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November 30, 2020

Electronically submitted

Mr. Andrew Wheeler
Administrator
US Environmental Protection Agency
1200 Pennsylvania Ave, NW
Mail Code: 5304-P
Washington, DC 20460

Subject: DEMONSTRATION SUPPORTING A SITE-SPECIFIC DEADLINE TO INITIATE CLOSURE FOR THE FLY ASH POND AND THE BOTTOM ASH POND Cholla Power Plant – Navajo County, Arizona

Dear Administrator Wheeler,

In accordance with 40 CFR 257.103(f)(2) and (f)(2)(viii), Arizona Public Service Company (APS) hereby submits this Demonstration and Notification of intent to seek a site-specific alternative deadline to initiate closure under the Alternative Closure Requirements of 40 CFR 257.103. This demonstration is for the Bottom Ash Pond and Fly Ash Pond at the APS Cholla Power Plant located in Navajo County, Arizona.

As you review this material, it is extremely important to us that you understand APS's clean energy commitment and how Cholla Power Plant fits into APS's plans for a clean energy future in Arizona. APS has committed to achieving 100% carbon-free electricity generation by 2050, including a full exit from coal-fired power plant ownership and operations by 2031. The planned cessation of coal-firing operations at Cholla Power Plant by 2025 is part of that plan. Nonetheless, from a resource adequacy standpoint—to ensure that APS can provide its customers clean, *affordable*, and *reliable* service—Cholla Power Plant must remain in operation through the beginning of 2025. So, as APS plans for a carbon-free generation future, it must still utilize its existing fossil-fueled resources, such as Cholla Power Plant, to provide reliable and affordable electricity service over the near term. In this respect, Cholla Power Plant remains critical to APS's future resource plans.

This file includes all required elements of a demonstration under 40 CFR 257.103(f)(2) except our most recent Groundwater Monitoring and Corrective Action Report (GMCAR) which is transmitted herewith as a separate document due to its size. Our 2019 GMCAR serves as the semiannual update on selecting and designing remedies pursuant to the Coal Combustion Residuals Rule for the second half of 2019. The 2019 GMCAR also includes one of the Alternative Source Demonstrations (ASDs) referenced in our submittal as an appendix; the other applicable ASD is an appendix to the Assessment of Corrective Measures report which is part of this file.

It has been our intent to organize the demonstration by applicable requirement of 40 CFR 257.103(f)(2). In many instances, one or more standalone reports fulfill the requirement. We have included hyperlinks and bookmarks in the file to facilitate navigation.

As indicated on EPA's website, this file has been submitted by EPA's preferred method of transmittal (i.e., e-mail) using APS's secure email service (Biscom). The demonstration package has also been uploaded to the APS Coal Combustion Residuals Rule Compliance Website located at:

https://www.aps.com/en/Utility/Regulatory-and-Legal/Environmental-Compliance#Cholla

File names by webpage list are as follows:

Fly Ash Pond > CH_AltClosDemo_002_20201125 (this file)
Bottom Ash Pond > CH_AltClosDemo_003_20201125 (this file)
Facility Wide > CH_GW_AnRpt_020_20200131 (the 2019 GMCAR)

No hardcopies have been transmitted. If you have any questions regarding the submitted demonstration, please contact Natalie Chrisman Lazarr at 602.316.1324 or via email at natalie.chrisman@aps.com.

Sincerely,

Richard Nicosia
Plant Manager
Cholla Power Plant

Enclosure

Cc: Kirsten Hillyer, US EPA
Frank Behan, US EPA
Richard Huggins, US EPA

Cholla Power Plant

Demonstration Supporting a Site-Specific Deadline to Initiate Closure for the Fly Ash Pond and the Bottom Ash Pond

in accordance with
40 CFR 257.103(f)(2)

November 30, 2020

aps.com/en/Utility/Regulatory-and-Legal/Environmental-Compliance

EXECUTIVE SUMMARY

The 420-acre Fly Ash Pond (FAP) and 80-acre Bottom Ash Pond (BAP) are unlined surface impoundments that receive coal combustion residuals (CCR) from coal-fired boiler operations at the Arizona Public Service Company (APS) Cholla Generating Station (the Facility). In accordance with the requirements of the federal CCR regulations, 40 CFR Part 257, Subpart D (CCR Rule), both the FAP and BAP must cease receiving CCR in the near term and "close for cause." Since APS plans to cease coal-fired boiler operations at the Facility no later than April 2025 and close the FAP and BAP by October 17, 2028, APS seeks to continue receiving CCR and non-CCR wastestreams in the FAP and BAP under the alternative closure provision of 40 CFR § 257.103(f)(2) thru June 2025 to accommodate decommissioning. This demonstration documents that all applicable criteria are met for qualification under this provision.

No Alternative Disposal Capacity is Available. The primary wastes that are currently managed in the FAP and BAP are flue gas desulfurization (FGD) solids and bottom ash/boiler slag generated as wet wastestreams. Lesser quantities of fly ash and co-disposed uniquely associated wastes are also directed to these units. Beginning in 2021, the anticipated quantities of slurried FGD solids to the FAP and sluiced bottom ash/boiler slag to the BAP will be on the order of 3,000 and 12,000 cubic feet (cu ft) per day, respectively. If the FAP and BAP were not available to receive these wastestreams, coal-fired electrical generation operations would need to shut down because:

- The FAP and BAP are the only existing CCR units located on-site that are sized and designed appropriately to receive CCR and non-CCR wastestreams generated by Facility operations. The 1.6-acre Sedimentation Pond is the only other existing CCR surface impoundment at the Facility. This pond is undersized for the subject wastestreams and has ceased receiving wastes and initiated closure activities. Cholla Reservoir is not a CCR unit. It is a cooling water pond for one of the Facility's boiler units.
- Management of CCR and non-CCR wastestreams in wet temporary storage on-site is not technically feasible, let alone safe or adequately protective of the environment, given the projected volumes and the corresponding number of tanks that would be required to contain the wastestreams.
- It is not technically feasible to send wet CCR off-site for disposal – there is no appropriate off-site treatment or disposal facility nearby to pipe the CCR to and trucking/conveying by rail significant quantities of liquids to an appropriate waste processing facility or landfill is impractical. Off-site transport of this liquid CCR risks creating significant threats to public safety; these risks far out-weigh the benefit of off-site disposal of CCR.

Due to the impending shut down of coal-fired boiler operations at the Facility, the CCR Rule does not require the development of new onsite disposal capacity or management practices (including conversion of the Facility from wet to dry handling of wastestreams) to comply with the alternative closure provision of 40 CFR 257.103(f)(2).

Potential Risks Due to Continued Impoundment Use have been Adequately Mitigated. Figure ES-1 depicts a generalized conceptual site model (CSM) for both the FAP and the BAP. Both surface impoundments were created by constructing dam systems in separate surface water drainage channels over 40 years ago and gradually filling the impoundments with CCR (historically fly ash and FGD solids at the FAP and bottom ash at the BAP). CCR discharges to the FAP are for final disposal; free water is left to evaporate. At the

BAP, sluice water used to transport the bottom ash to the unit is siphoned back to the Facility for reuse and dewatered bottom ash is removed from the unit and placed in the Bottom Ash Monofill.

Each unit has a dam system with a clay core that generally extends to the top of bedrock (a gypsiferous mudstone and siltstone referred to as the Moqui member of the Moenkopi Formation) where bedrock is shallow and an underlying slurry cutoff wall where bedrock is deep. The Moenkopi Moqui ranges in thickness in the vicinity of the Facility (from non-existent to over 300 ft) and separates the heterogeneous alluvium present in the drainage channels from a regional water supply aquifer referred to as the C-aquifer (comprised of Coconino Sandstone and the Schnebly Hill Formation). The C-aquifer is confined by the Moqui member of the Moenkopi Formation.

Over time, the Moenkopi Moqui has become locally saturated in the vicinity of the dams, and seepage from the impounded CCR placed in the FAP and BAP has been observed to discharge at the surface. In response, APS constructed multiple seepage collection systems in the 1990s to intercept these discharges and route them back to the units. The locations where seepage have occurred suggest that weathered portions of the Moqui or associated contacts with overlying strata may serve as horizontal conduits to alluvial sediments.

Investigation of groundwater downgradient of the impoundments has identified elevated concentrations of select constituents associated with CCR at statistically significant levels (SSLs) exceeding applicable Groundwater Protection Standards (GWPSs):

CCR Unit	Constituent	Maximum Observed Concentration (April/May 2020)	Groundwater Protection Standard	Basis for Groundwater Protection Level
FAP	Arsenic	0.015 mg/L	0.01 mg/L	MCL
	Cobalt*	0.0045 mg/L	0.006 mg/L	Alternative GWPS
	Fluoride	5.6 mg/L	4 mg/L	MCL
	Lithium	1.1 mg/L	0.31 mg/L	Background
	Molybdenum	0.30 mg/L	0.1 mg/L	Alternative GWPS
BAP	Cobalt	0.084 mg/L	0.006 mg/L	Alternative GWPS
	Lithium	1.3 mg/L	0.31 mg/L	Background

Notes: * Identified as present at SSLs over GWPSs based on an elevated reporting limit
mg/L = milligrams per liter

Both cobalt at the FAP and lithium at the BAP were removed as constituents of concern at the Facility through successful Alternative Source Demonstrations conducted in accordance with the CCR Rule. The CCR groundwater monitoring system at the Facility has been expanded to define the extent of impacted shallow groundwater plumes, portions of which have migrated off-site (for which APS has provided appropriate notifications under the CCR Rule and consulted with the property owners) and back on-site due to the geography of property ownership in the vicinity of the plumes. The downgradient extent of impacted groundwater is defined on property owned by the Facility.

An exposure pathway analysis and preliminary risk evaluation have been conducted to assess whether receptors to groundwater contamination associated with the FAP and BAP have been impacted. The results of this assessment indicate that exposure pathways are currently incomplete (i.e., receptors are not exposed), principally because contamination has remained generally localized, is limited to shallow groundwater predominantly present in the alluvial aquifer, and potential receptors use the C-aquifer for beneficial use as opposed to the alluvial aquifer. The alluvial aquifer where impacted groundwater occurs is not expected to be developed as a water supply in the future because it has naturally poor water quality (high total dissolved solids) and a low yield. As such, at this time, there are no exposures to this impacted groundwater and no exposure is expected in the future.

Nonetheless, to mitigate ongoing risk posed by the impacted shallow groundwater downgradient of the FAP and BAP, APS's Risk Mitigation Plan for continued operation includes:

- Limiting future releases to groundwater by reducing the hydraulic head in the FAP through the early shutdown of units (including Unit 4 in December 2020), modifying Facility operations to decrease FAP discharges, operating seepage intercept systems around the FAP and BAP, and exploring additional ways to dewater the FAP and enhance and increase seepage interception and extraction;
- Implementing risk mitigation measures including:
  - Maintaining Facility security
  - Inspecting and properly maintaining seepage intercept systems
  - Coordinating with well owners and routinely reviewing the Arizona Department of Water Resources' well registry to identify if new water supply wells are installed near the FAP and the BAP
  - Monitoring the location and extent of the groundwater plumes
  - Notifying the public, including surrounding property owners, of groundwater impacts and any associated risks before they occur; and
- Expediting and maintaining containment of groundwater impacts by progressing corrective action in accordance with the CCR Rule, implementing interim response measures while remedy selection is ongoing, and planning for possible contingency actions.

Planned interim response measures that will actively address groundwater impacts in the near-term include the installation of four new test wells in regions were constituent concentrations are highest downgradient of the FAP with the incorporation of these new wells as groundwater extraction wells in existing seepage collection system operations. Assessment and field testing of strategies to mitigate cobalt mobilization in groundwater downgradient of the BAP are also planned and will include oxidant amendment testing and extraction well testing with expansion of these remedial approaches to areas where the highest levels of cobalt mobilization have been identified.

The Facility is in Compliance with the CCR Rule. The Facility has maintained compliance with the requirements of the CCR Rule since initial promulgation in 2015. Specifically, APS has completed the following activities to timely comply with the groundwater monitoring and corrective action portions of the regulation (40 CFR 257.90 thru 257.98):

- Installation and certification (in September 2017) of a groundwater network to evaluate whether the groundwater downgradient of the Facility's CCR units has been impacted by leakage from the units (Montgomery & Associates, 2017);
- Baseline, detection, and assessment groundwater monitoring with reporting of associated results and public notifications documenting groundwater monitoring program transitions in annual Groundwater Monitoring and Corrective Action Reports (GMCARs) (Montgomery & Associates, 2018; Wood Environment and Infrastructure Solutions, Inc. [Wood], 2019a; and Wood, 2020a);
- Statistical evaluations of groundwater monitoring data (in October 2018) concluding that select constituents are present at SSLs that exceed GWPSs at the FAP and BAP as documented in technical memoranda and public notifications included with the 2018 GMCAR (Wood, 2019a);

- Characterization of groundwater downgradient of the FAP and BAP to evaluate and delineate impacts as documented in the Hydrogeologic Investigation of the FAP and BAP report included with the 2019 GMCAR (Wood, 2020a);
- Notifications of neighboring property owners (in June 2019) of the presence of impacted shallow groundwater underlying their properties (Wood, 2020a);
- An Assessment of Corrective Measures for the FAP and BAP in June 2019 (with associated public notifications and an extension demonstration included in the 2019 GMCAR) to support the future selection of remedies for groundwater impacts (Wood, 2019b);
- Alternative source demonstrations for cobalt at the FAP (included with the 2019 GMCAR [Wood, 2019a]) and lithium at the BAP (included with the Assessment of Corrective Measures [Wood, 2019b]); and
- Semiannual reporting documenting progress in remedy selection for the FAP and BAP (Wood, 2019c, Wood, 2020a, and Wood, 2020b).

Structural stability and safety factor assessments for the FAP and BAP dam systems have also been performed as required by the CCR Rule (AECOM, 2016a and AECOM, 2016b).

Coal-Fired Boiler Operations Will Cease and the Impoundments Will Close by October 2028. The closure plans for the FAP and BAP are similar and dictate that the units will be closed in place. Anticipated closure tasks with a schedule to close the impoundments no later than October 2028 are as follows:

Task	FAP Schedule	BAP Schedule	Comments
Pre-Construction	Q1 2020 – Q2 2025	Q1 2021 – Q2 2025	Includes land acquisition activities, excavation of diversion channels, etc.
Engineering	Q1 2023 – Q4 2024	Q1 2023 – Q4 2024	In addition to engineering design, geotechnical testing and borrow investigations will be performed
Permits	Q4 2023 – Q4 2024	Q4 2023 – Q4 2024	Approvals of dam modifications and closure plans will be required
Procurement	Q2 2024 – Q4 2024	Q2 2024 – Q4 2024	A contractor will be procured
Final Boiler Closure	Q2 2025	Q2 2025	Coal-fired power production will end no later than April 2025; discharges to the FAP and BAP (supporting decommissioning) will end no later than the end of June 2025
Construction	Q2 2025 – Q4 2028	Q2 2025 – Q2 2028	Includes dewatering of the impoundment for safe access, re-grading of the impoundment to promote drainage, installation of an evapotranspiration cap over CCR, and construction of perimeter drainage channels to route stormwater away from the closed unit

References

AECOM, 2016a. Final Summary Report, Structural Integrity Assessment, Fly Ash Pond, Cholla Power Plant, Joseph City, Arizona. August 26, 2016.

AECOM, 2016b. Final Summary Report, Structural Integrity Assessment, Fly Ash Pond, Cholla Power Plant, Joseph City, Arizona. August 26, 2016.

Montgomery & Associates, 2017. Cholla Power Plant Coal Combustion Residuals Program – Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks, Navajo County, Arizona. September 19, 2017.

Montgomery & Associates, 2018. Annual Groundwater Monitoring and Corrective Action Report for Cholla Power Plant Coal Combustion Residuals Program, November 2015 – December 2017, Navajo County, Arizona. January 30, 2018.

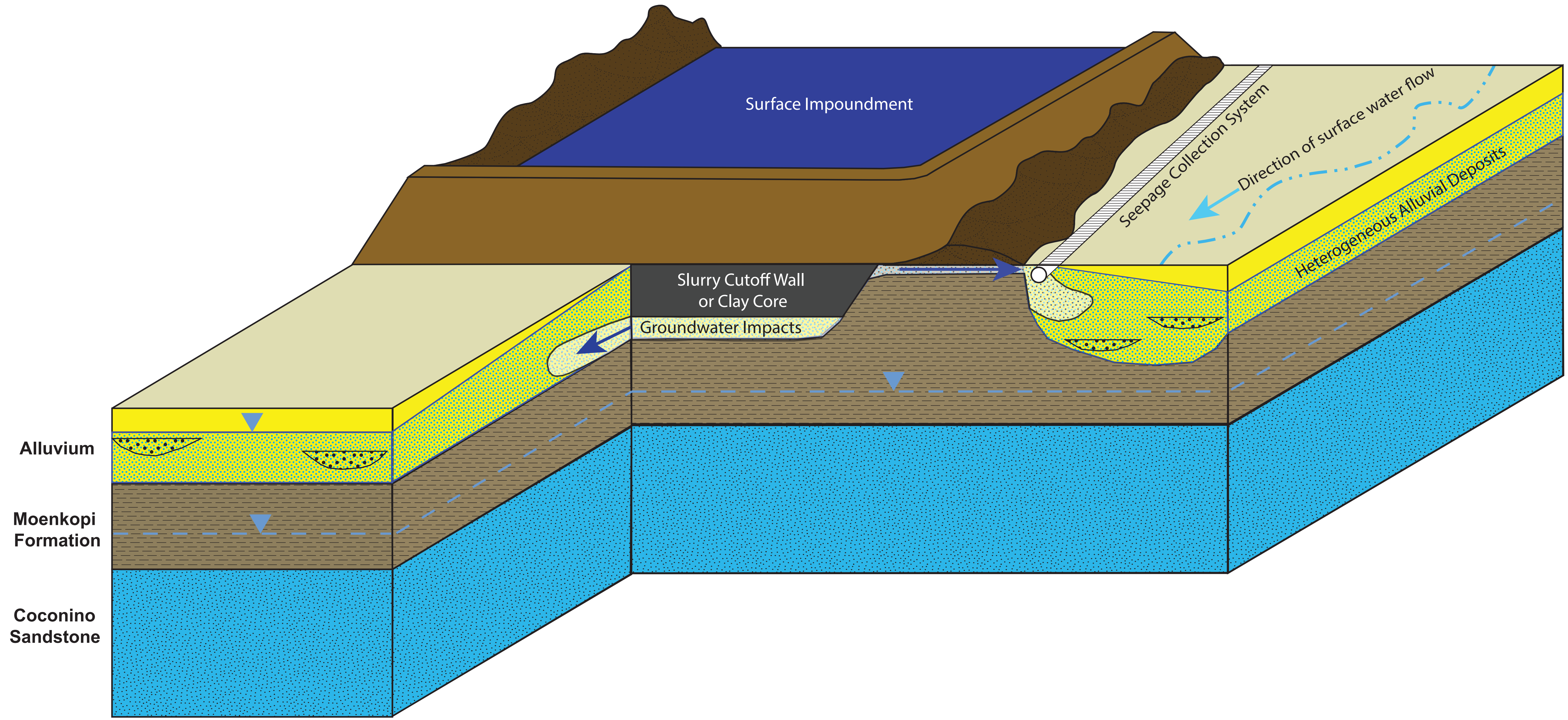
Wood Environment and Infrastructure Solutions, Inc. (Wood), 2019a. Annual Groundwater Monitoring and Corrective Action Report 2018, Coal Combustion Residuals Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. January 31, 2019.

Wood, 2019b. Assessment of Corrective Measures for the Fly Ash Pond and the Bottom Ash Pond, Coal Combustion Residuals Rule and Aquifer Protection Permit Compliance, Arizona Public Service Company, Cholla Power Plant, Navajo County, Arizona. June 14, 2019.

Wood, 2019c. Semi-Annual Report Documenting Progress in Remedy Selection for the Fly Ash Pond and Bottom Ash Pond, Cholla Power Plant, Navajo County, Arizona. July 15, 2019.

Wood, 2020a. Annual Groundwater Monitoring and Corrective Action Report 2018, Coal Combustion Residuals Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. January 31, 2019.

Wood, 2020b. Semiannual Report Documenting Progress in Remedy Selection for the Fly Ash Pond and Bottom Ash Pond, Cholla Power Plant, Navajo County, Arizona. July 15, 2020.



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Job No.:	14-2018-2040
PM:	MBH
Date:	10/01/2020
Scale:	Not to Scale

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Conceptual Site Model for the Fly Ash Pond and Bottom Ash Pond

Figure **ES-1**

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To facilitate review, this demonstration is organized by the applicable requirement of 40 CFR 257.103(f)(2). All required elements are included in this document except the 2019 Groundwater Monitoring and Corrective Action Report (GMCAR) which has been submitted separately with this document to complete the demonstration package. This document contains hyperlinks and bookmarks to assist with navigation.

Criterion per Subsection of §257.103(f)(2)	***Demonstration Requirement per Subsection of §257.103(f)(2)(v)***	***Location in Demonstration Where Requirement is Addressed***
(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.	*(A) …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.*	ATTACHMENT A – NO ALTERNATIVE DISPOSAL CAPACITY NARRATIVE
(ii) Potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated.	*(B) …the owner or operator must submit 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.* *(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.* *(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.*	ATTACHMENT B – RISK MITIGATION PLAN

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Criterion per Subsection of §257.103(f)(2)	Demonstration Requirement per Subsection of §257.103(f)(2)(v)	Location in Demonstration Where Requirement is Addressed
(iii) The facility is in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action.	(C) *…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;* *(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;* *(3) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;* *(4) Description of site hydrogeology including stratigraphic cross-sections;* *(5) Any corrective measures assessment required at § 257.96;* *(6) Any progress reports on remedy selection and design and the report of final remedy selection required at § 257.97(a);* *(7) The most recent structural stability assessment required at§ 257.73(d); and* *(8) The most recent safety factor assessment required at § 257.73(e).*	ATTACHMENT C – COMPLIANCE DEMONSTRATION C(1)........Compliance Certification C(2)(i).....Well Location Map C(2)(ii)....Well and Drilling Logs C(2)(iii) ...Potentiometric Surface Maps and Hydrographs Supplemental Hydrogeologic Reference Information – Monitoring System Certification Report C(3)........Constituent Concentration Data C(4)........Description of Site Hydrogeology C(5)........Corrective Measures Assessment C(6)........Remedy Selection Progress Reports (the 2019 Annual GMCAR which also presents remedy selection progress is transmitted separately with this document) C(7/8).....Most Recent Structural Stability Assessment and Most Recent Safety Factor Assessment

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Attachment A

ATTACHMENT A

CHOLLA POWER PLANT
NO ALTERNATIVE DISPOSAL CAPACITY NARRATIVE
40 CFR 257.103(f)(2)(i)(A)

Arizona Public Service Company (APS) currently operates coal steam boiler Units 1, 3, and 4 at the 840-megawatt (MW) Cholla Power Plant located near Joseph City, Arizona. Unit 4 (owned by PacifiCorp) will be shut down at the end of 2020 and Units 1 and 3 (owned by APS) will operate until no later than April 2025 to comply with Clean Air Act Regional Haze regulations, including a site-specific State Implementation Plan approved in 2017.

