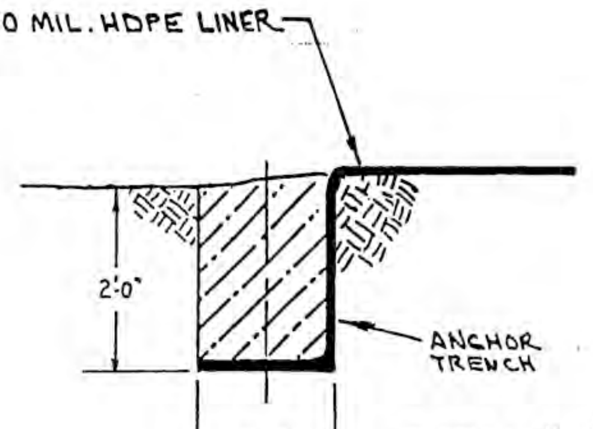
Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016

Analysis & Quality Review/Date
Testing Performed By: SOC & LC

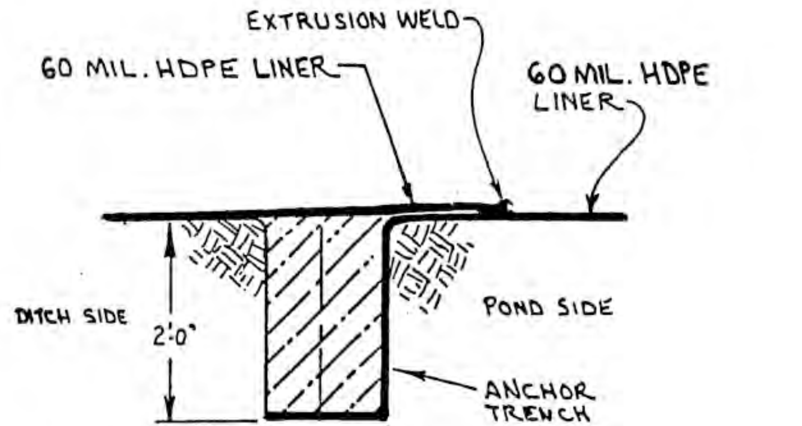
* - NOTE- THESE DIMENSIONS ARE SUBJECT TO ADJUSTMENT DEPENDING ON THE SAND / CLAY BALANCE VS. HAUL DISTANCE ON PROJECT.