Coal combustion residuals (CCR) generated at Cholla Power Plant, including fly ash, bottom ash, flue gas desulfurization (FGD) solids, and boiler slag, are currently managed on-site in three surface impoundments and one landfill (Table A-1) in accordance with applicable requirements of 40 Code of Federal Regulations (CFR) Section (§) 257 (i.e., the CCR Rule). During coal combustion at the plant, fly ash and bottom ash are produced by far in the highest quantities and have been over time slurried with transport water to the 420-acre Fly Ash Pond (FAP) and 80-acre Bottom Ash Pond (BAP), respectively. Lesser quantities of FGD solids, boiler slag, and co-disposed uniquely associated wastes (per CFR § 261(b)(4)(ii)) have also been discharged to the FAP and BAP. The FAP and BAP were placed in service in 1978 and have operated in more or less the same configuration since that time, although on-site fly ash disposal has significantly declined in response to the increasing sale of this commodity to the cement industry.

Table A-1. Summary Description of Cholla Power Plant CCR Units

CCR Unit	**Primary CCR Stored/ Treated/ Disposed of in Unit**	**Total Storage Capacity [acre ft]**	**Maximum Normal Operating Pool/Design Maximum Ash Elevation [ft amsl]**	**Water Level in November 2019 [ft amsl]**	**Estimated Solids Level Elevation in November 2019 [ft amsl]**	**Notes**
FAP *Surface Impoundment*	Slurried (Wet) Fly Ash and FGD solids	18,000	5,114	5,087	5,094 at discharge pipe	Most of the fly ash generated onsite is currently sold to a local cement manufacturer
BAP *Surface Impoundment*	Slurried (Wet) Bottom Ash/Boiler Slag	2,300	5,118	5,112	5,115 (varies)	Dredged solids from the BAP are landfilled in the BAM
Sedimentation Pond *Surface Impoundment*	Varies	10.7	5,017	5,014 - 5,015	5,015	Dredged solids are periodically slurried to the BAP or FAP; Unit closure planned no later than April 2021
Bottom Ash Monofill *Landfill*	Dredged Bottom Ash Solids	2,417	5,261	NA	5,184 for west capped portion; 5116 for east portion	---

<u>Notes:</u>
amsl – above mean sea level
ft – feet

Promulgated in 2015, the CCR Rule includes groundwater monitoring to evaluate if operating CCR surface impoundments and landfills are impacting the environment. Based on declarations that one or more of the Appendix IV constituents identified in the CCR Rule are present at statistically significant levels above Groundwater Protection Levels in groundwater downgradient of the FAP and BAP, these units have transitioned into Corrective Action to address the impacted groundwater. In accordance with the CCR Rule, because both units are unlined, they must cease receiving CCR in the near future and initiate closure per §257.101(a)(1).

Section 257.103(f)(2) of the CCR Rule includes an alternative closure provision that allows facilities with impending commitments to cease burning coal to continue to receive CCR beyond the timeline identified in §257.101(a)(1) for surface impoundments that are greater than 40 acres in areal extent (like the BAP and FAP) if the coal-fired boilers at the associated plant cease operation and the impoundment is closed no later than October 17, 2028. This alternative closure date is applicable, among other requirements, if a lack of alternative capacity can be demonstrated both on- and off-site.

The following sections present APS's demonstration that there is no alternative capacity for CCR and associated non-CCR storage, treatment, and/or disposal if coal combustion at Cholla Power Plant continues until April 2025 and the BAP and FAP cannot receive these wastestreams after April 11, 2021 (the date identified in §257.101(a)(1)). It is important to note that, for facilities with near-term retirement dates (i.e., pursuant to §257.103(f)(2)), there is no requirement to develop new onsite disposal capacity to comply with the alternative closure provision because coal-fired boiler operations will cease by a date certain prior to October of 2028. Specifically, the conversion of the facility from wet to dry handling of ash need not be considered as a feasible alternative (*See* 80 Fed. Reg. 21,301, at 21,423 [Apr. 17, 2015] and 85 Fed. Reg. 53,516 at 53,547 [Aug. 28, 2020]). Further, disposal options for offsite disposal of liquid-waste CCR are limited (See 85 Fed. Reg. 53,516 at 53,541 [Aug. 28, 2020]).

1. No Alternative Disposal Capacity On-Site

Quantity of CCR Wastestreams to be Managed. With the impending shutdown of Unit 4, Table A-2 presents the projected rates of CCR generation at Cholla Power Plant from January 2021 to the retirement of Units 1 and 3 (no later than April 2025). These rates are estimated based on recent power production data and are representative of the magnitude of volumetric disposal capacity required to maintain plant operations.

Table A-2. Projected Rates of CCR Generation Thru Retirement

CCR	Mass Rate [tons/day]	Volumetric Rate [cubic feet/day]	Volumetric Rate [gallons/day]	Notes
Fly Ash	329	9,400	Not Applicable	Fly ash is generated as a dry waste stream; only off-spec fly ash that cannot be sold is currently disposed of on-site in the FAP; this quantity has not been estimated but is a small fraction of the generated rate listed in this table
Bottom Ash/Boiler Slag	82	12,000	86,000	Bottom ash/boiler slag is sluiced to the BAP at approximately 25% solids by weight; volumetric rates of bottom ash/boiler slag presented in this table include water
FGD Solids	24	3,000	22,000	FGD solids are generated as a slurry at approximately 25% solids by weight and pumped to the FAP; volumetric rates of FGD solids presented in this table include water

As discussed previously, most of the fly ash that will be generated at Cholla Power Plant going forward will be sold to a local cement manufacturer and thus will not require ongoing management. A negligible amount of off-spec fly ash must be disposed of on-site and is currently blended with the FGD solid slurry and discharged to the FAP. Fly ash tracking records consistently indicate that more fly ash is sold than generated and therefore the amount diverted to the FAP is unquantifiable.

Non-CCR Wastestreams Managed. Cholla Power Plant has a wet bottom ash handling system. Bottom ash transport water (BATW) is sourced from the plant's general water system that recycles various low volume, intermittent, and uniquely associated liquid wastes including boiler and cooling tower blowdown, wash water, run-off, and plant wastewaters as BATW. BAP pond levels are maintained at a relatively constant level by siphoning water from the BAP back to the plant's general water system for reuse. Other Non-CCR wastestreams that are also uniquely associated wastes (per CFR § 261(b)(4)(ii)) are discharged in relatively small quantities to either general water or directly to the BAP.

Evaluation of Existing Infrastructure. As demonstrated by the site map depicted in Figure A-1, there are only two existing CCR units located on-site that are capable of receiving the quantities of wet-generated bottom ash/boiler slag and FGD sludge/off-spec fly ash arising from operation of one or more coal-fired boilers at Cholla Power Plant: the BAP and the FAP. The large basin adjacent to the plant is the Cholla Reservoir, an unlined lake used as a cooling water pond for Unit 1. The other two existing CCR units present at the site are the Sedimentation Pond (SEDI) and the Bottom Ash Monofill (BAM).

The SEDI is a 1.6-acre surface impoundment that processes relatively limited quantities of water from the plant's secondary wastewater treatment facility, the plant's oil/water separator, a vehicle wash system, plant wash down activities, and FGD system upset conditions. The SEDI is appreciably undersized to receive the significant quantities of bottom ash or FGD solids generated during coal combustion operations at the plant. Further, since this surface impoundment is unlined and CCR discharges are small enough to efficiently reroute, the SEDI ceased receiving waste as of October 30, 2020, the soonest that was technically feasible, and has initiated closure activities in accordance with 40 CFR §257.102(e)(1).

The BAM is a 43-acre landfill that receives drained bottom ash dredged from the BAP. For the reasons documented above, the BAM is not considered 'existing capacity' with regards to wet ash because this unit is a landfill and not designed to accommodate wet ash disposal.

Evaluation of Wet Temporary Storage. Based on the projected CCR generation rates presented in Table A-2 and the 4-year duration of anticipated operations from the date identified in §257.101(a)(1) (i.e., April 2021) to planned shutdown of coal-based power production (i.e., no later than April 2025), the total quantities of CCR that will require management during this period are approximately:

- 400 acre-ft of bottom ash/boiler slag and associated transport water; and
- 100 acre-ft of FGD solids generated as a slurry

On-site temporary storage of wet CCR could be considered for these quantities with commercially available frac tanks which are large capacity steel tanks that can be readily transported to the site and used to contain up to 21,000 gallons of liquid. The tanks typically have a footprint of 8 ft wide by 51 ft long and an un-filled weight of approximately 14 tons. Neglecting the relatively smaller quantities of non-CCR that would also require treatment/disposal, 4.1 tanks would be required to store bottom ash/boiler slag with associated transport water and 1.1 tank would be required to store slurry scrubber solids each day based on projected CCR generation rates. Over 4 years operation, over 7,600 frac tanks would need to be filled with CCR. If this number of tanks could be placed directly adjacent to each other with 10 ft of clearance around each tank, the area required for the tanks would be over 190 acres (almost half the footprint of the FAP). To ensure the safe storage of liquids, this entire area would need to be graded and compacted to allow placement of the tanks (each 21,000-gallon frac tank containing slurried bottom ash would weigh approximately 94 tons). An extensive network of temporary piping would also be required to convey CCR to the tanks that would need to be carefully constructed, operated, and protected from the elements to minimize the potential for breaks and spills.

When the tanks need to be emptied, liquid and solid management would need to be addressed as settling of solids will occur over time. Alternative tank configurations could be used to mitigate this issue (e.g., promote settling of bottom ash and recovery of water) but handling and processing requirements would increase significantly and likely be equivalent in scope to construction of a dry handling system for bottom ash management.

Given the volumes projected, the corresponding number of tanks that would be required to contain these wastestreams and the likely increased probability of spills, management of CCR and non-CCR volumes in wet temporary storage is not technically feasible.

Conclusion. On the basis that the BAP and FAP are the only CCR units on-site that are sized and designed appropriately to receive wet ash/boiler slag, FGD slurry, and uniquely associated co-disposed non-CCR waste from Cholla Power Plant coal combustion activities, there is no alternative disposal capacity on-site for these wastestreams if the BAP and FAP must stop receiving CCR by the timeline identified in §257.101(a)(1). If the BAP and FAP were required to close, Cholla Power Plant would need to shut down.

2. No Alternative Disposal Capacity Off-Site

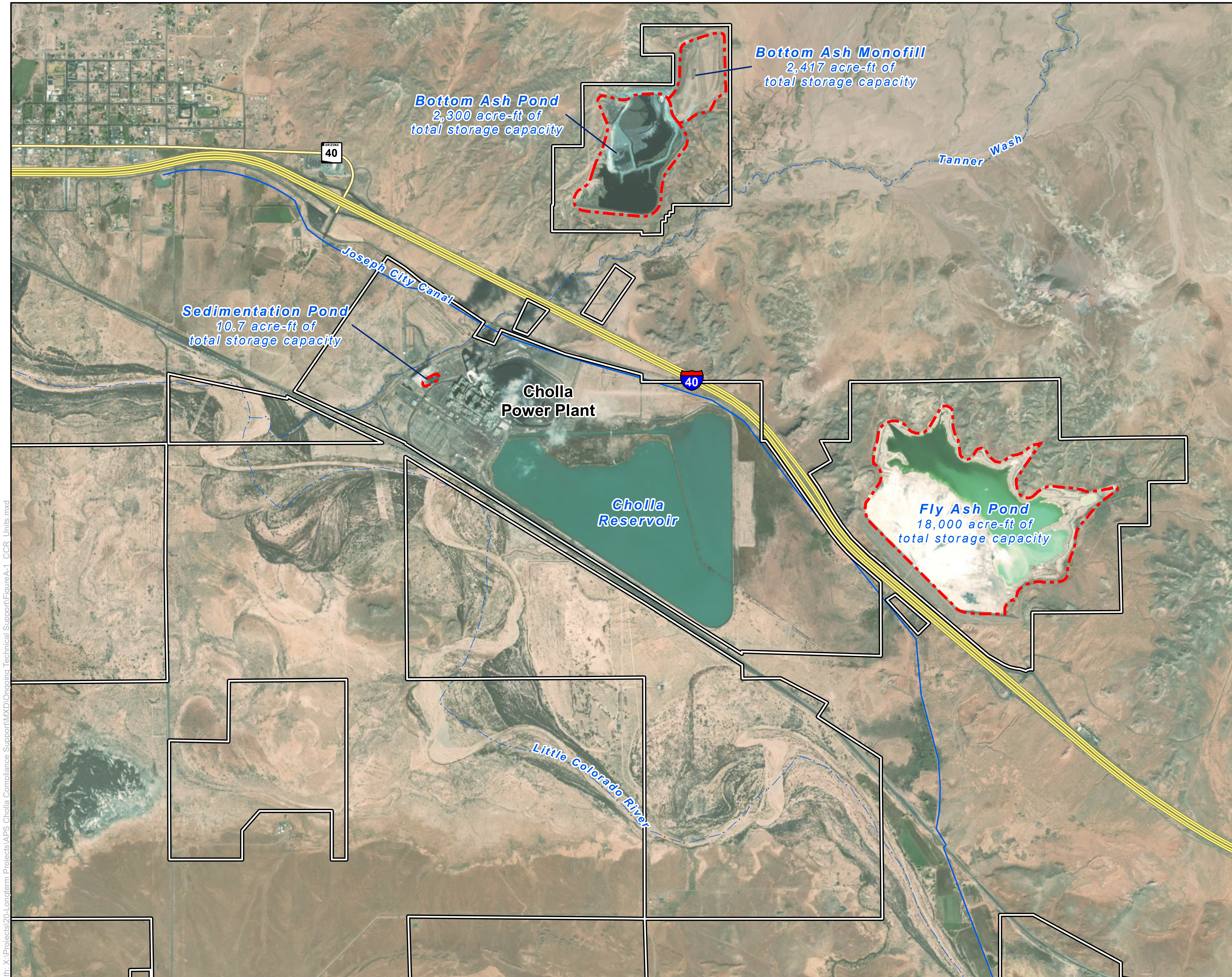
As there is no nearby treatment/waste handling facility that the wet CCR can be conveyed in a pipeline to, off-site disposal would likely involve either transporting the waste by truck or rail to an appropriate facility located hundreds of miles away. The nearest landfills to Cholla Power Plant include Waste Management's Painted Desert Landfill in Joseph City, Arizona, Cinder Lake Municipal Landfill in Flagstaff, Arizona and Blue Hills Regional Landfill in St Johns, Arizona. However, none of these landfills are permitted to receive industrial waste liquids. The most likely appropriate facility closest to Cholla Power Plant is Waste Management's Butterfield Station Landfill located south of Phoenix, Arizona, approximately 270 miles away. This landfill currently processes 30,000 gallons of waste liquid per day.

If the landfill found waste characteristics acceptable and the volume of liquid that the landfill could process was increased to accommodate Cholla Power Plant's wet CCR, the number of either 4,000-gallon tank trucks or 6,900-gallon rail tank containers required to transport CCR off-site for treatment/disposal each day (at the anticipated CCR generation rates identified in Table A-2) would be:

- 21.5 trucks for sluiced bottom ash/boiler slag and 5.5 trucks for slurried scrubber solids; or
- 12.5 rail tank containers for sluiced bottom ash/boiler slag and 3.2 rail tank containers for slurried scrubber solids.

Use of this number of vehicles each traveling 540 miles for a return trip every day over four years to transport liquid waste that could spill on public thoroughfares makes sending the anticipated volumes of wet CCR off-site for disposal infeasible. Transporting the waste off-site risks creating significant threats to public safety which do not out-weigh the benefit of off-site disposal of CCR.

On this basis, there is no alternative capacity off-site for CCR waste streams if the BAP and FAP must stop receiving CCR by the timeline identified in §257.101(a)(1). If the BAP and FAP were required to close, Cholla Power Plant would need to shut down.



State Overview

Legend

- Ephemeral Surface Water Feature
- Canal
- Approximate Extent of CCR Unit
- APS Land Ownership

Notes:

CCR Coal Combustion Residuals

Disclaimer: Parcel sizes and shapes are approximate and based on Navajo County Assessor and Arizona Public Service Company real estate records

0 1,100 2,200 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE A-1 **APS Property Ownership Map**

Job No. 1420182040
PM: MBH
Date: 9/17/2020
Scale: 1"= 2,200'

wood.

Attachment B

RISK MITIGATION PLAN
FOR THE FLY ASH POND AND THE BOTTOM ASH POND

Coal Combustion Residuals Rule Compliance

Arizona Public Service Company
Cholla Power Plant
Navajo County, Arizona

Submitted to:

Arizona Public Service Company
400 North 5th Street
Phoenix, Arizona 85004

Submitted by:

Wood Environment & Infrastructure Solutions, Inc.
Phoenix, Arizona

November 30, 2020

Wood Project No. 14-2018-2040

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1.0 INTRODUCTION

This Risk Mitigation Plan was prepared on behalf of the Arizona Public Service Company (APS) by Wood Environment & Infrastructure Solutions, Inc. (Wood) as part of an Alternative Closure Demonstration required by 40 Code of Federal Regulations (CFR) Section (§) 257.103(f)(2)(v)(B) of the amended Coal Combustion Residuals (CCR) Rule (Federal Register, 2020). The CCR surface impoundments addressed by this Risk Mitigation Plan are the Fly Ash Pond (FAP) and Bottom Ash Pond (BAP) located at the APS Cholla Power Plant (the Site) in Navajo County, Arizona.

§257.103(f)(2) of the CCR Rule includes an alternative closure provision for facilities with large surface impoundments (greater than 40 acres in extent) that are required to initiate closure for cause to continue to receive CCR and appropriate non-CCR discharges beyond the applicable cease discharge date (i.e., April 2021) if the coal-fired boilers at the associated plant cease operation and the impoundment is closed no later than October 2028.

To utilize this provision, the regulation requires owners or operators to demonstrate that potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated (§257.103(f)(2)(ii)). The demonstration must include submittal of a Risk Mitigation Plan describing measures that will be taken to expedite any required corrective action and that contains all of the following elements per §257.103(f)(2)(v)(B):

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

(2) *A discussion of the surface impoundment's ground water 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.*

(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.*

To address these requirements, this Risk Mitigation Plan presents a brief site background section that provides context for the three sections that follow and correspond directly to the three elements identified in §257.103(f)(2)(v)(B).

Consistent with the preamble to the CCR Rule amendment incorporating the requirement for a Risk Mitigation Plan, the scope of this report is limited to risks associated with groundwater contamination identified at the FAP and BAP during CCR Rule groundwater monitoring compliance activities.

2.0 SITE BACKGROUND

2.1 Plant Operations

The Site is an operating power plant owned by APS and PacifiCorp. The plant is currently equipped with three coal-fired boiler units (Units 1, 3, and 4) and has a net generating capacity of 840 megawatts. Unit 4 is scheduled to close in December 2020. APS plans to continue operation of Units 1 and 3 and place generated CCR in the FAP and BAP until no later than April 2025.

The plant and associated infrastructure are located on land owned/leased by APS adjacent to Interstate 40 (I-40) between the City of Winslow and the City of Holbrook near Joseph City in Navajo County, Arizona. The plant sits next to the Cholla Reservoir, a cooling pond and water storage reservoir that was originally constructed in the early 1900s by the Joseph City Irrigation Company (JCIC; Shilling, 2005). The current configuration of the reservoir was constructed in 1961 by APS to include a hot pond and a cold pond separated by an inverted weir (Aquatic Consulting & Testing, Inc., 2002). The ponds are shallow to promote cooling (less than 9 feet [ft] deep) and the typical water surface elevation is 5,022 ft above mean sea level (amsl). Cholla Reservoir receives deliveries of groundwater pumped from the nearby Cholla Well Field extracting from the C-Aquifer. Two of the wells in the Cholla Well Field are operated by the JCIC; water from these wells is principally used for irrigation but can be diverted to Cholla Reservoir when required.

Plant infrastructure includes four single CCR units referred to as the FAP, BAP, Bottom Ash Monofill (BAM), and Sedimentation Pond (SEDI). All the CCR units except the SEDI are located north of I-40 at a higher elevation than the plant (Figure 1). The SEDI was the first of the CCR Units placed into service in 1976. The FAP and BAP dams were completed in 1978, and the BAM came into operation in the late 1990s. The boundaries of CCR units depicted in Figure 1 are based on available historical plans for the units.

The 420-acre FAP and 80-acre BAP receive most of the CCR generated during coal combustion at the plant. Over time, the FAP has primarily received slurried (wet) fly ash and flue gas desulfurization (FGD) solids while the BAP has principally received sluiced bottom ash and various co-disposed uniquely associated wastes (per CFR §261(b)(4)(ii)). With the sale of much of the fly ash generated at plant, current discharges to the FAP consist predominantly of slurried FGD solids while the BAP continues to receive sluiced bottom ash and sluice water that is recirculated back to the plant through siphon lines. Drained bottom ash is removed from the BAP and placed in the BAM.

JCIC operates an irrigation pipeline/canal that conveys groundwater extracted from three production wells located to the southeast of the plant; the production wells are named JCIC-East, JCIC-West, and P-34. The extracted water is conveyed to agricultural properties located in the vicinity of Joseph City (Figure 1). Near the FAP and BAP, the conveyance structure is an underground pipeline that runs parallel to and just south of I-40. Various flow control and monitoring structures are present along the length of the pipeline and are used to fill stock ponds and irrigate fields adjacent to the pipeline.

2.2 Hydrology/Hydrogeology

Surface Water Hydrology. The plant is located north of the Little Colorado River within the Middle Little Colorado watershed. The Little Colorado River is a meandering, intermittent stream located within a large, alluvial floodplain. Near the plant, the Little Colorado River is ephemeral, and its current flow path is south of and parallel to the BNSF railroad tracks located south of the plant. Hydraulic connection between the Little Colorado River with the Little Colorado River Alluvium is limited at the plant by the depth to groundwater and expected to be influenced by one or more paleochannels in the underlying bedrock.

The FAP and BAP are located within ephemeral tributaries to the Little Colorado River alluvium underlying the plant area. An unnamed wash system with a drainage basin of approximately 1,200 acres discharges into the FAP. The BAP is located within a small tributary to Tanner Wash which only flows in response to precipitation.

Hydrogeology. The first hydrogeologic unit underlying the FAP and BAP, the Little Colorado River and Tanner Wash Alluvial Aquifer, extends under the plant area, Cholla Reservoir, and the Tanner Wash and Little Colorado River drainage channels. The alluvial aquifer in this area receives recharge from the Little Colorado River and any potential leakage through anthropogenic features such as the reservoir and the nearby JCIC pipeline/canal. Regionally, the alluvial aquifer is not used for drinking water or agricultural water due to relatively poor water quality (i.e., naturally-high total dissolved solids [TDS] concentrations) and low yield. For example, TDS concentrations measured in groundwater samples collected from the alluvial background well for CCR groundwater monitoring (i.e., MW-64A) have ranged between 10,000 and 13,000 milligrams per liter (mg/L). These concentrations exceed the Environmental Protection Agency secondary water quality standard for TDS of 500 mg/L and the maximum recommended TDS concentration for irrigation water of 2,000 mg/L (Ayers and Westcot, 1985). Alluvial wells installed near the Site have typically produced no greater than ten gallons per minute (gpm), while wells installed in the underlying C-Aquifer (discussed below) are reportedly capable of producing between 400 to 800 gpm (Hoffmann et al., 2005). The depth to water in the alluvial aquifer ranges from several feet to several tens of feet below ground surface (bgs) near the Site, varying spatially based on proximity to recharge sources and topography and seasonally based on rainfall-runoff patterns. Where present, groundwater flows generally in the downstream direction of the drainages under which it is present, that is, from east to west in the Little Colorado River alluvium and from north to south in the Tanner Wash alluvium. Localized groundwater flow direction in the Little Colorado River alluvial aquifer is also influenced by deeper paleochannels that may not coincide with the present-day river channel. The alluvial aquifer does not discharge into Cholla Reservoir. The depth to the alluvial aquifer is at least 20 ft lower than the base of the shallow reservoir.

The second hydrogeologic unit underlying the FAP and BAP is the C-Aquifer, which consists of the Coconino Sandstone and Schnebly Hill Formation in the vicinity of the plant. Groundwater in this aquifer exists under confined conditions in localized areas north of the Little Colorado River where sufficiently thick layers of the Moenkopi Formation's Moqui member acts as a confining bed. Groundwater movement in the C-aquifer is generally to the northwest. However, the Cholla well field (southwest of the plant) has created a cone of depression that has made the groundwater flow in a westerly direction in that area. Near the FAP dam, the inferred flow of the groundwater in the C-aquifer is generally towards the west.

The alluvial aquifer and the C-aquifer are generally separated by the Moenkopi Formation, a regional aquitard that creates a barrier between the two aquifers in the vicinity of the Site. In areas where the C-aquifer is confined (primarily north of the Little Colorado River), the Wupatki member of the Moenkopi Formation has been observed to be water-bearing (i.e., in hydraulic communication with the C-aquifer); however, the overlying Moqui member, which can be up to 300 feet thick in the vicinity of the plant, limits hydraulic connection between the alluvial aquifer and the C-aquifer.

2.3 Construction/Operation of the FAP and BAP

FAP. Figure 2 shows relevant FAP infrastructure including the layout of the dam and locations of existing seepage collection systems and groundwater monitoring wells completed in the alluvium, which is the uppermost aquifer underlying the FAP per the CCR groundwater monitoring system certification report (Montgomery & Associates, 2017). Key construction/operation information for the FAP is as follows:

- The FAP has a total storage capacity of 18,000 acre-ft and a normal operating pool/maximum design ash elevation of 5,114 ft amsl.

- The primary CCR streams currently placed in the FAP include flue gas desulfurization (FGD) slurry and small amounts of fly ash that are not sold to a cement manufacturer. Over time, bottom ash, boiler slag, and various co-disposed uniquely associated wastes (e.g., boiler cleaning waste, oil/water separator solids, and storm water) have also been placed in the FAP.

- The FAP is located within an unnamed drainage channel that formerly discharged into the Little Colorado River alluvium and is generally bounded to the northwest, north and east by bedrock outcrops and to the southwest and south by a dam system.

- The FAP dam was constructed approximately 40 years ago on alluvial and Moenkopi Moqui geologic units.

- The FAP dam has a clay core and an underlying slurry cutoff wall that extends one foot into the Moenkopi Moqui or two feet into stiff clay along the centerline of the dam where the alluvium prior to dam construction was greater than 20 ft thick. Where the alluvium was less than 20 ft thick, no cutoff wall was constructed, and the clay core was extended through the alluvium to the top of the Moenkopi Moqui bedrock. As a result, the slurry cutoff wall is only located in the middle portion of the dam and the extended clay core is located on the edges of the dam (Figure 2).

- The alluvium within the footprint of the FAP had minimal quantities of groundwater prior to the construction and operation of the FAP; furthermore, pre-construction boreholes advanced (in support of dam design) within the footprint of the FAP in the Moenkopi Moqui did not generally encounter groundwater prior to construction and operation of the FAP.

- Site investigations and evaluations to support design of the dam concluded that the alluvium has a relatively low permeability for alluvial materials due to the presence of silt and clay in the formation; the underlying Moenkopi Moqui is understood to have a low vertical permeability, but could possibly have a higher lateral secondary permeability through bedding planes, fractures, joint structures, and the presence of gypsum nodules, stringers and layers.

- Following dam construction, fourteen piezometers were drilled and screened in the Moenkopi Moqui downgradient of the dam to monitor dam stability. During drilling in 1979, none of the piezometers encountered groundwater. As of late 2018, all but two of the piezometers downgradient of the dam that are screened in the Moenkopi Moqui have measurable water levels. Piezometers screened downgradient of the FAP dam in the Moenkopi Moqui have approximately 30 to 50 feet of head and monitored levels appear to fluctuate with long-term water level trends in the FAP suggesting a localized hydraulic connection between the FAP and the Moenkopi Moqui in the vicinity of the dam.

- Extracted C-Aquifer groundwater from the JCIC canal that runs parallel to and south of the I-40 in the vicinity of the FAP is used to irrigate unlined stock ponds and fields immediately south of the FAP. The impacts of these activities on the alluvial aquifer are not well defined; however, investigation of redox conditions in the vicinity of some of these surface discharges indicate that the discharges appear to have promoted localized reducing conditions that contribute to varying inorganic constituent concentrations (i.e., arsenic) in the area.

- In anticipation of pond closure, APS began limiting the volume of water and CCR discharged into the FAP in early 2016. Since that time, the pond level has declined by 10.5 ft. In November 2019, the reservoir level during the annual dam inspection was 5087 ft amsl (APS, 2020).

- There are three existing seepage collection systems located downgradient of the FAP (the I-40 Seep, Geronimo Seep, and Hunt Seep collection systems) that collect shallow groundwater. Seepage water from the Geronimo Seep and Hunt Seep collection systems is pumped back to the plant for reuse, while seepage water collected from the I-40 Seep collection system (when present) is drained to a shallow, unlined evaporation pond. The collection systems were installed from 1993 to 1995 and designed to address observed seepage at the ground surface.

BAP. Figure 3 shows relevant BAP infrastructure including the layout of the dam and locations of existing seepage collection systems and groundwater monitoring wells completed in the Tanner Wash alluvium, which is the uppermost aquifer underlying the BAP per the CCR groundwater monitoring system certification report (Montgomery & Associates, 2017). Key construction/operation information for the BAP is as follows:

- The 80-acre BAP has a total storage capacity of 2,300 acre-ft and a normal operating pool/maximum design ash elevation of 5,112 ft amsl.

- The primary CCR stream currently placed in the BAP is slurried bottom ash with transport water. The bottom ash settles in the east and west upstream storage cells of the unit and the water is decanted to the reservoir portion of the unit where it is ultimately siphoned back to the plant for reuse. Bottom ash that has been drained of water is excavated from the BAP and placed in the BAM. In addition to bottom ash, smaller quantities of fly ash, boiler slag, FGD sludge, SEDI pond effluent, and co-disposed uniquely associated wastes (i.e., cooling tower blowdown, oil/water separator effluent and solids, boiler cleaning waste, and storm water) have also been placed in the BAP over time.

- The BAP is located within a drainage channel that formerly discharged into Tanner Wash and is bounded to the west by a bedrock outcrop and to the south and east by a dam system. The BAM is located adjacent to and northeast of the BAP.

- The BAP dam is comprised of the southern and eastern dams operating as one dam system. The southern BAP dam was constructed on alluvial and Moenkopi Moqui geologic units within a tributary to Tanner Wash. The eastern BAP dam was constructed on alluvial, Moenkopi Holbrook, Moenkopi Moqui, and Chinle geologic units and generally is aligned parallel to flow in Tanner Wash. The dams have been used to impound bottom ash at the Site for approximately 40 years.

- Similar to the FAP, the southern BAP dam has a slurry cutoff wall in the region of the dam where the alluvium was greater than 20 feet thick prior to construction, and elsewhere in the southern and eastern dams, where the alluvium was less than 20 feet thick, the clay core extended through the alluvium to bedrock. As a result, the slurry cutoff wall was only constructed in the middle portion of the southern dam.

- Since the slurry cutoff wall was designed to provide dam stability and not prevent seepage under the dam, the slurry cutoff wall in the southern portion of the dam does not extend all the way through the alluvium to the Moenkopi Moqui bedrock. There is an approximately 10 to 20-ft thick layer of alluvium at the base of the cutoff wall above the Moqui. The base of the slurry cutoff wall is at an elevation of 4980 ft amsl.

- The alluvium in Tanner Wash and the wash beneath the southern dam appears to have a zone of coarser material at depth that includes clasts of petrified wood, likely eroded from the Chinle formation. It is likely that the various geologic units surrounding Tanner Wash contribute to natural variations in groundwater quality in the alluvium.

- Along the toe of the eastern dam, piezometers are screened in the Moenkopi Holbrook and Moenkopi Moqui formations and all have water elevations ranging between approximately 5,050 to 5,090 ft amsl. The Moenkopi Moqui is understood to have a low vertical permeability but could possibly have a higher lateral secondary permeability through bedding planes, fractures, joint structures, and the presence of gypsum nodules, stringers, and layers. To the east of the eastern dam, the ground surface elevation declines and intersects the potentiometric surface produced by head in the BAP. Surface seeps have occurred where flow may be migrating through distinct beds in the Moqui that intersect ground surface.

- In general, there are multiple pathways for seepage flow beyond the southern and eastern dams. The potentiometric surface indicates hydraulic connection between the water in the BAP and the groundwater elevations in monitoring wells and piezometers screened in the alluvium, Moenkopi Holbrook, and Moenkopi Moqui. Water level elevations in a majority of the piezometers have increased over time since their installation.

- There are four existing seepage collection systems and one monitoring location downgradient of the BAP (the P-226, Tanner Wash, Petroglyph, and Toe Drain seepage collection systems and the West Abutment seep monitoring location). These systems extract intercepted groundwater and pump the seepage back to the BAP. The collection systems were installed in the early 1990s and were designed to address observed seepage at the ground surface.

3.0 MEASURES TO LIMIT FUTURE RELEASES TO GROUNDWATER DURING OPERATION (*§257.103(F)(2)(V)(B)(1)*)

This section responds to the risk mitigation plan requirement identified in §257.103(f)(2)(v)(B)(1) by presenting:

- Operational measures the plant has recently taken and plans to take in the future to reduce the quantity of CCR and associated water discharged to the FAP during planned operations thru shutdown; and
- Ongoing operation of existing seepage interception systems that will limit the quantity of contaminant mass introduced to the aquifer downgradient of the FAP and BAP.

3.1 Operational Measures

Since the rate of seepage from an unlined surface impoundment is a function, in part, of the hydraulic head in the impoundment, one of the most effective approaches that can be implemented to limit the release of discharges to surrounding groundwater is to reduce the hydraulic head in the impoundment.

As indicated in Section 2.1, the water level in the BAP is controlled operationally by siphoning bottom ash transport water back to the plant for reuse. There is a minimum water level that must be maintained for the recirculation system to operate properly and therefore limited flexibility to reduce the hydraulic head in this unit too far in advance of shut down. However, discharges to the FAP are for final disposal since there is no use for the water in this unit at the plant (the total dissolved solids content is on the order of 70,000 milligrams per liter). As a result, APS has been able to implement operational measures to reduce the quantity of CCR and associated water discharged to the FAP which contribute to decreasing the hydraulic head in this impoundment and limiting releases of seepage from the unit to groundwater.

Operational measures that have recently, or are expected to, reduce the hydraulic head in the FAP include:

- ***Shutdown of Unit 2 in 2015*** – The shutdown of a coal-fired boiler unit reduces the quantity of CCR generated at a plant as well as the amount of wastewater produced from associated process equipment (e.g., cooling tower blowdown). From 2014 (before shutdown) to 2017 (after shutdown), the rates of fly ash, bottom ash, and scrubber solids generated decreased significantly:

Table 1 Summary of CCR Waste Reduction from 2014 to 2017

CCR Waste Stream	CCR Generation Rate in 2014 [tons per year]	CCR Generation Rate in 2017 [tons per year]	Percent Decrease
Fly Ash	461,000	277,000	40%
Bottom Ash	115,000	69,100	40%
FGD Scrubber Solids	81,700	25,800	68%

<u>Note</u>: CCR generation rates estimated from power production data.

A significant portion of the fly ash generated at the plant has been sold to local cement manufacturers for some time. The quantity of fly ash sold has increased to the extent such that with the shutdown of Unit 2, there have been limited discharges of fly ash to the FAP since that time.

- ***Plant modifications to Limit Discharges to the FAP*** – Other measures taken recently to limit discharges to the FAP include rerouting discharges from the FAP seepage collection systems (back to the plant) that formerly discharged into the FAP, removing a discharge line from the plant's general water system to the FAP that was previously used to balance flows at the plant, and repairing various service water leaks.

The above-mentioned measures have resulted in an average decline in the water level at the FAP of approximately 2.5 feet per year since March 2016. The water level in the FAP had been increasing at a rate of 0.5 ft per year in the 15 years prior to shutting down Unit 2 and taking these measures.

- ***Shutdown of Unit 4 at the end of 2020*** – Only Units 1 and 3 will remain operational until shutdown of the plant. Shutdown of Unit 4 will result in another decrease in CCR generation rates starting in 2021:

Table 2 Summary of CCR Waste Reduction after 2019

CCR Waste Stream	Average CCR Generation Rate from 2017-2019 [tons per year]	Estimated CCR Generation Rate from 2021-2024 [tons per year]	Percent Decrease
Fly Ash	253,000	120,000	53%
Bottom Ash	63,300	30,000	53%
FGD Scrubber Solids	27,400	8,700	68%

Note: CCR generation rates estimated from power production data.

- ***Additional Activities Conducted in Advance of FAP Closure*** - Water levels in the FAP will continue to be monitored through plant shutdown to evaluate progress and promote the implementation of timely enhancements to the FAP dewatering strategy. Assessment and planning for additional measures to reduce the hydraulic head in the FAP is ongoing. Construction of run-on controls to limit the introduction of stormwater into the FAP will begin no later than 2023 and additional operational modifications to reduce the quantity of water discharged to the FAP are being evaluated. APS is also exploring whether there are any feasible options for treatment of free water at the FAP.

3.2 Seepage Intercept System Operation

APS maintains and routinely inspects several seepage intercept trenches and extraction wells which capture shallow impacted groundwater before it migrates downgradient in the alluvial aquifer system. The captured groundwater is then conveyed to the plant either directly (in the case of the FAP) or indirectly (in the case of the BAP).

These systems (or upgraded systems serving the same function) will continue to operate until groundwater complies with GWPSs (see Section 5.0). Operational activities for these systems include weekly visits to each system by APS personnel and maintenance as required by APS contractors.

The systems are briefly described in Tables 3 and 4 that follow and shown on Figures 2 and 3.

Table 3 Summary of Seepage Intercept Systems at the FAP

FAP	
Geronimo Seepage Intercept System	Two seepage intercept trenches and two extraction wells. The intercept trenches channel water to two sumps. The wells and sumps are set to operate when groundwater reaches a defined level in each well and sump.
Hunt Seepage Intercept System	One seepage intercept trench which is sloped to a sump at the western end of the trench. An extraction well is also present south of the trench. The well and sump are set to operate when groundwater reaches a defined level in the well and sump.
I-40 Seepage Intercept System	One seepage intercept trench which connects to a pipe which is sloped to drain to a shallow, unlined evaporation pond.

Table 4 Summary of Seepage Intercept Systems at the BAP

BAP	
P-226 Seepage Intercept System	Ten extraction wells screened in the alluvium. The wells are set to operate when groundwater reaches a defined level in each well.
Tanner Wash Seepage Intercept System	Three seepage intercept trenches sloped to a sump. The pump in the sump is set to operate when the water level in the sump reaches a defined depth.
Petroglyph Seepage Intercept System	Two trenches sloped to a sump. The pump in the sump is set to operate when the water level in the sump reached a defined level.
Toe Drain Seepage Intercept System/West Abutment Seep Monitoring	Seepage at the western abutment of the southern dam is monitored using a weir. After monitoring, seepage infiltrates back into the aquifer and is collected in the Toe Drain Seepage Intercept System.

As long as these systems are consistently and appropriately operated, they limit discharges to groundwater. Improvements to these systems will be conducted as part of the remedial process for impacted groundwater (Section 5.0) and will be implemented as soon as practicable.

4.0 GROUNDWATER IMPACT DELINEATION, CONTAMINANT EXPOSURE PATHWAY ANALYSIS, AND RISK MITIGATION MEASURES (*§257.103(F)(2)(V)(B)(2)*)

This section responds to the risk mitigation plan requirement identified in §257.103(f)(2)(v)(B)(2) by presenting:

- Ongoing groundwater monitoring activities and data that form the basis for the delineation of constituent plumes associated with the FAP and BAP;
- An exposure pathway analyses for the contaminated groundwater as well as a discussion of why human health and ecological risk receptors are not currently being impacted; and
- Risk mitigation measures to promptly detect and mitigate exposure pathways with the potential to impact receptors in the future.

4.1 Groundwater Monitoring Program

An array of CCR monitoring system and supplementary groundwater wells are in place at the Site to monitor the downgradient groundwater conditions of the FAP and BAP. Most of these monitoring wells are installed in either the Little Colorado River or Tanner Wash Alluvium. The remaining wells are completed in the Coconino Sandstone Formation of the C-Aquifer or the Moenkopi Formation that separates the alluvium from the C-Aquifer. The groundwater monitoring network is shown on Figure 1 and the most recent groundwater monitoring activities are summarized in the *Annual Groundwater Monitoring and Corrective Action Report for 2019* (Wood, 2020a). As noted in the Annual Report, the groundwater flow direction in the alluvium downgradient of the FAP dam (i.e., the waste boundary) is west-southwest. The groundwater flow direction in the alluvium underlying the BAP is generally to the southwest along Tanner Wash; however, there is a radial component of groundwater flow towards the east-southeast due to hydraulic head from the BAP.

APS initiated CCR groundwater detection monitoring at the Site in November 2015 and completed collection of at least eight initial rounds of monitoring at all wells in October 2017, in accordance with the CCR Rule. Statistical analysis of CCR Rule Appendix III constituent data collected during detection monitoring was completed in January 2018 and updated in May 2018. The analysis concluded that there was enough evidence to declare a statistically significant increase over background for one or more CCR Rule Appendix III constituents at the FAP and BAP (Montgomery & Associates, 2018).

On the basis of this analysis, assessment monitoring was initiated at these CCR units and a statistical evaluation of CCR Rule Appendix IV constituent monitoring data was conducted. The results indicated groundwater protection standard (GWPS) exceedances for arsenic, cobalt, fluoride, lithium, and molybdenum downgradient of the FAP (Wood, 2018a) and cobalt and lithium downgradient of the BAP (Wood, 2018b). To address the GWPS exceedances of these constituents of concern (COCs), APS evaluated potential corrective measures for groundwater impacts at the FAP and the BAP in a Corrective Measures Assessment (CMA; Section 5).

4.2 Nature and Extent of COCs

FAP. Figures 4 through 8 present iso-concentration contour maps for fluoride, arsenic, cobalt, lithium, and molybdenum at the FAP, respectively, based on the results of monitoring well installation activities and groundwater sampling conducted from October 2018 through April 2020. The extent of groundwater impacts is defined by the respective COC GWPSs. Iso-concentration maps depict higher concentrations of these constituents in the alluvium immediately downgradient of the dam where the cutoff wall is not present. This observation, as well as groundwater level contours, suggest that the presence of the cutoff wall mitigates seepage of COC mass from the FAP to the alluvial aquifer.

In general, the extent of FAP COCs is limited to the alluvium directly downgradient of dam and no more than approximately a quarter of a mile south of I-40. Estimates of travel time for the COC plume at the time the CCR Groundwater Monitoring System was certified (Montgomery & Associates, 2017) suggest a rate of migration of 0.18 ft per day between the FAP and the edge of the FAP alluvium and a rate of migration of 0.81 ft per day in the Little Colorado River alluvium (south of I-40) based on measured hydraulic gradients and estimated aquifer hydraulic conductivities and porosities.