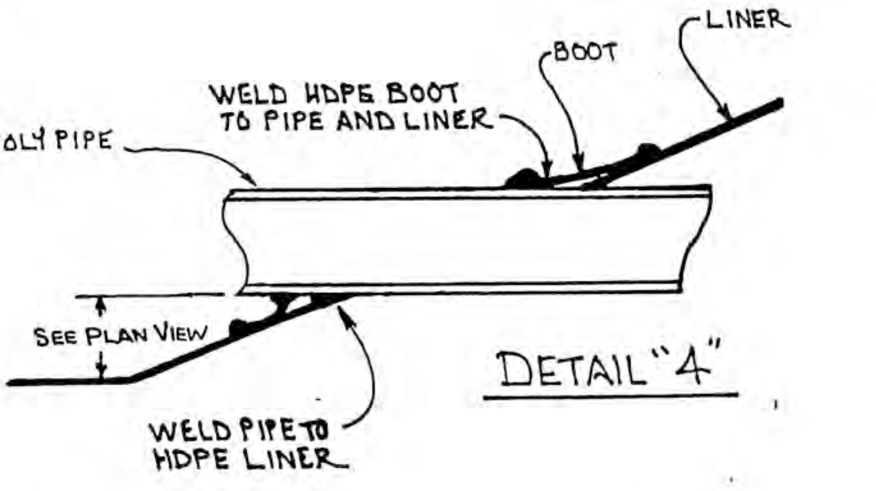
SECTION A-A

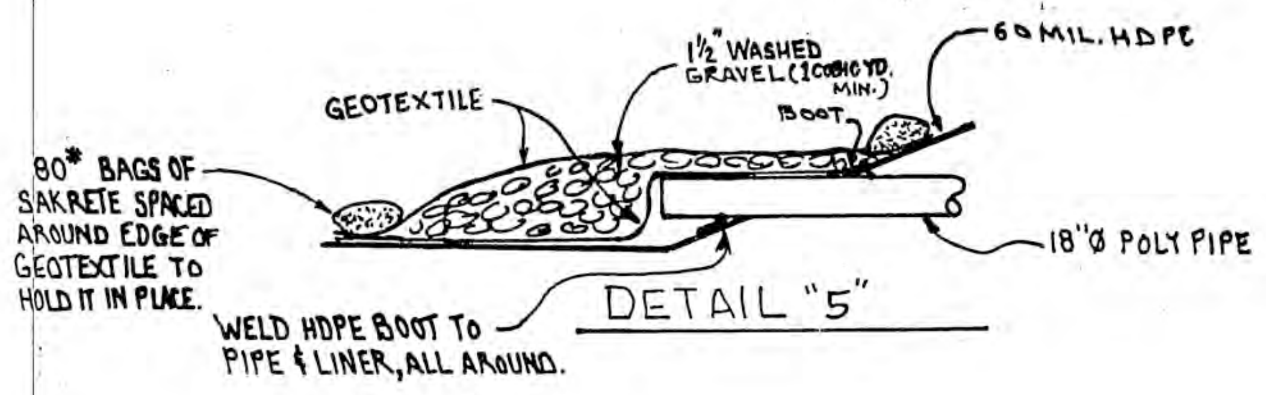


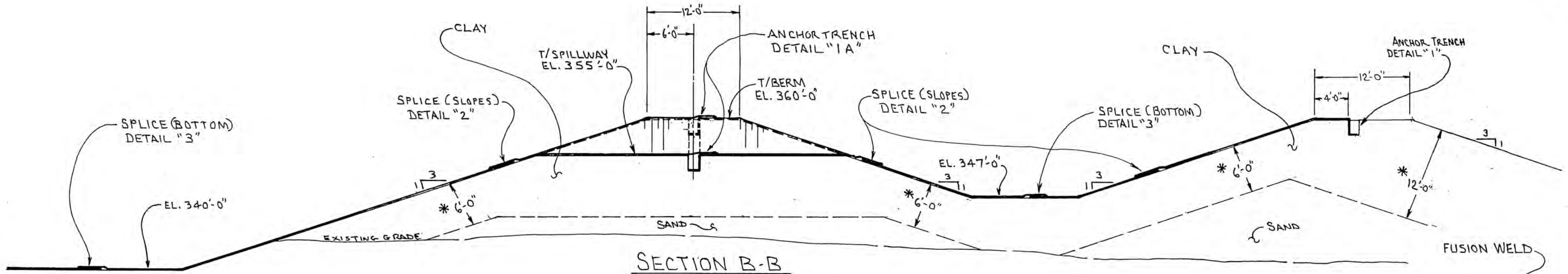
DETAIL "1"



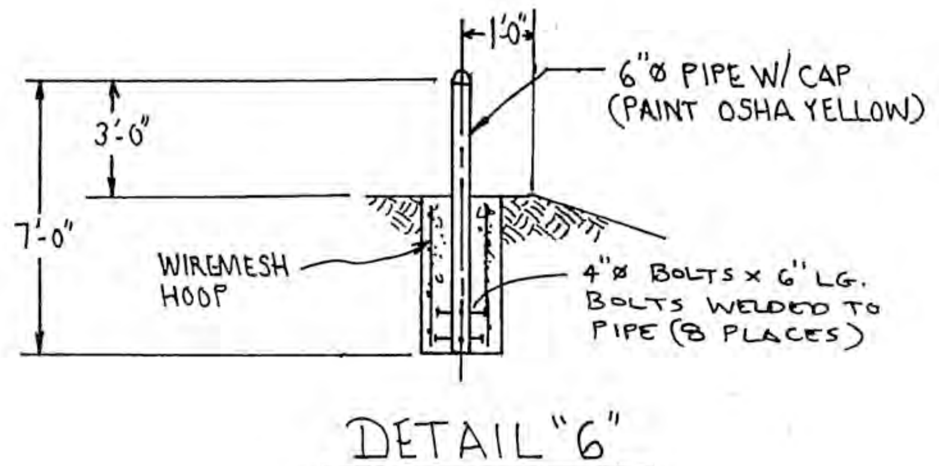
DETAIL "1A"