Evaluation conducted after declaring statistically significant levels (SSLs) of arsenic and cobalt over respective GWPSs indicates that the presence of these constituents in groundwater downgradient of the FAP may not be solely associated with leakage of COC mass from the FAP. The distributions of arsenic and cobalt in the aquifer downgradient of the FAP are not consistent with the distribution of other FAP COCs (i.e., fluoride, lithium, molybdenum) or boron, which has been used to indicate the presence of CCR in groundwater at the Site. Arsenic is a naturally occurring constituent in soil and groundwater and observed variations are likely associated with the heterogeneity of arsenic-containing minerals in the alluvial sediments or localized redox interactions promoted by irrigating the area from the JCIC canal. Cobalt is not routinely present at concentrations exceeding the GWPS in downgradient monitoring wells and was likely identified as a COC based on a false positive SSL during the initial statistical analysis of CCR Rule Appendix IV data (Wood, 2018a). The results of an ASD conducted to evaluate arsenic and cobalt at the FAP concluded that the exceedance declared for cobalt at the FAP is not attributable to a release from the FAP (Wood, 2020b). The ASD was inconclusive for arsenic at the FAP and recommended additional investigation.

Wood completed additional studies and collected additional water quality data to evaluate the possibility that the elevated concentrations of arsenic in groundwater are the result of localized reducing conditions. The results of this evaluation suggest the FAP is not the cause of the elevated arsenic concentrations at MW-67A. Rather, the analytical data indicate reduced groundwater is causing the mobilization of arsenic from aquifer sediments into groundwater near MW-67A. Accordingly, the iso-concentration contour for arsenic concentrations in groundwater downgradient of the FAP has been revised and is depicted on Figure 5.

BAP. Figures 9 and 10 show current iso-concentration contour maps for cobalt and lithium, respectively, at the BAP, based on the results of groundwater sampling conducted from October 2018 through April 2020. The extent of impact is defined by the respective COC GWPSs. The iso-concentration map for cobalt suggests that this constituent is present in groundwater around the entire downgradient extent of the south and eastern dams at concentrations that exceed the GWPS. The highest concentrations are located in the vicinity of M-52A (screened from 20 to 70 ft bgs) and Tanner Wash well W-307 (screened from 40 to 60 ft bgs). Based on the relative absence of cobalt in BAP water, a cobalt leaching evaluation was conducted with bottom ash and samples collected from various geologic formations in the vicinity of the BAP. The results indicated that elevated cobalt concentrations in groundwater are not directly attributable to water in the BAP but result from the mobilization of cobalt from the solid materials which underlie the BAP (Wood, 2020c).

Groundwater monitoring indicates that elevated concentrations of cobalt are confined to properties north of I-40; the plant area is not impacted. Estimates of travel time for the COC plume at the time the CCR Groundwater Monitoring System was certified (Montgomery & Associates, 2017) suggest a rate of migration of 0.15 ft per day between the BAP and the edge of the BAP alluvium and a rate of migration of

0.96 ft per day in the Little Colorado River alluvium (south of I-40) based on measured hydraulic gradients and estimated aquifer hydraulic conductivities and porosities.

Groundwater analysis conducted after declaring SSLs of lithium over the GWPS indicates that the presence of this constituent in groundwater downgradient of the BAP is not associated with leakage of COC mass from the BAP. An ASD conducted for this constituent indicates that the distribution of lithium in the aquifer downgradient of the BAP is not consistent with the distribution of boron, a CCR indicator constituent. Furthermore, the absence of lithium in pond water samples collected from the BAP and the variability of lithium concentrations in Tanner Wash alluvial groundwater suggests that observed lithium concentrations are associated with natural variations in the lithium levels due to aquifer heterogeneity (Wood, 2019b).

4.3 Exposure Pathway Analysis

There are currently no off-site receptors being impacted by groundwater contamination present in the alluvial aquifer downgradient of the FAP and BAP. Furthermore, there are no anticipated future impacts to receptors, but the risk mitigation measures identified in Section 4.5 will need to be implemented to ensure receptors are not exposed to impacted groundwater in the future. Nevertheless, the pathways for exposure to groundwater contamination by off-site residential, commercial, recreational, and possible livestock receptors have been analyzed to support development of appropriate mitigation measures.

Figure 11 depicts the exposure pathway analysis for impacts due to groundwater contamination downgradient of the FAP and BAP. The analysis summarizes associated receiving media, transport mechanisms, exposure routes, and potential receptors. As indicated, the primary pathways to potential receptors occur through the transport of contaminated surface water and/or groundwater in the alluvial aquifers and C-Aquifer to secondary receiving media (i.e., surface water bodies and extracted potable, irrigation, or commercial water) and the subsequent exposure of these receptors via ingestion and dermal contact with the contaminants. Each of these pathways is discussed below.

4.3.1 Surface Water Pathway

The surface water exposure pathway involves the discharge of impacted groundwater to the land surface at surface seeps located on the downgradient edge of the FAP and BAP (groundwater does not discharge to Cholla Reservoir or the Little Colorado River as the depth to groundwater is sufficiently lower than the base of this shallow lake or the river in the vicinity of the plant). If seepage water from the FAP and BAP discharged to surface in an uncontrolled manner, it could then potentially migrate to nearby surface water bodies through surface runoff. Nearby surface water bodies include the ephemeral stream in Tanner Wash and small ponds used for livestock watering or irrigation. Potential receptors for this pathway include individuals who may use the ephemeral surface water bodies on off-site property near the FAP and BAP for outdoor recreational activities and populations who utilize the ponds for agriculture or livestock watering. Exposure routes include ingestion and dermal contact.

As discussed in Section 3.3, APS operates seepage intercept systems at the FAP and the BAP which effectively capture seepage water before it can migrate to nearby surface water bodies through surface runoff. There are no uncontrolled surface seeps that discharge into Tanner Wash. Additionally, APS limits access to the seepage intercept systems with fencing. Therefore, the surface water pathway is currently an incomplete pathway (i.e., no receptors are being exposed to contamination). This pathway could potentially become complete if operation of the seepage intercept systems is discontinued.

4.3.2 Alluvial Groundwater Pathway

This section examines the potential for impacted groundwater downgradient of the FAP and the BAP to migrate off-site to privately-owned wells installed in the alluvial aquifer. Potential receptors for this pathway include populations who may utilize the alluvial aquifer for potable water, irrigation water, or commercial water in the future (i.e. residential and commercial receptors). Exposure routes for this pathway include ingestion and dermal contact.

As indicated in Section 3.1, the alluvial aquifer in the vicinity of the Site is not used as a water source due to high background concentrations of total dissolved solids in the alluvial groundwater and poor yield of the associated aquifer. Additionally, the viability of the underlying C-Aquifer as a water source is likely to prevent potential future receptors from selecting the alluvial aquifer as a water source. To ensure no receptors are currently utilizing the alluvial aquifer downgradient of the FAP and the BAP as a water source, APS reviewed the Arizona Department of Water Resources (ADWR) well registry database (Wells 55 database) to identify privately-owned water supply wells located near the Site. The water supply wells identified from the Wells 55 database are depicted on Figure 12; each well's construction details are summarized in Table 1. The well construction details, and lithologic logs included in the Wells 55 database indicate that the ADWR-registered water supply wells depicted on Figure 12 are installed in the underlying C-Aquifer, and not in the alluvial aquifer. Therefore, the alluvial groundwater pathway is currently incomplete (i.e., no receptors are being exposed to contamination). This pathway could become complete and result in receptor exposure to the contaminated groundwater under the following conditions:

- The installation of a water supply well in the alluvial aquifer downgradient of the FAP and the BAP; and
- The migration of impacted groundwater downgradient of the FAP and the BAP to an alluvial water supply well.

Risk mitigation measures to address this possibility are discussed in Section 4.5.

4.3.3 C-Aquifer Groundwater Pathway

This section examines the potential for impacted alluvial groundwater downgradient of the FAP and BAP to reach water supply wells installed in the C-Aquifer. Potential receptors for this pathway include populations who extract groundwater from the C-Aquifer for water supply purposes, which could include both residential and commercial receptors. Exposure mechanisms for this pathway include ingestion and dermal contact.

Figure 12 depicts ADWR-registered water supply wells installed in the C-Aquifer downgradient of the Site. As discussed in Section 2.2, the C-Aquifer is confined by the Moqui member of the Moenkopi Formation in areas where alluvial groundwater is impacted by the FAP and the BAP. The aquitard created by this confining unit acts as a barrier to the vertical migration of impacted groundwater within the Little Colorado River and Tanner Wash alluvial aquifer immediately downgradient of the FAP and BAP to the C-Aquifer. Furthermore, groundwater elevations measured in wells installed in the C-Aquifer indicate that an upward hydraulic gradient exists from the C-Aquifer to the overlying confining unit. The upward hydraulic gradient acts as a barrier to the downward vertical migration of impacted groundwater to the C-Aquifer. Therefore, the C-Aquifer pathway to downgradient receptors is currently incomplete (i.e., no receptors are being exposed to contamination), but could potentially become complete in the future if impacted groundwater in the alluvial aquifers migrates to areas where the alluvial aquifer and the C-Aquifer are in direct communication. These locations could potentially include:

- Areas where the Moqui Member of the Moenkopi Formation is absent; or
- C-Aquifer wells with damaged or faulty annular seals between the alluvial aquifer and C-Aquifer.

The risk mitigation measures for this pathway are discussed in Section 4.5.

4.4 Risk Evaluation

Wood conducted a risk evaluation using current concentrations of CCR constituents in groundwater and seepage water to estimate the human health and ecological risk posed by the impacted groundwater plume in the event that one or more exposure pathways become a complete pathway to a receptor (i.e., a receptor is exposed to contamination) in the future. To be conservative, the risk evaluation included all CCR constituents that have been detected at SSLs over GWPSs in groundwater from the alluvial aquifer at the FAP and the BAP, regardless of whether a successful ASD has excluded the constituent as a Site COC.

The human health risk evaluation was performed using all rounds of data collected (2015 to present) by combining the data by area (BAP and FAP) to develop 95% upper confidence limit (UCL) exposure point concentrations (EPCs) for each evaluated constituent. The EPCs were compared to risk-based threshold values developed using a hazard quotient of 1 and cancer risk of 10^{-4} (generally consistent with GWPSs) for hypothetical future off-site residential exposure scenario and hypothetical future on- or off-site industrial worker scenario. For the wells with exceedances, Wood also prepared trend graphs over time to support the overall assessment.

Results are summarized as follows:

- The conservative evaluation of a hypothetical future off-site residential receptor exposure to the impacted alluvial groundwater at the FAP identified arsenic, lithium, and molybdenum as constituents of interest (COI). The calculated EPCs for these COI only marginally exceeded screening level risk-based thresholds.
- At the BAP, the evaluation of potential exposure to the off-site impacted alluvial groundwater by the hypothetical future off-site residential receptor identified cobalt and lithium as COI. The EPC for cobalt exceeded the GWPS by an order of magnitude while the EPC for lithium was slightly above background.
- The conservative risk evaluations completed for the hypothetical future on-site and off-site industrial worker identified lithium as the only COI in groundwater at the FAP at an EPC concentration that only marginally exceeded background. This constituent was removed as a COC at the BAP based on a successful ASD.
- The seeps downgradient of the BAP identified cobalt, fluoride, and lead at concentrations virtually equivalent to (cobalt) or approximately two times greater than (fluoride and lead) screening levels for aquatic and/or terrestrial ecological receptors. Lithium was not detected above corresponding screening criteria. The seep water is collected in intercept trenches and reused as part of site operations; therefore, the detection of cobalt, fluoride, and lead at concentrations equivalent to, or slightly above, corresponding ecological screening levels is not considered to be a concern.

The evaluation of hypothetical future residential or industrial worker exposure to the impacted alluvial aquifer at the FAP and BAP is a conservative evaluation of potential risk as the alluvial aquifer is not used as a source of drinking water supply to either residents or industrial workers due to poor water quality and limited yield (the C-aquifer supplies drinking water for both these receptors). Thus, there is no current complete exposure pathway for the alluvial aquifer and no receptors are being impacted. Furthermore, as the C-aquifer supplies water for the plant, future usage of the alluvial aquifer as a source of on-site potable water is unlikely. Adjacent property owners have been notified of the elevated concentrations of CCR constituents in groundwater and there is no reasonable expectation that a future water supply well would be installed in the alluvial aquifer on these properties. The nearest off-site water supply well is located approximately 2,500 feet to the south of the FAP and is installed at a depth of 130 feet in the C-aquifer with a water level of 105 feet bgs. There is no identified connection between the alluvial aquifer at the FAP and BAP with the underlying C-aquifer as a confining unit is present between the aquifers. The measures presented in Section 4.5 will be used to monitor for and mitigate connections identified in the future. Therefore, the potential for either residential or industrial worker exposure to the CCR constituents present in the alluvial groundwater at the FAP and BAP is considered negligible.

Compliance groundwater monitoring for the FAP and BAP under the Federal CCR Rule will continue and APS will proactively evaluate the data and update this evaluation, if warranted. The Risk Evaluation and detailed results are presented in Appendix A.

4.5 Risk Mitigation Measures

This section describes the risk mitigation measures that are currently or are soon to be in place and will control the risk of exposure to potential receptors of impacted groundwater currently defined in the alluvium downgradient of the FAP and BAP.

4.5.1 Site Security

The APS facility maintains site security measures which include controlled access at the main entrance and regular site surveillance. The entire property boundary is fenced and includes signage throughout prohibiting trespassing on to the property. Seepage collection systems (located on and off-Site) are also enclosed in security fencing. The surface completions on groundwater monitoring wells are locked to prevent access.

By excluding non-APS personnel from the Site and APS-infrastructure located off-Site, potential receptors cannot interact with impacted groundwater in alluvial monitoring wells or in seepage collection systems, thereby limiting the potential for the surface water and alluvial aquifer pathways to become complete.

4.5.2 Seepage Collection System Operation

As discussed in Section 3.2, APS maintains and routinely inspects several seepage intercept trenches and extraction wells which capture shallow impacted groundwater before it can impact surface water. As long as these systems are consistently and appropriately operated, they intercept seepage water before it can migrate to nearby surface water bodies through surface runoff, thus preventing the surface water exposure pathway from being completed and impacting receptors in the future. Where warranted, improvements to these systems are planned as part of corrective measures implementation.

In addition to routine operation and maintenance of seepage collection systems, quarterly inspections of the areas around the FAP and BAP will be conducted to ensure that additional surface expressions of groundwater are identified and addressed through installation of new or expanded seepage collection systems. Seepage collection system operations as well as quarterly inspections of the area around the FAP and BAP for new indications of seepage will be documented in the Annual Groundwater Monitoring and Corrective Action Report (GMCAR).

4.5.3 Coordination with Well Owners and Routine Well Registry Updates

APS will enter into discussions with adjacent and impacted property owners to form agreements that contractually prohibit screening new wells in the impacted aquifer. APS will also review the ADWR Wells 55 database on an ongoing quarterly basis to determine if such wells have been installed. On an as needed basis, APS will enter into additional discussions with third-party owners and operators of such new wells to contractually prohibit screening of newly constructed wells within the impacted aquifer. Well registry reviews will be documented in the Annual GMCAR prepared for the Site.

In the event that a new or existing water supply well screened in the C-aquifer is identified within 1,000 ft of the impacted alluvial groundwater, APS will notify the well owner of the proximity of potential impacts and request permission to evaluate whether their extracted groundwater has been contaminated by alluvial aquifer interactions with the C-aquifer. Arizona's well construction regulation (Arizona Administrative Code R12-15-812B) requires that wells be appropriately cased and grouted to prevent cross-contamination where known mineralized (e.g., TDS exceeding 3,000 mg/L) or polluted zones of water occur. Nonetheless, , APS will take appropriate steps to rehabilitate the well or provide a replacement well to eliminate any identified potential for cross-contamination.

4.5.4 Ongoing Groundwater Monitoring

To comply with §257.90 thru §257.95 of the CCR Rule, APS currently monitors groundwater in the alluvium downgradient of the FAP and BAP for the COCs on a semiannual basis. The ongoing groundwater monitoring provides information on the extent and magnitude of groundwater impacts in the alluvial aquifer and allows for continual assessment of the alluvial aquifer and C-Aquifer exposure pathways discussed in Section 4.3. The monitoring frequency is sufficient to identify changes at the extents of identified plumes given the limited migration of COCs observed to date and provides opportunity for the implementation of corrective measures necessary to mitigate groundwater plume migration, limit the impact of contaminated groundwater to the alluvial aquifer, and ensure potential receptors are not impacted. APS will continue to evaluate interactions between the alluvial aquifer and the C-Aquifer to understand where connections may occur so that potential exposure pathways to receptors continue to be mitigated in the future.

Additionally, APS has developed a numerical groundwater model to evaluate the fate and transport of COCs in groundwater downgradient of the FAP and BAP. The next numerical groundwater model update is scheduled for early 2021 (see Section 5.2.4) and will incorporate information that was not available at the time the initial model was developed. This tool will be integral to predicting the future migration and attenuation of the plumes and provide a useful basis for evaluation of groundwater monitoring data as it is collected.

4.5.5 Public Notification

Open and transparent communication with the public is key to successful risk identification and mitigation and is required per the CCR Rule. To date, APS has notified affected private property owners downgradient of the FAP and the BAP of GWPS exceedances in groundwater. Prior to sending the notification letters, APS met with property owners interested in discussing the status of groundwater underlying their property.

APS has also identified and interviewed key area stakeholders in preparation for a planned open house to present the findings of the CMA prior to selecting a remedy for the FAP and the BAP. The purpose of the interviews was to assess the public's understanding of site conditions so that the presentation content and materials can be developed with a clear and concise message.

In addition, APS maintains a CCR information webpage in accordance with §257.105 and §257.106 of the CCR Rule. Notifications required by the CCR Rule are posted to this webpage.

5.0 PLAN TO EXPEDITE AND MAINTAIN CONTAINMENT OF GROUNDWATER IMPACTS (*§257.103(F)(2)(V)(B)(3)*)

This section responds to the risk mitigation plan requirement indicated in §257.103(f)(2)(v)(B)(3) by presenting a plan to expedite and maintain containment of groundwater impacts and includes:

- Corrective measures assessment and remedy selection pursuant to the requirements of the CCR Rule;
- Implementation of interim response measures to address impacts while remedy selection is ongoing; and
- Identification of ongoing risk mitigation activities that would prompt contingency actions for possible groundwater impacts in the future.

5.1 Corrective Measures Assessment and Remedy Selection

In 2019, APS completed a CMA for the FAP and BAP and identified various corrective measures alternatives for consideration at the Site within the aggressive timeframe required by the CCR Rule. *The Assessment of Corrective Measures for the Fly Ash Pond and the Bottom Ash Pond* (Wood, 2019a) includes documentation of the nature and extent of impacts in groundwater downgradient of the FAP and BAP and an assessment of applicable corrective measures based on available information. The assessment screens applicable technologies for each unit, assembles retained technologies into developed alternatives, and then assesses the alternative corrective measures using the criteria defined in §257.96 of the CCR Rule (Assessment of Corrective Measures).

The technology screening process and CMA were informed by the development of a numerical groundwater flow and contaminant transport model for the Site which reflected the understanding of the unit-specific CSMs at the time the CMA was prepared. A total of eight technologies were screened for the FAP and nine for the BAP. A total of four alternatives were evaluated for the FAP and two for the BAP.

The CMA also identified multiple pre-design studies that were required to refine the understanding of the Site prior to remedy selection. These studies are currently being progressed with routine status updates reported on a semiannual basis.

As required by §257.96(e) of the CCR Rule, the results of the CMA for the FAP and the BAP will be made available to interested and affected parties through an open house at least 30 days prior to selecting a remedy or remedies for the FAP and the BAP. Once the remedy is selected, a remedy selection report will be prepared to describe the retained corrective measures, identify how the corrective measures comply with the requirements of the CCR Rule, and present a schedule for implementing and completing remedial activities.

Typical remedy implementation schedules include sequential remedial design, construction, operation, and post-operational phases with extended durations that are common in groundwater remediation projects. However, if pilot-scale field testing of likely remediation strategies can be implemented and evaluated (a.k.a. interim response measures) prior to or concurrent with remedial design activities, groundwater remediation efforts could be expedited by multiple years (on the order of 1 to 10 years), providing valuable insight into what works at the Site and increasing the certainty of how long plume remediation will take.

5.2 Implementation of Interim Response Measures

Since remedy selection has not occurred and investigations supporting this process are ongoing, it is difficult to explicitly identify what the schedule impacts of implementing expediting measures would be compared to what was already planned to comply with the CCR Rule. It could be argued that since there are no receptors to groundwater impacts, any identified corrective measures beyond source control and monitored natural attenuation (which according to initial groundwater modeling efforts conducted during the CMA process could take over 100 years) will expedite and maintain containment of identified plumes. However, focusing solely on the potential schedule impacts of active remediation technologies does not present a comprehensive plan to identify what APS will do to address groundwater impacts as soon as technically feasible.

To this end, APS plans to expedite and maintain containment of groundwater contamination in the near-term with the implementation of a series of interim response measures that will promote plume remediation while advancing remedy selection by demonstrating and evaluating what is successful in the field. The basis and planned schedule for these interim response measures are discussed in the following subsections. Progress in interim response measure implementation will be documented in the Annual GMCAR. Tables 5 and 6 provide an overview of how these response measures fit into the likely elements of the selected remedy including what activities have been conducted to date, what activities are planned in the future and how planned activities expedite corrective measures implementation.

5.2.1 Seepage and Groundwater Extraction at the FAP

The highest COC concentrations in the groundwater plumes downgradient of the FAP are generally located directly adjacent to the FAP dam at either monitoring wells M-51A or W-123, which are both screened at least partially at the top of the Moenkopi Moqui Formation. This observation has prompted recent investigation in this vicinity and assessment of existing seepage collection system operations which have contributed to the conclusion that weathered portions of the Moqui appear to be acting as a limited network of preferential flow conduits to alluvial sediments for seepage from the FAP. This conclusion is based in part on the fact that:

- The construction of the dam system relies on the Moqui as competent bedrock,
- The shallow Moqui has become locally saturated over many years of FAP operation,
- The Moqui likely has a relatively higher vertical permeability than horizontal permeability due to bedding planes and the potential for dissolution of gypsum stringers, and
- There is a significant level of dilution observed between the FAP water and groundwater concentrations after 40 years of discharging waste to the FAP.

Since existing seepage collection systems at the FAP have inadequate influence where the highest COC concentrations in groundwater are observed, APS will implement an interim response measure at the FAP near the dam where seepage is discharging to groundwater. The basis for this approach is that interception strategies in source areas have the most impact on limiting the mass of contamination discharging to the environment and the time COCs remain at concentrations that exceed GWPSs.

The selection of an appropriate interception approach for the interim response measure has been carefully considered given the implications for dam stability and potential to compromise the vertical permeability of the Moqui at this location (which could be as thin as 20 ft in thickness based on the boring log for Coconino monitoring well W-125). Technologies that remove water in lieu of impounding water are thus preferable so a containment well system has been selected as the interim response measure approach. Implementation of the interim response measure will be used to further assess alternative technologies for seepage/groundwater interception identified in the CMA (i.e., a containment well system, seepage collection trench and/or cutoff walls).

Cone penetration tests conducted in July 2020 in the soils on the downstream edge of the FAP have helped further characterize this area and have identified non-continuous layering of alluvial soils with varying permeabilities (sands, clays, and gravel) as well as the extent of competent Moqui. Testing has also identified artesian conditions in the vicinity of the Geronimo Seepage Collection System. These results will be documented in a technical memorandum attached to the 2020 GMCAR and have been used to locate four new test wells that will target the locations of artesian conditions and potentially thicker zones of gravelly alluvium. The new wells are scheduled to be installed in December 2020 with aquifer testing conducted immediately thereafter. These new wells will be converted to extraction wells and incorporated into the existing Geronimo Seepage Collection System prior to July of 2021 as an interim response measure to expedite plume containment and better understand whether additional technologies are required to address seepage in this region. The interim response measure is expected to be effective in expanding the influence of the Geronimo Seepage Collection System because existing operations are likely only removing water from shallow French drains and the new containment well system will extract impacted groundwater closer to where discharges of seepage from the Moqui to the alluvium are occurring.

While APS does not at this time have sufficient data to determine how much sooner GWPSs will be achieved through the use of this measure, the extent of influence and corresponding extraction rates of test wells achieved during implementation of this expediting measure will be invaluable in assessing how long various remedial alternatives will take to clean up groundwater at the FAP. The update of the contaminant fate and transport model which is also being expedited as an interim response measure (see Subsection 5.2.4) will be integral to assessing the impact of containment operations. At a minimum, implementation of this interim response measure prior to remedy selection is occurring at least six months to a year sooner than APS had originally planned to initiate field operations as part of the final remedy selected pursuant to the CCR Rule's CMA process (see 40 CFR §257.98).

5.2.2 In-Situ Remediation at the BAP

At the BAP, the COC is cobalt which is present in groundwater downgradient of the BAP at concentrations that are two orders of magnitude higher than cobalt concentrations in the BAP water (which do not exceed the GWPS). The distribution of elevated cobalt concentrations in groundwater downgradient of the BAP generally correspond to the distribution of boron concentrations in groundwater so cobalt impacts in alluvial groundwater appear to be related to BAP operations; however, the mechanism for cobalt release was not understood at the time the CMA was prepared.

Additional characterization activities completed in 2020 suggest that cobalt is being mobilized under reduced conditions from native soils through the introduction of a relatively permanent source of water at the BAP that infiltrates into the surrounding arid environment. The most effective means of addressing this type of contaminant release is to target where and why the transformation is occurring and either change the conditions that promote contaminant release or contain the impacts at these locations.

The concentrations of cobalt are relatively dilute in the bulk of the groundwater plume (generally on the order of 0.02 to 0.03 mg/L compared to a GWPS of 0.006 mg/L) but highest near the southeast corner of the BAP dam at monitoring well M-52A (0.039 mg/L) and at well W-307 located in Tanner Wash (0.084 mg/L). Both of these wells are located near or downgradient of surface seeps installed along the eastern portion of the dam system that are being controlled by seepage collection systems targeting shallow groundwater.

On the basis that there is limited alluvial thickness around the eastern portion of the dam system to support groundwater extraction (existing seepage collection systems have not adequately controlled impacts) and in-situ treatment strategies can successfully change the redox environment in localized areas, APS will implement an interim measure at the BAP that includes both laboratory and field-scale oxidant amendment testing in regions where concentrations are highest to evaluate both the efficacy of this approach and whether potential adverse effects resulting from the change in redox conditions occur with this remedial approach. A test plan will be developed in early 2021 and will include a schedule that will target interim measure implementation prior to the end of the 2021. A well installation program in the vicinity of the BAP has already been scheduled for the first quarter of 2020 that includes investigation of groundwater upgradient of W-307 pending access to land owned by the Bureau of Land Management. Samples of alluvial and Moqui soils will be collected during this field effort for laboratory testing.

APS will also evaluate conventional plume containment on APS property downgradient of the southern portion of the BAP dam as an additional interim measure to improve seepage collection system operations, where feasible. The alluvial thickness at this location is significant enough to support a containment well approach but requires further analysis to assess the potential impact operations would have on the cobalt plume (for instance, shallow monitoring well W-306 located adjacent to the dam does not have appreciable concentrations of cobalt but cobalt concentrations at co-located deep well W-305 are elevated). Development of a strategy to evaluate containment in this vicinity will be included in the test plan identified earlier in this section and will likely include the installation and aquifer testing of at least one new extraction well in a manner similar to that identified for the FAP. Operation of the test well will commence no later than July 2021.

Similar to the interim response measure planned for the FAP, there is insufficient data at this time to determine how much sooner GWPSs will be achieved through implementation of planned interim response measures at the BAP; however, the extent and duration of oxidant amendment influence achieved during implementation of the oxidant amendment expediting measure and the extent of influence and groundwater extraction rate achieved through the containment well expediting measure will be invaluable in assessing how long various remedial alternatives will take to clean up groundwater at the BAP. The update of the contaminant fate and transport model which is also being expedited as an interim response measure (see Subsection 5.2.4) will be integral to assessing the impact of these potential remedial approaches. At a minimum, implementation of these interim response measures prior to remedy selection is occurring at least six months to a year sooner than APS had originally planned to initiate field operations as part of the final remedy selected pursuant to the CCR Rule's CMA process (see 40 CFR §257.98).

5.2.3 Evaluation of FAP Dewatering Strategies

Reducing the hydraulic head in the FAP will have the most significant impact on the duration that groundwater exceeds GWPSs at the Site because this activity will promote source control of contaminant mass flux in the groundwater plume. Evaluation of seepage collection system operations indicates that the quantity of seepage/groundwater removed from the Geronimo and Hunt systems has declined in recent years and may be attributable, in part, to declines in the water level in the FAP.

As indicated in Section 3.1, FAP dewatering is being prioritized and proactive measures to reduce the amount of water discharged into the unit are occurring so that the unit can be closed as soon as technically feasible. Additional strategies that will be evaluated in 2021 as potential interim measures to promote FAP dewatering include extraction of free water at the FAP with treatment prior to reuse in plant operations and reuse of extracted free water in scrubber system operations. The progress of FAP dewatering will be presented in the Annual GMCAR.

5.2.4 COC Natural Attenuation Assessment and Groundwater Model Update

The successful integration of monitored natural attenuation into a groundwater remedy requires demonstrating that declines in COC concentrations are occurring at rates protective of human health and the environment. Since development of this type of demonstration requires more time than was available prior to completion of the CMA in accordance with the CCR Rule, APS will advance a natural attenuation demonstration as an interim measure by:

- Evaluating collected groundwater data for trends,
- Identifying applicable attenuation mechanisms for each COC,
- Collecting evidence demonstrating attenuation mechanisms,
- Assessing plume stability, and
- Refining assessments of plume migration.

Monitored natural attenuation of COCs is expected to be an element of the selected remedy because concentrations are only marginally elevated relative to GWPSs (in most instances maximum concentrations are within the same order of magnitude as the respective GWPS), concentrations are anticipated to decline once the CCR units are closed, and there are no receptors of contaminant impacts.

The results of the natural attenuation demonstration as well as the information obtained through implementation of the FAP and BAP interim response measures identified in Sections 5.2.1 and 5.2.2 will be incorporated into an update of the numerical groundwater flow and contaminant fate and transport model developed for the Site. The model will be used to estimate and track the duration that groundwater will exceed GWPSs downgradient of the BAP and FAP. A groundwater model update workplan has been developed and the update will begin in early 2021. Since the update will be able to incorporate the results of the FAP and BAP interim response measures, updates to estimates required for cleanup based on field data will occur sooner than originally planned.

5.3 Possible Contingency Actions

To ensure that impacts beyond those that are currently understood are mitigated in a timely manner, ongoing monitoring and evaluation are incorporated into this plan to expedite and maintain containment of groundwater impacts. As discussed in Section 4.5, routine review of well installation records, groundwater monitoring, and site inspections will be conducted on an ongoing basis to assess whether changes that are not currently anticipated in the remedy are required. Assessment of this information will be necessary to evaluate observed trends, update plume maps and the groundwater model, and ultimately improve the CSM.

If these activities indicate that a new release or change in the nature or extent of groundwater contamination is occurring, likely contingency actions will include:

- Increasing the sampling frequency at wells in the vicinity of the issue;
- Expanding the monitoring well network to support an evaluation of the lateral and vertical extent of the issue; and
- Implementation of upgrades or enhancements to seepage collection or groundwater remediation systems (including but not limited to installing new seepage collection systems if new seepage

locations are identified, implementing a downgradient groundwater containment system if plume migration with the potential to impact a downgradient receptor is identified, and/or exploring additional in-situ chemical treatment options).

Additional contingency actions may be considered depending on the nature of additional releases identified in the future; however, these actions cannot be anticipated at this time.

6.0 REFERENCES

Aquatic Consulting & Testing, 2002. *Cholla Reservoir Report*.

Arizona Public Service Co. (APS), 2020. *Cholla Power Plant Fly Ash Dam, Bottom Ash Dam, Sedimentation Pond, and Bottom Ash Monofill Annual CCR Impoundment and Landfill Inspection Report, 2019*. APS Generation Engineering, Design Engineering. January 21, 2020.

Ayers, R.S. and D.W. Westcot, 1985. *Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29, Rev.1.* Food and Agriculture Organization of the United Nations, Rome, Italy.

Federal Register, 2020.*Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure,* Final Rule July 29,2020.

Hoffman, J.P.; Bills, D.J; Phillips, J.V; Halford, K.J.; 2005. *Geologic, hydrologic, and chemical data from the C aquifer near Leupp, Arizona*. United States Geological Survey (USGS) Scientific Investigations Report 2005-5280.

Montgomery & Associates, 2017. *Cholla Power Plant Coal Combustion Residuals Program - Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks*. Navajo County, Arizona. Document #CH_GW_SystemCert_020_20170919. September 19, 2017.

Montgomery & Associates, 2018. *Cholla Power Plant Coal Combustion Residuals Program – Statistical Analysis of Baseline Groundwater Monitoring Data November 2015 through September 2017*. Prepared for Arizona Public Service. January 12, 2018. Revised May 22, 2018.

Shilling, 2005. A Description, History, and Finder's Guide for the Joseph City Irrigation System, Navajo County, Arizona. Report. Linda Shilling. Tempe, Arizona: Archaeological Consulting Services, Ltd. July 8, 2005.

Wood Environment & Infrastructure Solutions, Inc. (Wood), 2018a. *CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Fly Ash Pond*. Arizona Public Service Cholla Power Plant - Navajo County, Arizona. Technical Memorandum. Prepared on behalf of Arizona Public Service. October 15, 2018.

Wood, 2018b. *CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Bottom Ash Pond*. Arizona Public Service Cholla Power Plant - Navajo County, Arizona. Technical Memorandum. Prepared on behalf of Arizona Public Service. October 15, 2018.

Wood, 2019a. *Assessment of Corrective Measures for the Fly Ash Pond and the Bottom Ash Pond.* Coal Combustion Residual Rule and Aquifer Protection Permit Compliance, Arizona Public Service Company, Cholla Power Plant, Navajo County, Arizona. Prepared on behalf of APS. June 14, 2019.

Wood, 2019b. *Alternative Source Demonstration for Lithium at the BAP*. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Technical Memorandum. June 6, 2019.

Wood, 2020a. *Annual Groundwater Monitoring and Corrective Action Report for 2019.* Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Prepared on behalf of APS. January 31, 2020.

Wood, 2020b. *Alternative Source Demonstration for Arsenic and Cobalt at the FAP*. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Technical Memorandum. January 31, 2020.

Wood, 2020c. *Cobalt Leaching Evaluation at the Bottom Ash Pond*. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Technical Memorandum. April 20, 2020.

TABLES

Table 5 Summary of Measures Expediting Corrective Action at The Bottom Ash Pond

Corrective Measure	Activities Conducted thru 2020	Planned Activities to Expedite Corrective Action*	How Activities Expedite Corrective Action
Operation of Seepage/Impacted Groundwater Collection Systems	• Installation and operation of the P-226, Tanner Wash, Petroglyph, and Toe Drain seepage collection systems as well as the West Abutment seep monitoring location (since the early to mid-1990s) to address observed seepage near the BAP at ground surface • Evaluation of existing seepage collection system operations (in 2020) to assess system effectiveness • Planning for a new evaporation pond (since 2018) to receive discharge from seepage collection systems after shutdown of coal combustion at the plant	• Continued operation and routine maintenance of existing seepage collection systems • Improvement of seepage collection systems based on inspections and **implementation of interim response measures to intercept/remediate impacted groundwater (i.e., in-situ treatment supplemented by groundwater extraction) and promote remedy selection** • Remedial investigation to further assess the mechanisms and which geologic formations principally participate in cobalt dissolution reactions with BAP water • Integration of collection system operational/water quality data into Corrective Action monitoring and evaluation to assess status and promote remedy effectiveness • Design and construction of the new evaporation pond with planned completion no later than April 2025	• Interception and removal of impacted seepage/groundwater from the BAP reduce the mass of contamination in the aquifer and therefore reduce the time contamination remains at elevated concentrations in the impacted groundwater • Understanding the conditions that promote the dissolution of cobalt from specific geologic formations around the BAP may allow for the development of targeted remedial measures in select areas around the unit to limit the source of cobalt in groundwater until the pond can be dewatered
Draining/Evaporation of Free Liquid from the BAP with Capping and Closure In-Place	• Conduct of a water balance study (in 2019) to assess how long free water will be present in the BAP and estimate when capping activities can be completed • Planning of BAP closure in place (since 2015) to develop closure and post closure plans	• Monitoring of the operational BAP water balance to better understand seepage quantity and predict how long dewatering will occur • Suspension of discharges to the BAP with the shutdown of coal combustion at the plant no later than April 2025 • When safe, mobilization of heavy equipment and recontouring of the BAP surface to promote drainage and soil stability • Installation of a final cover system to reduce infiltration into the subgrade of the cover and drain surface water to a detention pond that will discharge to Tanner Wash no later than October 2028	• Suspension of discharges to the BAP with the subsequent capping and closure of the pond will result in a declining hydraulic head in the pond and a reduction in the rate of seepage discharge from the BAP to the surrounding environment
Natural Attenuation of the COC in the Impacted Alluvial Aquifer	• Characterization of the downgradient extent of impacts from BAP seepage to alluvial groundwater (since 2018) • Construction of a groundwater model to evaluate future migration and attenuation of impacted groundwater downgradient of the BAP (in 2019) • Assessment of cobalt mobilization mechanisms downgradient of the BAP (in 2020) • Quantitative risk evaluation to evaluate baseline risks posed by impacted groundwater (in 2020) • Identification of exposure pathways and potential receptors (in 2020) with notification of off-site property owners (in 2019)	• Continued monitoring of the BAP groundwater well network • Installation of additional monitoring wells as needed to define and evaluate the extent of impacted groundwater • **Updating of the groundwater model as an interim response measure to incorporate information collected since the initial model was developed and refine the effects of potential remedial measures to limit the source of cobalt in groundwater**	• Prompt characterization of impacts and potential exposure pathways to receptors promotes implementing risk-based control measures

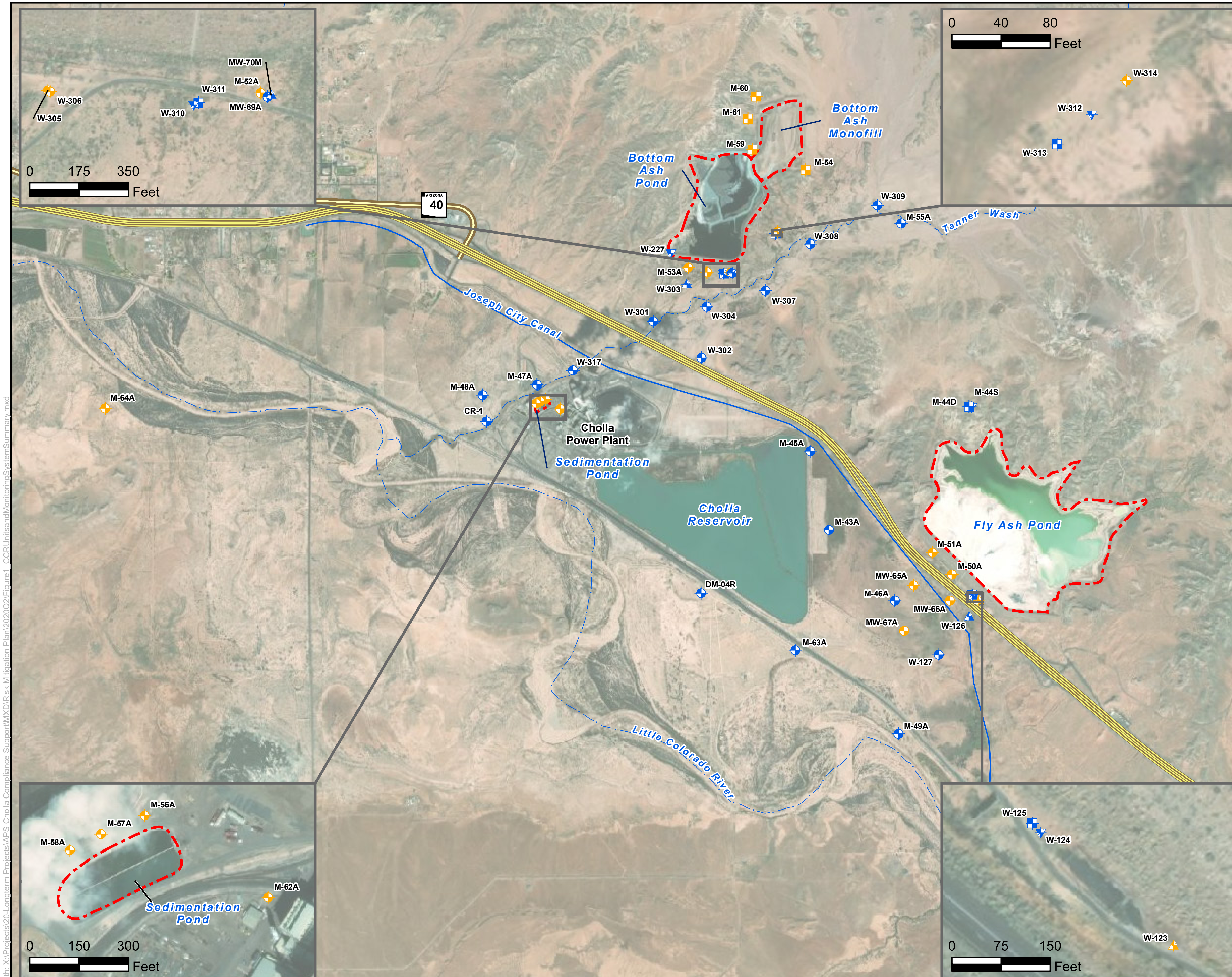
Notes:
* These activities have been identified for planning purposes to expedite implementation of remediation; planned activities will be updated as necessary during the remedy selection process.

Table 6 Summary of Measures Expediting Corrective Action at The Fly Ash Pond

Corrective Measure	Activities Conducted thru 2020 to Expedite Corrective Action	Planned Activities to Expedite Corrective Action*	How Activities Expedite Corrective Action
Operation of Seepage/Impacted Groundwater Collection Systems	• Installation and operation of the Geronimo, Hunt, and I-40 seepage collection systems (since the early to mid-1990s) to address observed seepage near the FAP at ground surface • Evaluation of existing seepage collection system operations (in 2020) to assess system effectiveness and identify improvements to enhance seepage interception and collection downgradient of the FAP • Planning for a new evaporation pond (since 2018) to receive discharge from seepage collection systems after shutdown of coal combustion at the plant	• Continued operation and routine maintenance of existing seepage collection systems • Improvement of seepage collection systems and **implementation of an interim response measure (i.e., groundwater extraction) to intercept impacted groundwater and promote remedy selection** • Integration collection system operational/water quality data into Corrective Action monitoring and evaluation to assess status and promote remedy effectiveness • Design and construction of the new evaporation pond with planned completion no later than April 2025	• Interception and removal of impacted seepage/groundwater from the FAP reduce the mass of contamination in the aquifer and therefore reduce the time contamination remains at elevated concentrations in the impacted groundwater • Potential additional containment measures as part of pre-design studies performed at Geronimo Seepage Intercept System would increase containment and reduce the time contamination remains at elevated concentrations in the impacted groundwater
Draining/Evaporation of Free Liquid from the FAP with Capping and Closure In-Place	• Reduction of discharges to the FAP (since 2015) to promote dewatering and prepare the unit for closure • Conduct of water balance studies (in 2016) to assess how long free water will be present in the FAP and estimate when capping activities can be completed • Conduct of dewatering studies (since 2016) to evaluate engineering strategies promoting draining and evaporation of water in the FAP • Planning for FAP closure in place (since 2015) to develop closure and post closure plans	• Monitoring of the operational FAP water balance to better understand seepage quantity and predict how long dewatering will occur • Continued **evaluation of dewatering strategies as part of an interim response measure** • Staging of structural fill adjacent to the FAP and use of the fill in elevation bridging to promote surface stabilization • Suspension of discharges to the FAP with the shutdown of coal combustion at the plant no later than April 2025 • Once dewatered sufficiently to safely mobilize heavy equipment, recontouring of the FAP surface to promote drainage and soil stability • Construction of diversion channels to convey storm water around the perimeter of the FAP and into detention basins that will convey the storm water under I-40 • Installation of a final cover system to reduce infiltration into the subgrade of the cover no later than October 2028	• Suspension of discharges to the FAP with the subsequent capping and closure of the pond will result in a declining hydraulic head in the pond and a reduction in the rate of seepage discharge from the FAP to the surrounding environment
Natural Attenuation of COCs in the Impacted Alluvial Aquifer	• Characterization of the downgradient extent of impacts from FAP seepage to alluvial groundwater (since 2018) • Construction of a groundwater model to evaluate future migration and attenuation of impacted groundwater downgradient of the FAP (in 2019) • Assessment of naturally occurring arsenic mobilization mechanisms downgradient of the FAP (in 2020) • Quantitative risk evaluation to evaluate baseline risks posed by impacted groundwater (in 2020) • Identification of exposure pathways and potential receptors (in 2020) with notification of off-site property owners (in 2019)	• Continued monitoring of the FAP groundwater well network • Installation of additional monitoring wells as needed to define and evaluate the extent of impacted groundwater • **Updating of the groundwater model as an interim to incorporate information collected since the initial model was developed and refine the effects of planned upgrades to seepage collection systems**	• Prompt characterization of impacts and potential exposure pathways promotes implementing risk-based control measures

Notes:
* These activities have been identified for planning purposes to expedite implementation of remediation; planned activities will be updated as necessary during the remedy selection process.