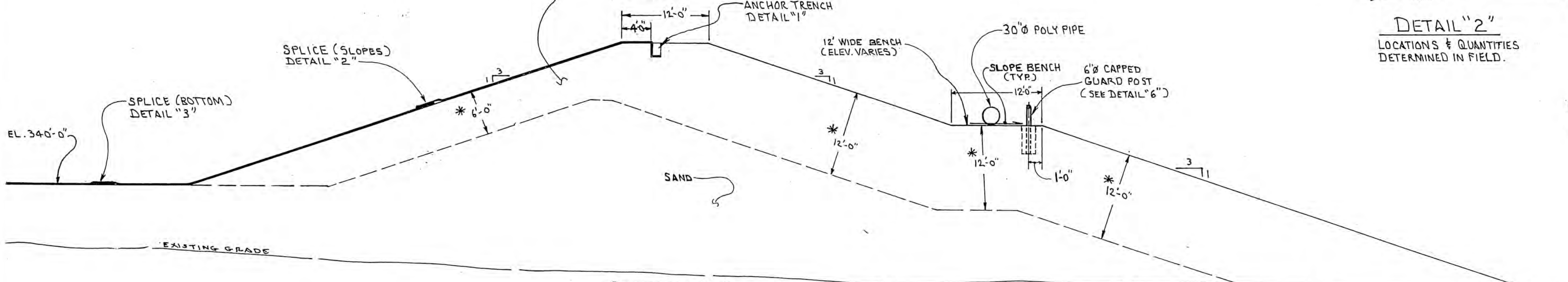


SECTION B-B

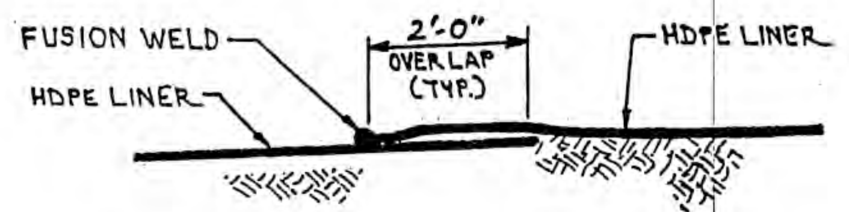


DETAIL "6"
50' ON CENTERS
(20 REQUIRED)

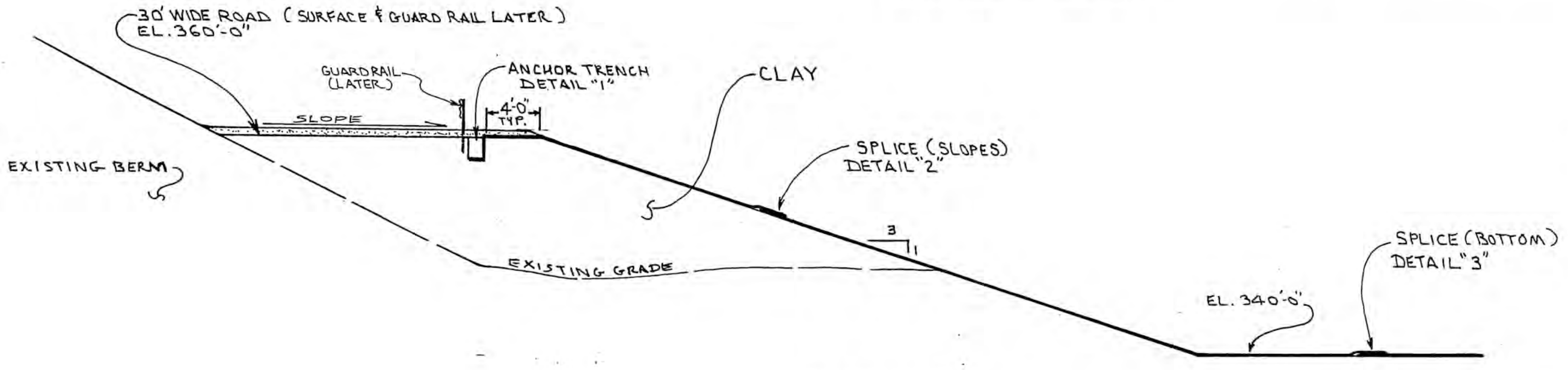
DETAIL "2"
LOCATIONS & QUANTITIES DETERMINED IN FIELD.