FIGURES



State Overview

Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Ephemeral Surface Water Feature
- Canal
- Approximate Extent of CCR Unit

Notes:

CCR Coal Combustion Residuals

0 1,250 2,500 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 1

CCR Units and Monitoring System Summary

Job No. 1420182040
PM: MBH
Date: 10/8/2020
Scale: 1"= 2500'

wood.

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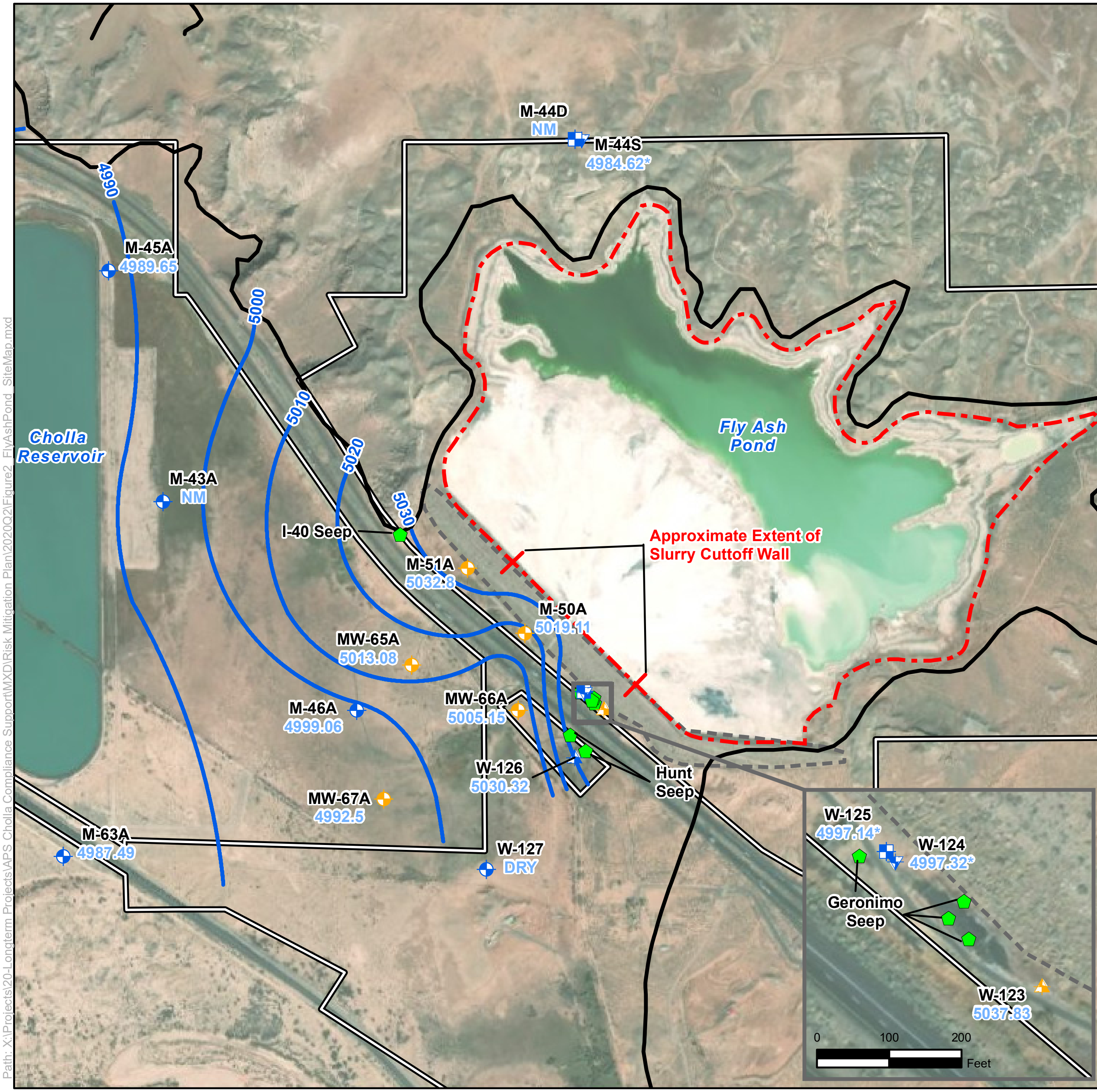

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Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Seep and Collection System Location
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- Approximate Extent of Dam
- APS Land Ownership in Plant Area and Around CCR Units

Alluvial Aquifer Potentiometric Surface - April 2020

- Groundwater Elevation (Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.83	Groundwater elevation (ft amsl) measured in April 2020
NM	Not Measured
*	Well not used in potentiometric surface mapping
ft amsl	Feet above mean sea level

0 625 1,250
Feet

N

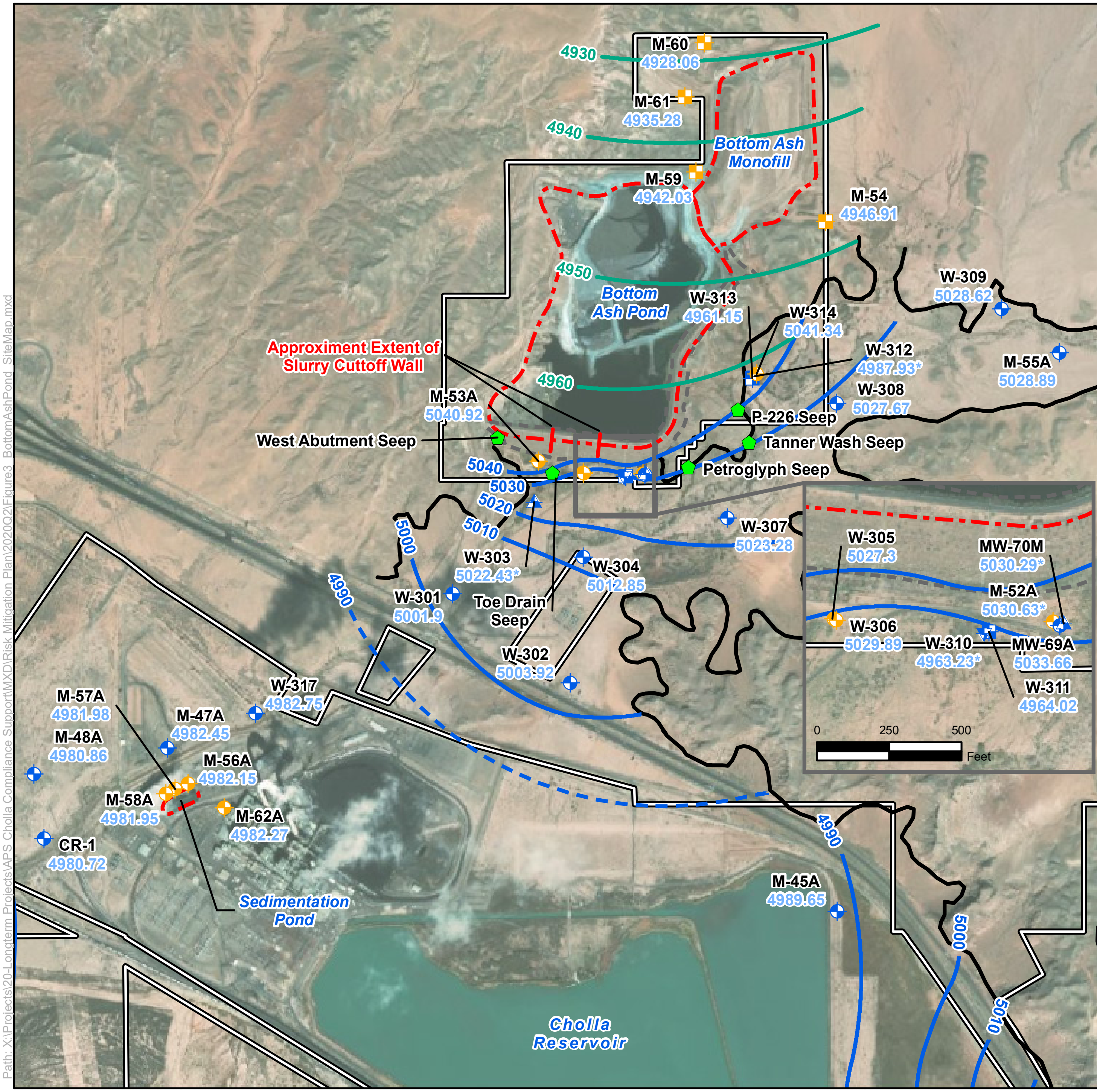
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 2

Existing Infrastructure at the Fly Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/8/2020
Scale:	1"= 1250'

wood.



Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Seep and Inception System Location
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- Approximate Extent of Dam
- APS Land Ownership in Plant Area and Around CCR Units

Groundwater Elevation- April 2020 (Dashed Where Inferred)

- Alluvial Aquifer Potentiometric Surface
- Coconino Aquifer Potentiometric Surface

Notes:

W-308	Well Identification
5027.67	Groundwater elevation (ft amsl) measured in April 2020
*	Well not used in potentiometric surface mapping
ft amsl	Feet above mean sea level

0 750 1,500 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 3

Existing Infrastructure at the Bottom Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/8/2020
Scale:	1"= 1,500

wood.

The map shown here has been created with all due and reasonable care and is strictly for use with Wood Environment & Infrastructure Solutions, Inc. Project Number 1420182040. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. Wood Environment & Infrastructure Solutions, Inc. assumes no liability, direct or indirect,whatsoever for any such third party or unintended use.

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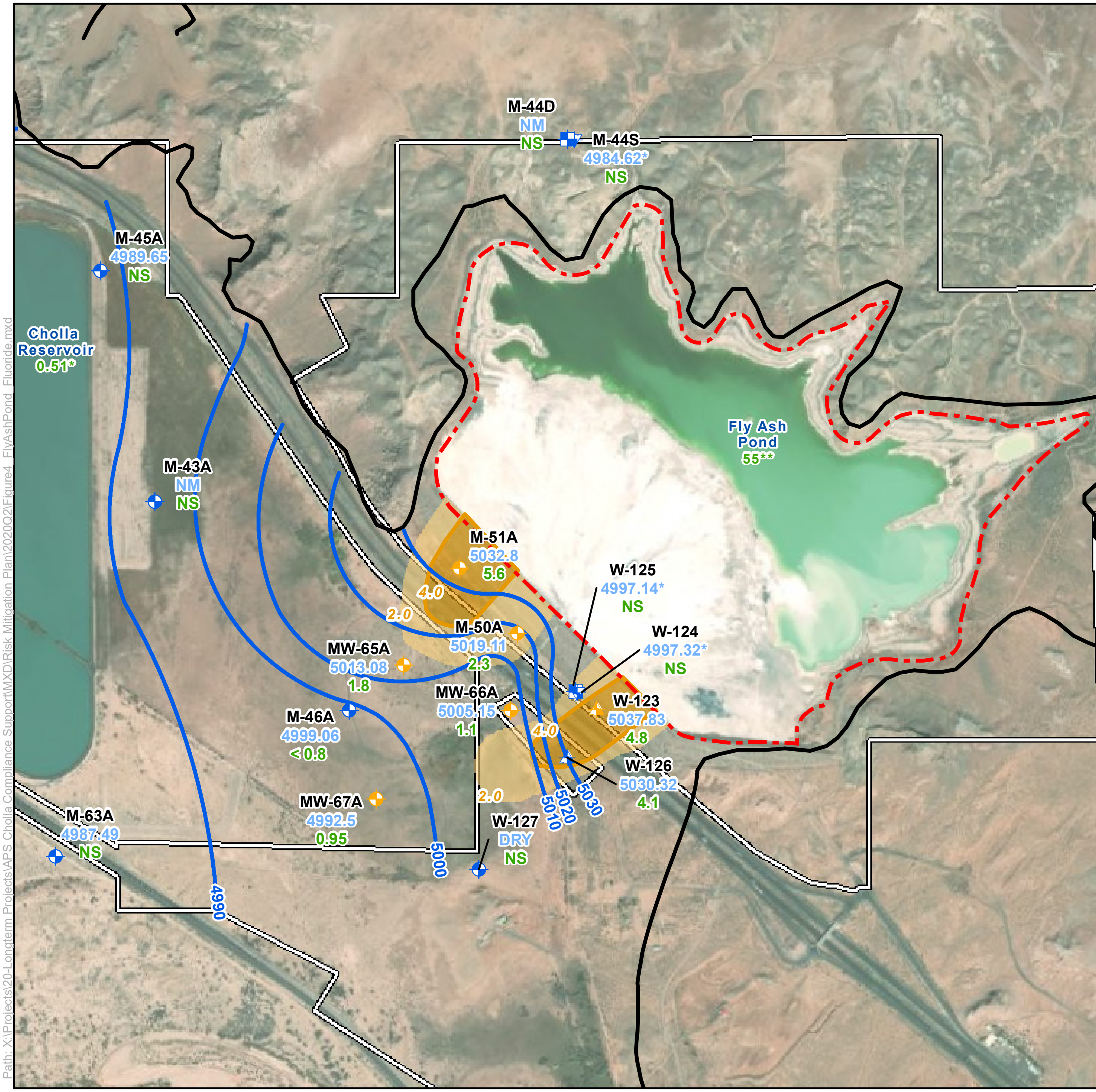


Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- APS Land Ownership

Alluvial Aquifer Potentiometric Surface - April 2020

- Groundwater Elevation (Dashed Where Inferred)

Fluoride Concentration in Alluvial Aquifer (May 2020)

- 2 mg/L
- 4 mg/L
- GWPS (4 mg/L; Dashed Where Inferred)

Notes:

W-126	Well Identification
5030.32	Groundwater elevation (ft amsl) measured in April 2020
NM	Not Measured
*	Well not used in potentiometric surface mapping
4.1	Fluoride concentration (mg/L)
*	Sampled in October 2018
**	Sampled in December 2016
NS	Not Sampled
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
CCR	Coal Combustion Residuals
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

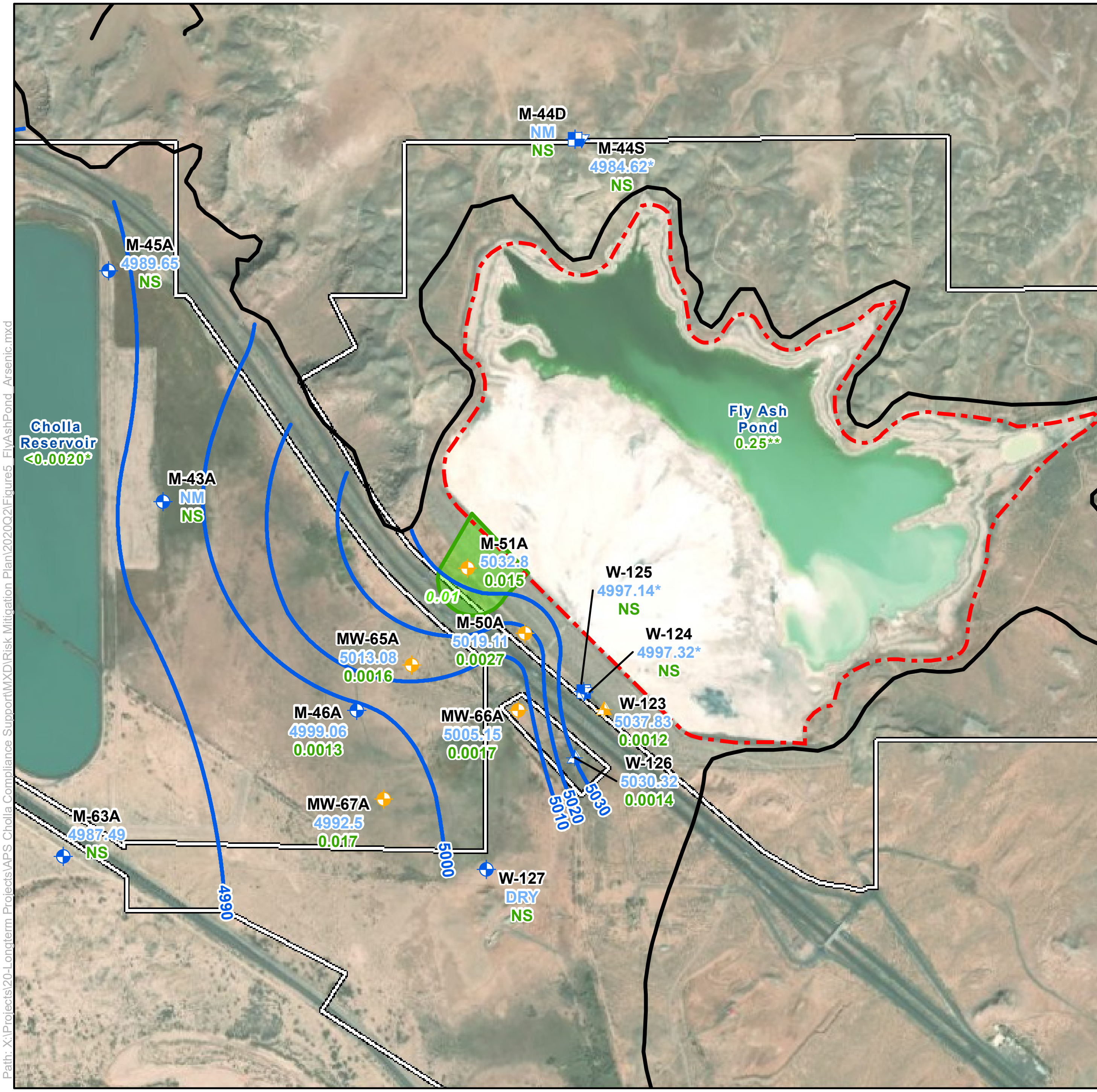
FIGURE 4

Fluoride Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/8/2020
Scale:	1"= 1250'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\Risk Mitigation Plan\2020Q2\Figure4_FlyAshPond_Fluoride.mxd



Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- APS Land Ownership

Alluvial Aquifer Potentiometric Surface - April 2020

- Groundwater Elevation (Dashed Where Inferred)

Arsenic Concentration in Alluvial Aquifer (May 2020)

- >0.01 mg/L
- GWPS (0.01 mg/L; Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.83	Groundwater elevation (ft amsl) measured in April 2020
NM	Not Measured
*	Well not used in potentiometric surface mapping
0.0012	Arsenic concentration (mg/L)
*	Sampled in October 2018
**	Sampled in December 2016
NS	Not Sampled
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
CCR	Coal Combustion Residuals
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

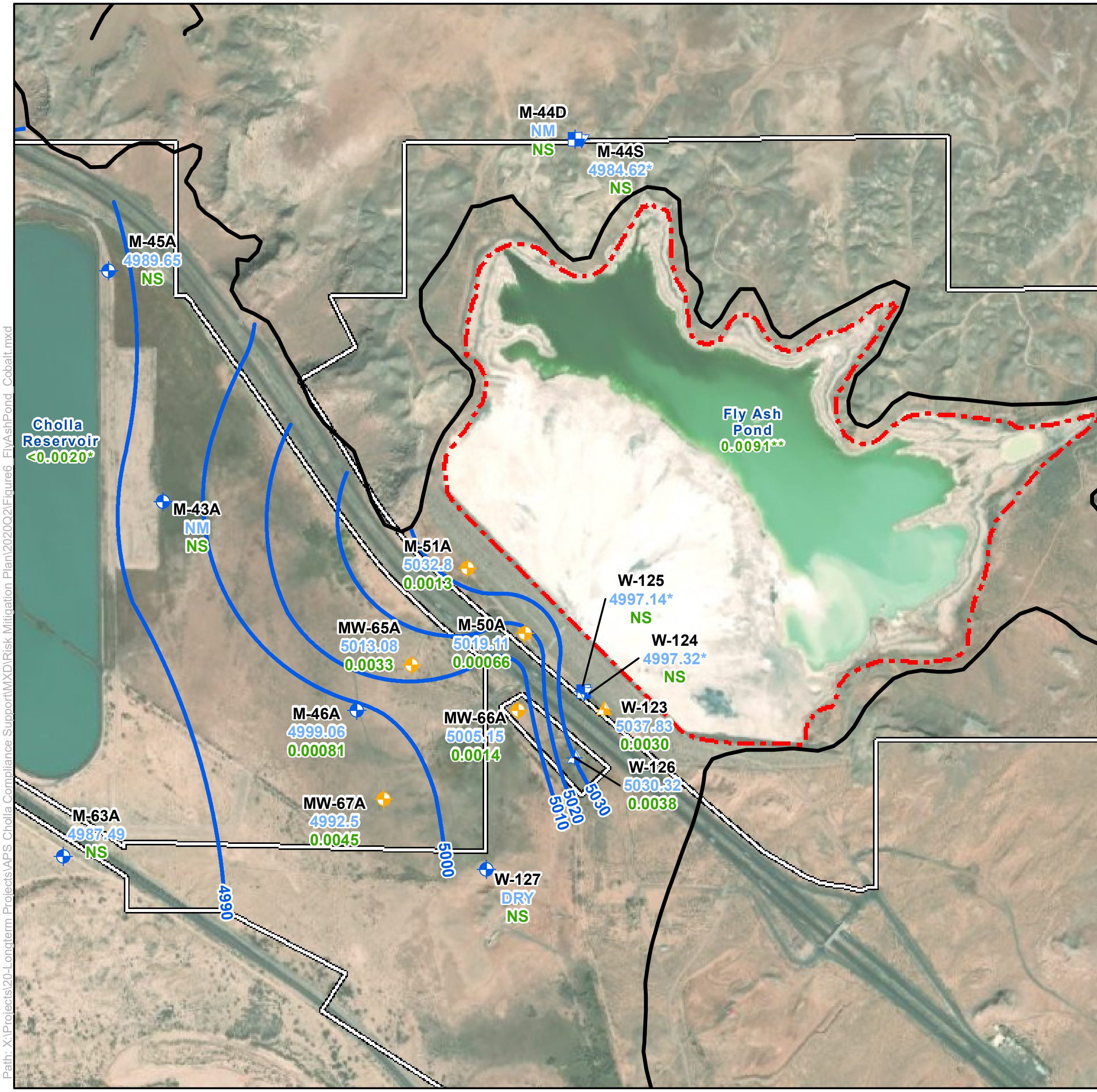
FIGURE 5

Arsenic Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/8/2020
Scale:	1"= 1250'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\Risk Mitigation Plan\2020Q2\Figure5_FlyAshPond_Arsenic.mxd



Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- APS Land Ownership

Alluvial Aquifer Potentiometric Surface - April 2020

- Groundwater Elevation (Dashed Where Inferred)

GWPS for Cobalt is 0.006 mg/L (no exceedences)

Notes:

W-123	Well Identification
5037.83	Groundwater elevation (ft amsl) measured in April 2020
NM	Not Measured
*	Well not used in potentiometric surface mapping
0.0030	Cobalt concentration (mg/L) sampled in May 2020
*	Sampled in October 2018
**	Sampled in December 2016
NS	Not Sampled
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
CCR	Coal Combustion Residuals
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

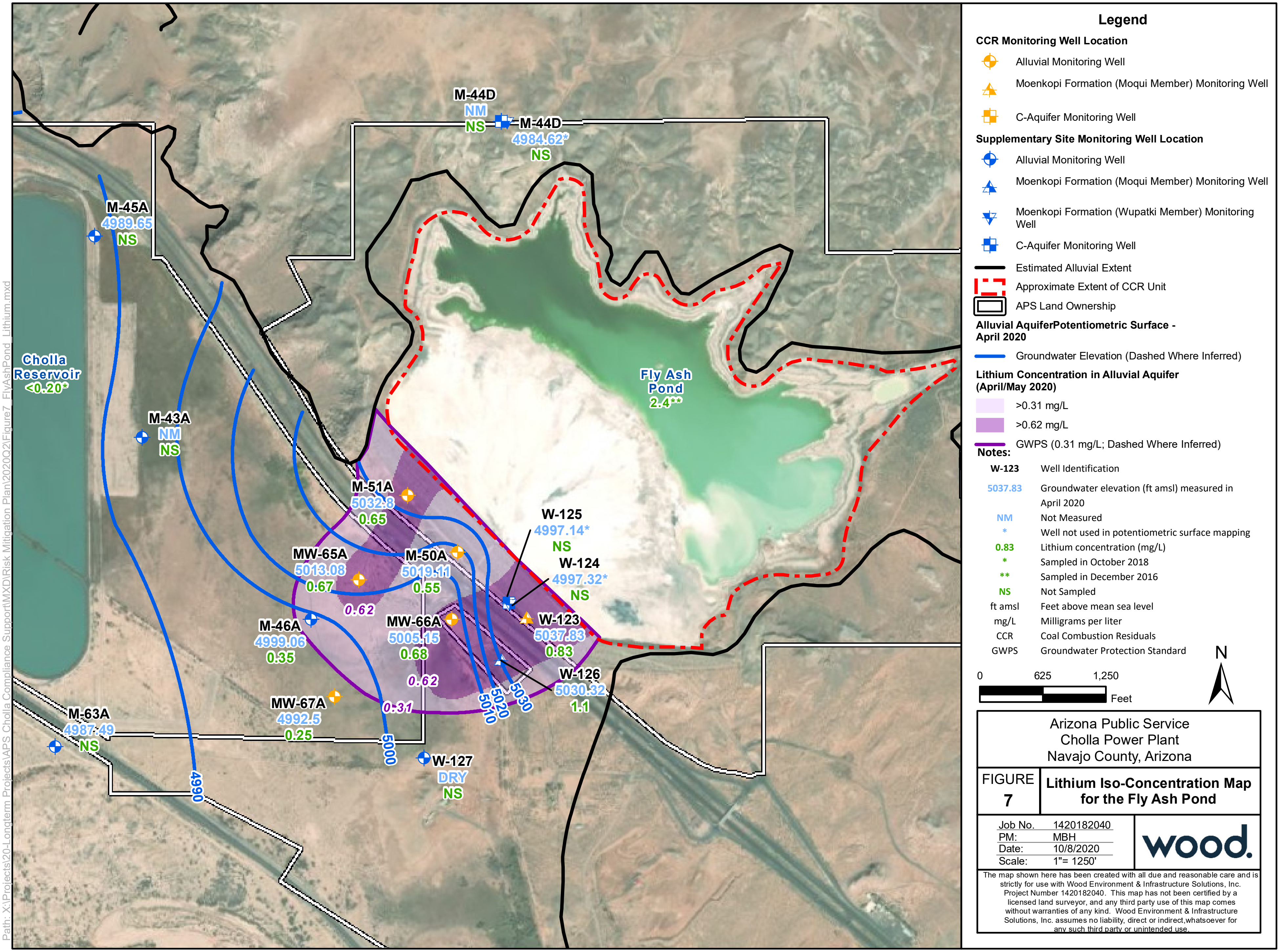
FIGURE 6

Cobalt Iso-Concentration Map for the Fly Ash Pond

Job No. 1420182040
PM: MBH
Date: 10/8/2020
Scale: 1"= 1250'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\Risk Mitigation Plan\2020Q2\Figure6_FlyAshPond_Cobalt.mxd



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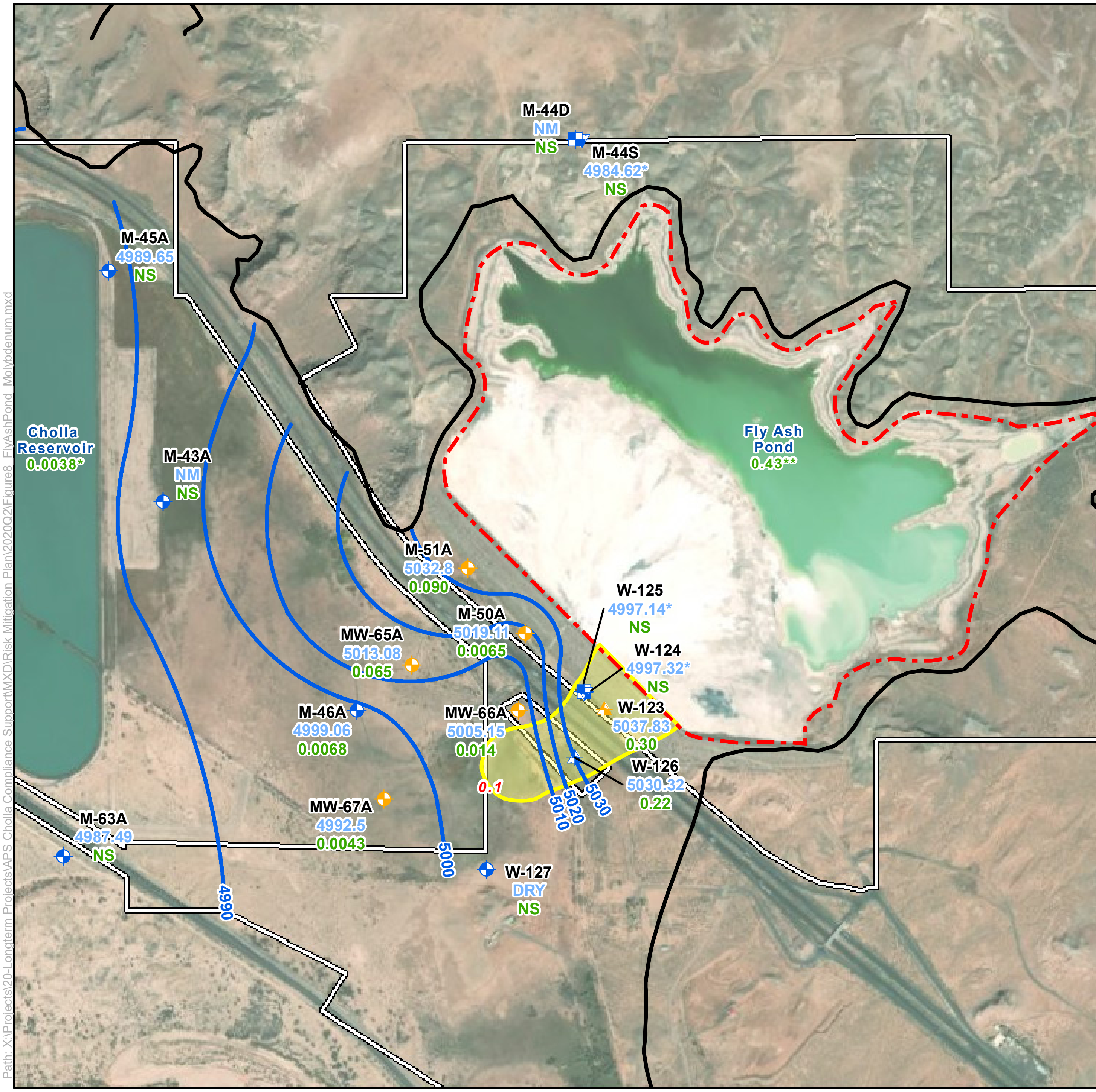


Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- APS Land Ownership

Alluvial Aquifer Potentiometric Surface - April 2020

- Groundwater Elevation (Dashed Where Inferred)

Molybdenum Concentration in Alluvial Aquifer (May 2020)

- >0.1 mg/L
- GWPS (0.1 mg/L; Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.83	Groundwater elevation (ft amsl) measured in April 2020
NM	Not Measured
*	Well not used in potentiometric surface mapping
0.30	Molybdenum concentration (mg/L)
*	Sampled in October 2018
**	Sampled in December 2016
NS	Not Sampled
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
CCR	Coal Combustion Residuals
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

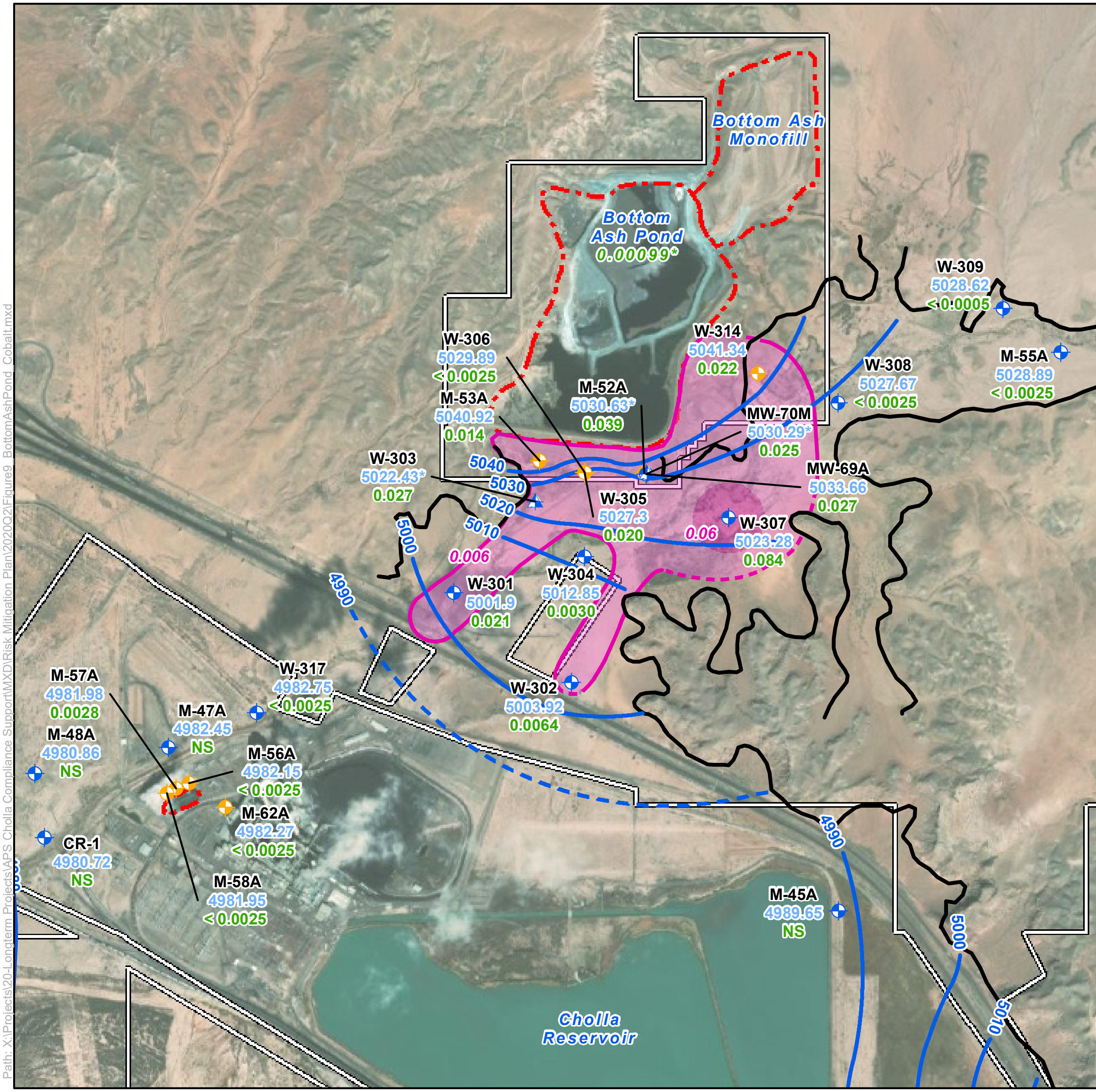
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 8

Molybdenum Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/8/2020
Scale:	1"= 1250'

wood.



Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- APS Land Ownership

Alluvial Aquifer Potentiometric Surface - April 2020

- Groundwater Elevation (Dashed Where Inferred)

Cobalt Concentration in Alluvial Aquifer (April/May 2020)

- >0.06 mg/L
- >0.006 mg/L
- GWPS (0.006 mg/L; Dashed Where Inferred)

Notes:

W-309	Well Identification
5028.62	Groundwater elevation (ft amsl) measured in April 2020
*	Well not used in potentiometric surface mapping
<0.0005	Cobalt concentration (mg/L) measured in April/May 2020
*	Sampled in March 2019
NS	Not Sampled
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
GWPS	Groundwater Protection Standard

0 750 1,500 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

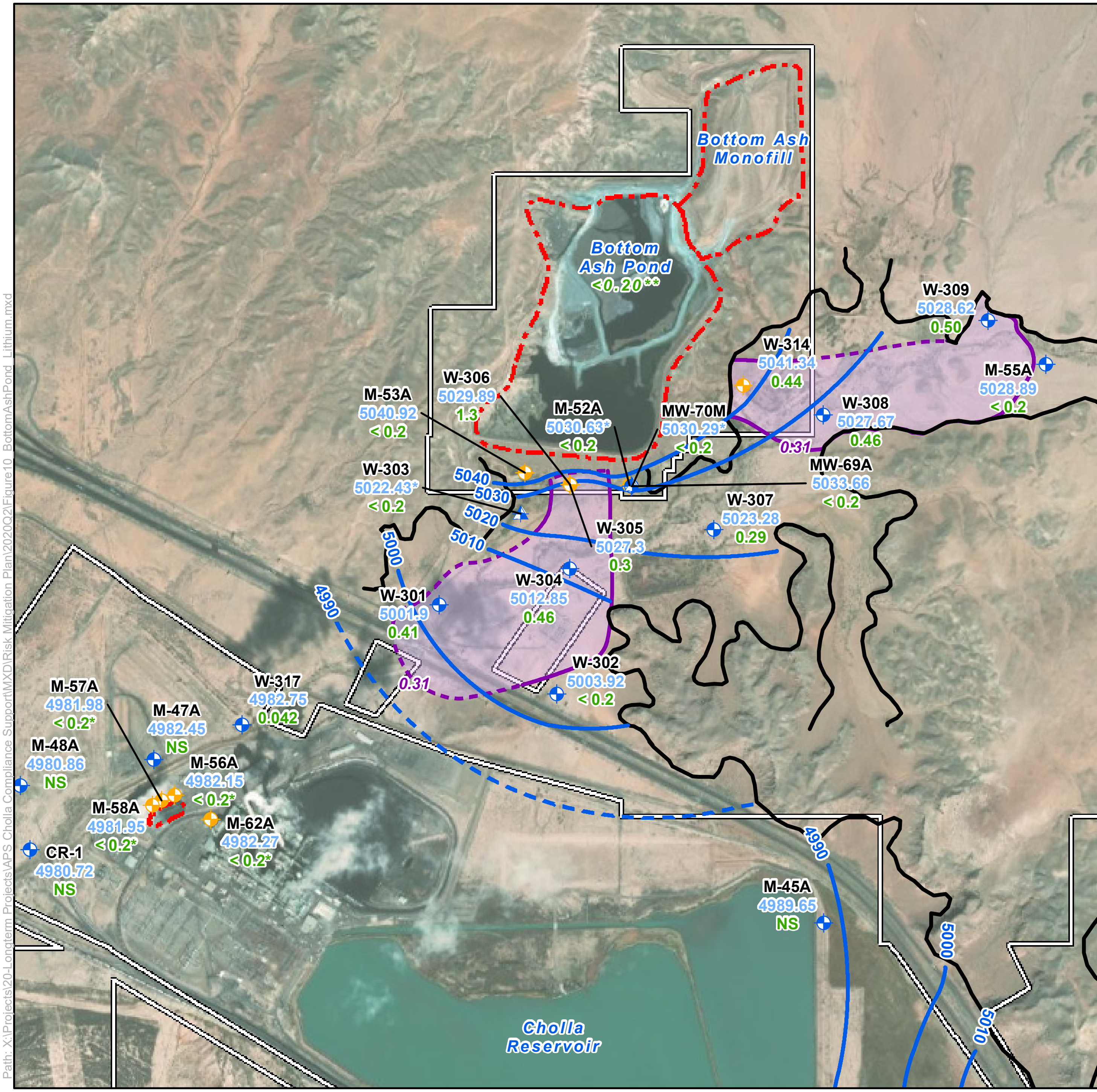
FIGURE 9

Cobalt Iso-Concentration Map for the Bottom Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/12/2020
Scale:	1"= 1,500'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\Risk Mitigation Plan\2020Q2\Figure9_BottomAshPond_Cobalt.mxd



Legend

CCR Monitoring Well Location
- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well

Supplementary Site Monitoring Well Location
- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- APS Land Ownership

Alluvial Aquifer Potentiometric Surface - April 2020
- Groundwater Elevation (Dashed Where Inferred)

Lithium Concentration in Alluvial Aquifer (April/May 2020)
- >0.31 mg/L
- GWPS (0.31 mg/L; Dashed Where Inferred)

Notes:

W-309	Well Identification
5028.62	Groundwater elevation (ft amsl) measured in April 2020
*	Well not used in potentiometric surface mapping
0.50	Lithium concentration (mg/L)
*	Sampled in August 2020
**	Sampled in March 2019
NS	Not Sampled
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
CCR	Coal Combustion Residuals
GWPS	Groundwater Protection Standard

0 750 1,500 Feet

N

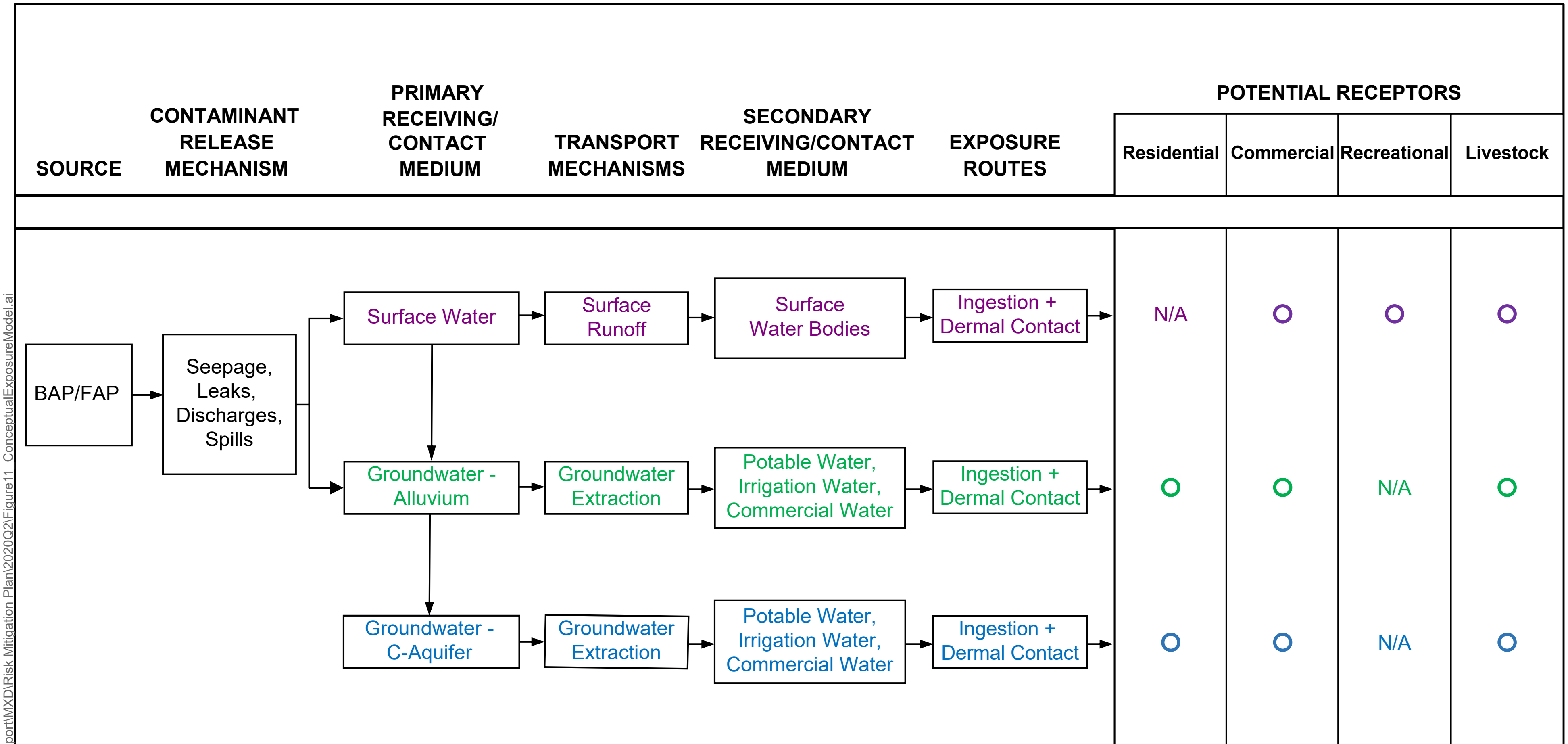
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 10

Lithium Iso-Concentration Map for the Bottom Ash Pond

Job No.	1420182040
PM:	MBH
Date:	10/8/2020
Scale:	1"= 1,500'

wood.