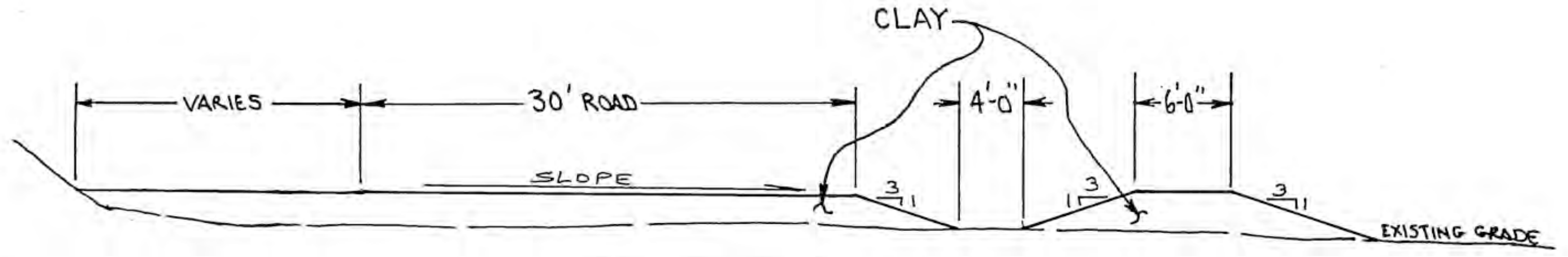
SECTION C-C



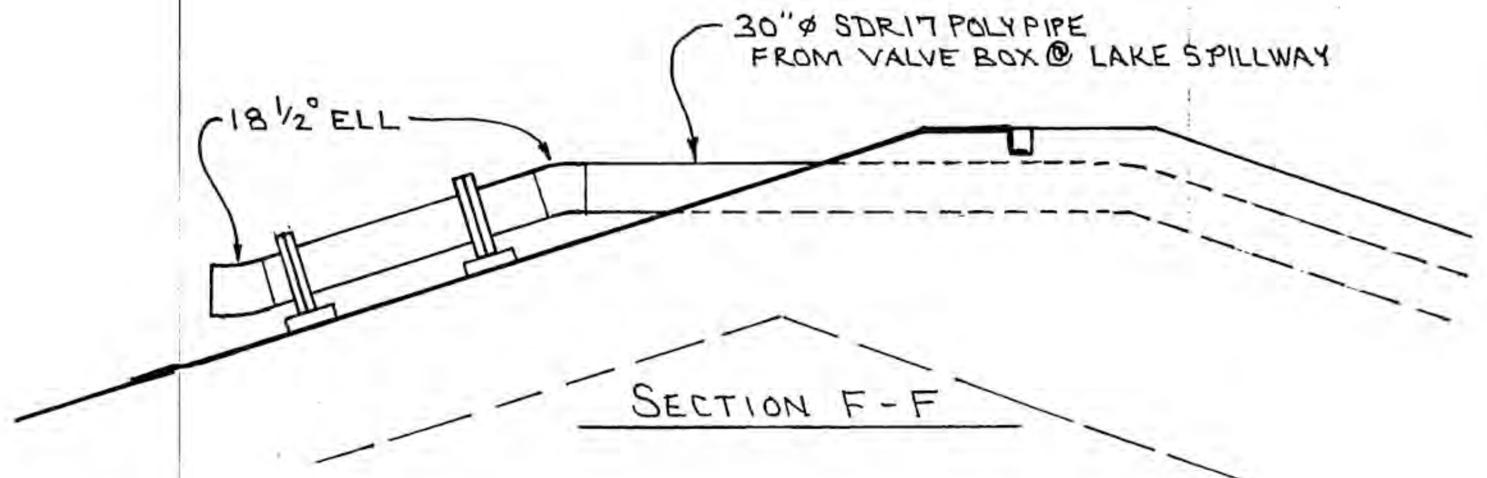
DETAIL "3"
LOCATIONS & QUANTITIES DETERMINED IN FIELD



SECTION D-D



SECTION E-E

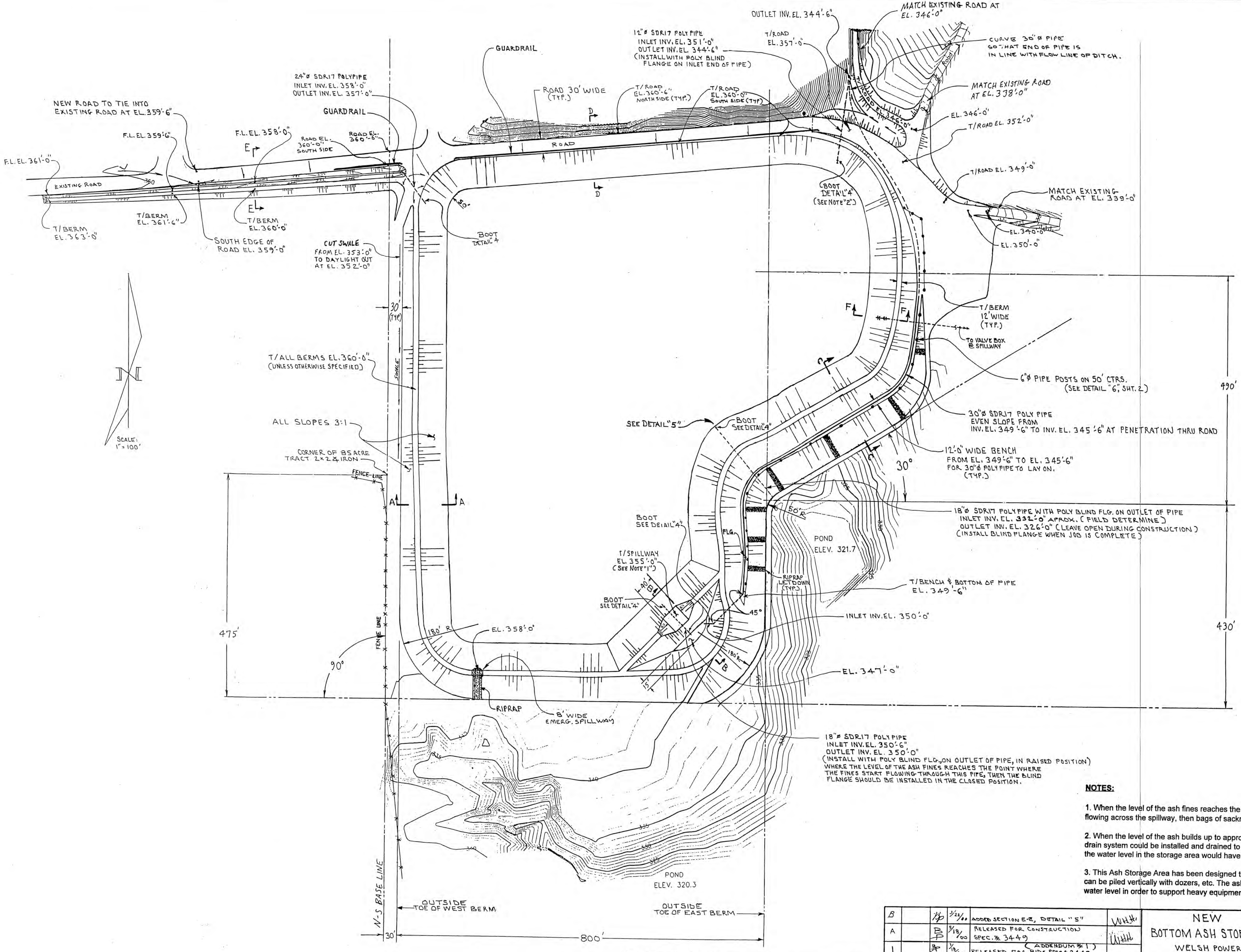


REV	W.O.	BY	DATE	SUBJECT	APPROVED
B		BP	10/29/00	AS BUILT	
A		BP	5/18/00	RELEASED FOR CONSTRUCTION SPEC. # 3449	WHH
1		BP	3/13/00	(ADDENDUM #1) RELEASED FOR BIDS SPEC. # 3449	
		BP	3/10/00	RELEASED FOR BIDS	

NEW
BOTTOM ASH STORAGE AREA
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.

	DEPT.
	DIV.
APPROVED	
DRWN. BY: BP	DATE: 3-10-00
SCALE: AS SHOWN	W.O.
SH. 2 OF 2	DRWG. NO. WEPX-335



NOTES:

1. When the level of the ash fines reaches the point where the fines start flowing across the spillway, then bags of sackrete can be installed to raise the spillway elevation.

2. When the level of the ash builds up to approx. elev. 355 along the north and east sides, a french drain system could be installed and drained to this outlet to help hold the water table down. Of course the water level in the storage area would have to be at elev. 351 or above for the french drain to function.

3. This Ash Storage Area has been designed to hold the water level as low as possible so the ash can be piled vertically with dozers, etc. The ash level needs to be approx. 4 ft. to 5 ft. above the water level in order to support heavy equipment.

REV.	W.O.	BY	DATE	SUBJECT	APPROVED
C		BP	10-29-00	AS BUILT	

REV	W.O.	BY	DATE	SUBJECT	APPROVED
B		BP	7/22/00	ADDED SECTION E-E, DETAIL "5"	WHH
A		BP	5/18/00	RELEASED FOR CONSTRUCTION SPEC.# 3449	WHH
1		BP	3/13/00	RELEASED FOR BIDS SPEC.#3449 (ADDENDUM #1)	
		BP	3-10-00	RELEASED FOR BIDS	

NEW
BOTTOM ASH STORAGE AREA
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.

	DEPT.
	DIV.
APPROVED	
DRWN. BY: BP	DATE: 3-10-00
SCALE: 1"=100'	W.O.
SH. 1 of 2	DRWG. NO. WEPX-335