Notes:

○ Incomplete exposure pathway (receptors are currently not impacted)

N/A Not Applicable

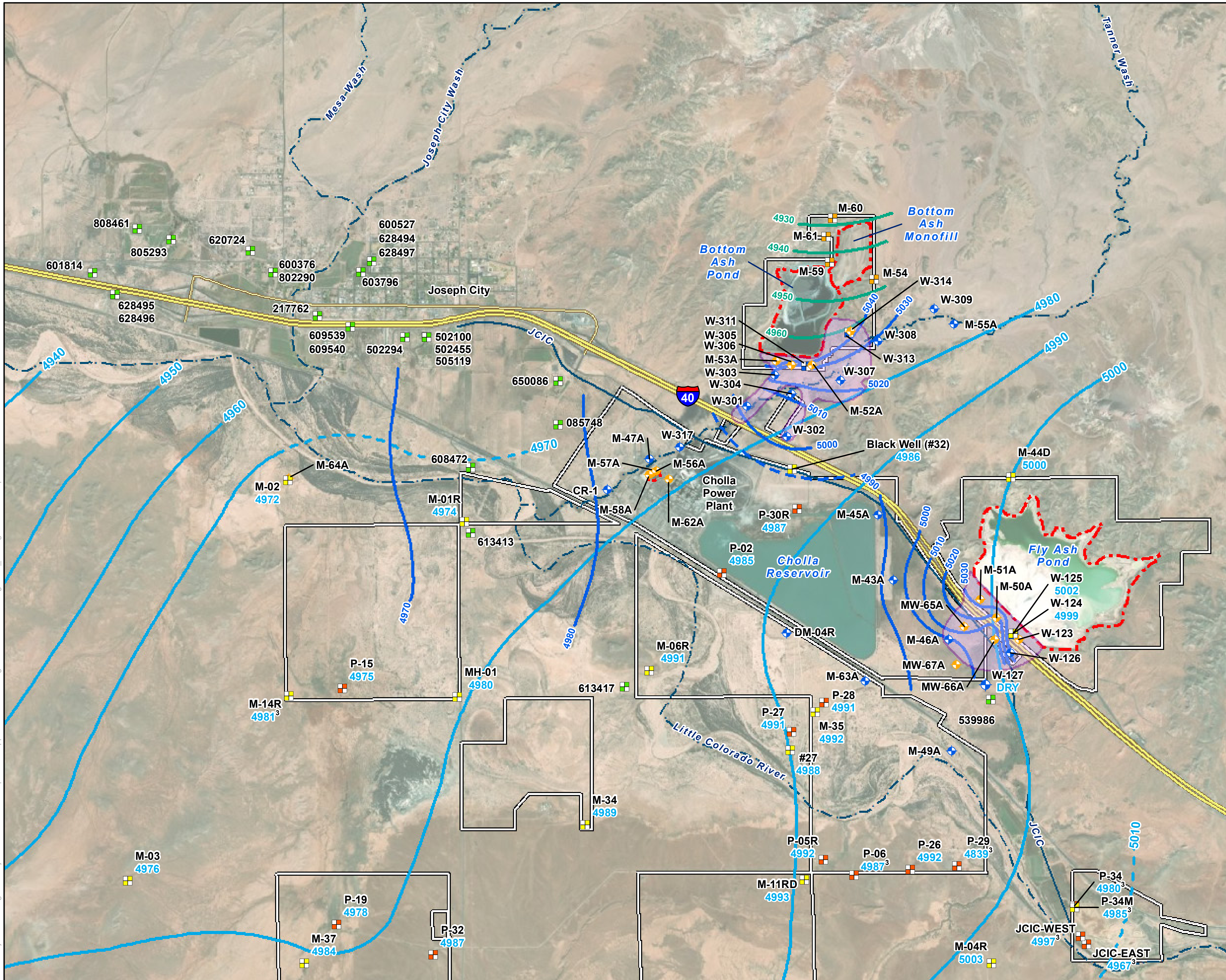
Job No.: 14-2018-2040
PM: MBH
Date: 11/16/2020
Scale: As Shown

Risk Mitigation Plan
Coal Combustion Residual Units Fly Ash Pond and Bottom Ash Pond
Cholla Power Plant, Navajo County, Arizona

Conceptual Exposure Model

FIGURE **11**

wood.



Legend

- C-Aquifer Downgradient Wells from ADWR Registry[1]

APS Wells

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- C-Aquifer Monitoring Wells[2]
- C-Aquifer Production Wells[2]
- C-Aquifer CCR Monitoring Well Location
- C-Aquifer Supplementary Site Monitoring Well Location
- Joseph City Irrigation Company Canal (JCIC)
- Ephemeral Surface Water Feature
- C-Aquifer Potentiometric Surface from Montgomery & Associates - April/May 2019 (Dashed Where Inferred)
- Alluvial Aquifer Potentiometric Surface from Wood - April 2020 (Dashed Where Inferred)
- C-Aquifer Potentiometric Surface from Wood - April 2020 (Dashed Where Inferred)
- Approximate Extent of Groundwater Impacts in Alluvial Aquifer
- Approximate Extent of CCR Unit
- APS Land Ownership in Plant Area and Around CCR

Notes:

566237	ADWR Well Registry Number
M-34	Well Identification
5000	C-Aquifer groundwater elevation level (ft amsl) from Montgomery & Associates
5000	Alluvial groundwater elevation level (ft amsl) from Wood (April 2020)
5000	C-Aquifer groundwater elevation level (ft amsl) from Wood (April 2020)
CCR	Coal Combustion Residuals
ADWR	Arizona Department of Water Resources
ft amsl	Feet above mean sea level
1	ADWR wells inferred to be installed in C-Aquifer based on well construction details and lithologic logs. ADWR wells are located by cadastral coordinates – see Table 1
2	Wells used to generate Montgomery & Associates provided groundwater contours
3	Well not used in C-Aquifer contouring

0 1,000 2,000 3,000 6,000 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 12

Downgradient Well Map

Job No. 1420182040
PM: MBH
Date: 10/12/2020
Scale: 1"= 3000'

wood.

APPENDIX A

APPENDIX A

Risk Evaluation
Arizona Public Service Cholla Power Plant
Joseph City, Arizona

Submitted to:

Arizona Public Service Company
400 North 5th Street
Phoenix, Arizona 85004

Submitted by:

Wood Environment & Infrastructure Solutions, Inc.
Phoenix, Arizona

November 30, 2020

Wood Project No. 14-2018-2040

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List of Acronyms and Abbreviations

ADEQ Arizona Department of Environmental Quality
ASD Alternate Source Demonstration
APS Arizona Public Service
BAP Bottom Ash Pond
CCR Coal Combustion Residual
CEM Conceptual Exposure Model
CFR Code Federal Regulations
COI Constituent of Interest
COPI Constituent of Potential Interest
EPC Exposure Point Concentration
FAP Fly Ash Pond
GWPS Groundwater Protection Standard
HQ Hazard Quotient
MCL Maximum Contaminant Level
mg/L Milligrams per liter
RAGS Risk Assessment Guidance for Superfund
RME Reasonable Maximum Exposure
RSL Regional Screening Level
SSL Statistically Significant Level
UCL Upper Confidence Limit
USEPA United States Environmental Protection Agency
VRP Voluntary Remediation Program

EXECUTIVE SUMMARY

A risk evaluation was conducted for coal combustion residual (CCR) constituents[1] that exhibit statistically significant levels (SSLs) over Groundwater Protection Standards (GWPSs) in groundwater from the alluvial aquifer at the Fly Ash Pond (FAP) and the Bottom Ash Pond (BAP) at the Arizona Public Service (APS) Cholla Power Plant site. To be conservative, the risk evaluation included CCR constituents that have been detected at SSLs over GWPSs in groundwater downgradient of the FAP and BAP, regardless of whether a successful Alternative Source Demonstration (ASD) has excluded the constituent as a site constituent of concern. This evaluation incorporated principles and assumptions consistent with the USEPA's CCR Rule (40 CFR § 257, Subpart D) and relies on a conservative, health-protective approach that is consistent with the risk approaches outlined in USEPA and Arizona risk assessment guidance.

The risk evaluation included the development of a site-specific conceptual exposure model (CEM) and a stepwise risk screening process for the constituents evaluated in comparison to health-protective screening criteria. A Mann-Kendall trend analysis was conducted to evaluate if concentrations demonstrated an increasing or decreasing trend over time.

The data associated with the FAP and BAP were conservatively evaluated in comparison to health-protective screening criteria for a hypothetical future industrial worker as well as a hypothetical future downgradient off-site residential receptor. At this time, there is no current exposure to the alluvial aquifer. The alluvial aquifer is not used as a drinking water supply due to poor water quality. Furthermore, potable water at the site is obtained from the C-aquifer, and as such, future usage of the alluvial aquifer as a source of on-site potable groundwater is unlikely. The risk evaluation was conducted for future on- or off-site industrial workers and off-site residential receptors nonetheless as a conservative approach to gain an understanding of the relative risk associated with presence of the evaluated CCR constituents in the alluvial aquifer. This is a conservative approach as there is a hydraulic divide between the alluvial aquifer, which has little available water, and the C-aquifer (i.e., where groundwater is utilized) so any possible connectivity would be a finite stream of alluvial aquifer groundwater mixing with a much larger volume of C-aquifer groundwater causing a much lower concentration in groundwater for the hypothetical exposure. Thus, if the alluvial aquifer groundwater risk evaluation is below or near standards then C-aquifer groundwater would be at even lower exposure point concentrations.

Adjacent property owners have been notified of the presence of CCR constituents in alluvial groundwater and there is no reasonable expectation that a future water supply well would be installed near either the FAP or the BAP. The nearest off-site water supply well is located approximately 2,500 feet to the south of the FAP.

SSLs over GWPSs were identified in wells installed in the alluvial aquifer at the FAP for arsenic (M-51A), cobalt (M-51A), fluoride (M-51A), lithium (M-50A, M-51A, and W-123) and molybdenum (W-123). The wells identified with the SSLs, as well as the other monitoring network wells for the FAP, are located on property owned by APS and are considered to represent "on-site" groundwater.

SSLs over GWPSs were identified in wells installed in the alluvial aquifer at the BAP for cobalt (M-52A, M-53A, W-305, and W-314) and lithium (W-306). The wells identified with SSLs at the BAP are on-site wells located on property owned by APS and are considered "on-site" groundwater. Additional wells associated with the BAP are located off-site and were also included in the risk evaluations.

[1] The constituents included in the risk evaluation also occur naturally in the site geologic setting.

The initial risk evaluation compared data from the wells with SSLs over GWPSs at the FAP and BAP to health-protective screening criteria for a potential future hypothetical off-site residential receptors and a future hypothetical on-site and off-site industrial worker to identify the constituents of potential interest (COPI). The identification of certain constituents as SSLs over GWPSs (e.g., cobalt at the FAP and lithium at the BAP) have been demonstrated to be associated with alternate sources, but as a conservative measure these constituents were retained for evaluation. The constituents evaluated including arsenic, fluoride, lithium, and molybdenum were identified as COPIs in on-site FAP groundwater for the hypothetical off-site residential receptor due to exceedances of the residential screening levels. Molybdenum was not identified as a COPI in on-site FAP groundwater for the hypothetical industrial worker. Cobalt and lithium were identified as COPIs in on-site and off-site BAP groundwater for both the hypothetical off-site residential and industrial worker receptors.

The Mann-Kendall analyses completed for the evaluated constituents in the FAP wells with SSLs over GWPSs indicated there is no trend in the data for arsenic and fluoride at M-51A. Lithium concentrations showed statistically significant evidence of a decreasing trend at M-50A and M-51A, and statistically significant evidence of an increasing trend at W-123. Molybdenum concentrations showed statistically significant evidence of an increasing trend at W-123. Wells, M-50A, M-51A, and W-123 are located near the base of the FAP on the north side of I-40 on APS property.

The Mann-Kendall analyses completed for the evaluated constituents in the on-site BAP wells with SSLs over GWPSs indicated there is no trend in the data for cobalt at M-52A and W-314. Cobalt concentrations show statistically significant evidence of a decreasing trend at M-53A, and statistically significant evidence of an increasing trend at W-305. Lithium concentrations show statistically significant evidence of an increasing trend at W-306. Wells W-305 and W-306 are located at the base of the BAP to the north of the property boundary. The Mann-Kendall analyses completed for the off-site BAP wells with exceedances of the residential screening levels indicated no significant trend in the data for cobalt at W-301, W-302, and W-303 or in the data for lithium at W-301, W-302, W-308 and W-309. Cobalt data show statistically significant evidence of an increasing trend at W-307 and lithium data show statistically significant evidence of an increase trend at M-55A. W-317 was not evaluated as it did not have an exceedance of the residential screening levels.

In the refined risk evaluation, 95 percent upper confidence limits (UCLs) were calculated for the COPI which represent the exposure point concentration (EPC) that would be used in a risk assessment. In the refined risk evaluation, it was conservatively assumed that groundwater with the evaluated constituents might flow off-site in the future. Therefore, EPCs were compared to the health-protective screening criteria for both a hypothetical future on-site and off-site industrial worker as well as the hypothetical future downgradient off-site residential receptor.

Based on the refined risk evaluations arsenic, lithium, and molybdenum were identified as COIs in FAP groundwater for the hypothetical off-site residential receptor. The EPCs for these constituents, however, are either equivalent to or less than two times the residential screening levels. Cobalt and lithium were identified as COIs in off-site BAP groundwater based on the hypothetical off-site residential receptor. The EPC for cobalt exceeds the residential screening level by less than one order of magnitude, and the EPC for lithium is only slightly above background.

The seeps downgradient of the BAP identified cobalt, fluoride, and lead at concentrations virtually equivalent to (cobalt) or approximately two times greater than (fluoride and lead) screening levels for aquatic and/or terrestrial ecological receptors. Lithium was not detected above corresponding screening criteria. The seep water is collected in intercept trenches and treated as a part of site operations; therefore, the detection of cobalt, fluoride, and lead at concentrations equivalent to, or slightly above, corresponding ecological screening levels is not considered to be a concern.

The conservative risk evaluations completed for the evaluated constituents in FAP and BAP groundwater for the hypothetical future on-site and off-site industrial worker identified lithium as the COI in groundwater at the FAP (at concentrations less than two times the background level). The alternate source demonstration (ASD) that has been submitted for BAP groundwater indicated that lithium is naturally occurring and is not related to leakage from the BAP. Therefore, assuming the acceptance of the ASD for lithium, no COI were identified for either on-site or off-site groundwater at the BAP based on hypothetical future industrial worker exposure.

The evaluation of the hypothetical future residential or industrial worker exposure to the evaluated constituents in the alluvial aquifer at the FAP and BAP is a conservative evaluation of potential risk as the alluvial aquifer is not used as a source of drinking water supply due to poor water quality. Furthermore, as the C-aquifer supplies drinking water for the plant, future usage of the alluvial aquifer as a source of on-site potable water is unlikely. Adjacent property owners have been notified of the elevated concentrations of CCR constituents in alluvial groundwater and there is no reasonable expectation that a future water supply well would be installed in the alluvial aquifer on these properties. The nearest off-site water supply well is located approximately 2,500 feet to the south of the FAP and is installed at a depth of 130 feet in the C-aquifer with a water level of 105 feet bgs. There is no identified connection between the alluvial aquifer at the FAP and BAP with the underlying C-aquifer as a confining unit is present between the aquifers. Therefore, the potential for either future residential or industrial worker exposure to the CCR constituents present in the alluvial groundwater at the FAP and BAP is considered negligible.

Compliance groundwater monitoring for the FAP and BAP under the Federal CCR Rule will continue and APS will proactively evaluate the data and update this evaluation, if warranted.

1.0 INTRODUCTION

This report presents the results of a risk evaluation for coal combustion residual (CCR) constituents[2] in groundwater that exhibit statistically significant levels (SSLs) over groundwater protection standards (GWPSs) at the Arizona Public Service (APS) Cholla Power Plant site. To be conservative, the risk evaluation included CCR constituents that have been detected at SSLs over GWPSs in groundwater downgradient of the FAP and BAP, regardless of whether a successful Alternative Source Demonstration (ASD) has excluded the constituent as a site constituent of concern. This evaluation incorporated principles and assumptions consistent with the USEPA's CCR Rule (40 CFR § 257, Subpart D) (USEPA, 2020a) and relies on a conservative, health-protective approach that is consistent with the risk approaches outlined in the USEPA Regional Screening Levels (RSLs) User's Guide (USEPA, 2020b) and in Arizona risk assessment guidance (ADHS, 2003; ADEQ, 2014).

The risk evaluation includes the development of a site-specific CEM and a stepwise risk screening process for identified SSLs over GWPSs for the Bottom Ash Pond (BAP) and the Fly Ash Pond (FAP). Arsenic, cobalt, fluoride, lithium, and molybdenum in the FAP and cobalt and lithium in the BAP were previously identified as SSLs using the GWPSs established in accordance with the "Disposal of Coal Combustion Residuals from Electric Utilities" Final Rule, 40 C.F.R. 257.95(h) (USEPA, 2020a; Wood, 2020a).

SSLs over GWPSs were identified in wells installed in the alluvial aquifer at the FAP for arsenic, cobalt, and fluoride (M-51A), lithium (M-50A, M-51A, and W-123), and molybdenum (W-123). At the BAP, SSLs over GWPSs were identified in wells installed in the alluvial aquifer for cobalt (M-52A, M-53A, W-305, and W-314) and lithium (W-306) (Wood, 2020c).

Based on the results of the risk evaluation for the evaluated constituents as presented in the following sections, a site-specific recommended path forward is provided.

2.0 POTENTIAL EXPOSURE PATHWAYS AND RECEPTORS

The alluvial aquifer is not used as a drinking water supply due to poor water quality. Potable water at the site is obtained from the C-aquifer, and as such, future usage of the alluvial aquifer as a source of on-site potable water is unlikely. The risk evaluation associated with potential exposure to groundwater in the alluvial aquifer was conducted nonetheless as a conservative approach to gain an understanding of the relative risk associated with presence of the evaluated CCR constituents in this aquifer.

The CEM (presented as **Figure 11** in the Risk Mitigation Plan) depicts the conservative potential exposure pathways and receptors included in the risk evaluation, which are discussed below.

2.1 Potential Groundwater Exposure Pathway

The potential for groundwater exposure to hypothetical future industrial workers and hypothetical off-site residential receptors was evaluated. There is considered to be no human receptors with direct contact with surface water due to the presence of the seepage intercept system which effectively captures seepage water.

Exposure was considered to occur through ingestion and dermal contact with groundwater. The evaluated constituents (i.e., arsenic, cobalt, fluoride, lithium, and molybdenum) are not volatile; therefore, inhalation

[2] The constituents included in the risk evaluation also occur naturally in the site geologic setting.

of vapors while showering/bathing was not evaluated. The exposure pathways/receptors are discussed in detail in Section 3.1 of the Risk Mitigation Plan (Wood, 2020a).

2.1.1 Hypothetical Downgradient Off-Site Residential Receptor

Because the FAP and BAP are located on industrial property there is no potential for exposure to residential receptors. However, there is considered to be the potential for off-site exposure to hypothetical future residential receptors downgradient of the FAP or BAP if a private water supply well is installed in the alluvial aquifer downgradient of the FAP and BAP. The risk evaluation screening conservatively assumed that these hypothetical future residential receptors may have daily exposure to the evaluated constituents in downgradient off-site groundwater through potable water use, including incidental ingestion and dermal contact. Because the SSL wells are located on-site at both the FAP and the BAP, it was conservatively assumed for the initial screen that the on-site groundwater without any attenuation or dilution within the aquifer media represented potential concentrations in off-site groundwater for screening purposes only.

Note that inferred portions of the iso-concentration contours for the evaluated constituents that are not present on APS property are limited in extent and are located either near Interstate 40 (I-40) or are interspersed between portions of land owned by APS. The property owners have been notified of the presence of CCR constituents in the alluvial groundwater and there is no reasonable expectation that a future water supply well would be installed at these locations. There are no private water supply wells on-site and the nearest water supply well is located approximately 2,500 feet to the south. As such, the use of on-site or off-site groundwater as a source of drinking water by residential receptors is highly unlikely and the evaluation of residential receptors is only undertaken for informational purposes.

2.1.2 Hypothetical Industrial Workers

The FAP and BAP are located on industrial property owned by APS. Although potable water at the site is obtained from the C-aquifer, the risk evaluation screening conservatively assumed that hypothetical future plant workers may have daily exposure to the evaluated constituents in the alluvial on-site groundwater monitoring wells through potable water use, including incidental ingestion and dermal contact. In addition, hypothetical future off-site workers were conservatively assumed to have the potential to come into contact with the alluvial groundwater off-site and downgradient of the FAP and BAP through potable water use, including incidental ingestion and dermal contact.

2.2 Potential Surface Water Exposure Pathway

The potential for exposure to surface water was evaluated for the Petroglyph and Tanner Wash seeps which are the nearest seeps downgradient of the BAP. The potential for exposure to seep water was evaluated for ecological receptors including both terrestrial and aquatic biota. Potential routes of exposure include ingestion of seep water by cattle through livestock watering activities, and direct contact with surface water by aquatic receptors as well as through the food chain pathway.

3.0 RISK EVALUATION SCREENING

The initial step in the risk evaluation is the comparison of concentrations of the evaluated constituents in groundwater to health-protective levels for the hypothetically complete exposure pathways. The approach used is consistent with the ADEQ regulations and guidance and USEPA guidance. ADEQ allows for the evaluation of risk to support site-specific remedial approaches in programs such as the Voluntary Remediation Program (VRP) (ADEQ, 2014).

The initial risk evaluation screening was performed for the potential groundwater exposure pathway by comparing the concentrations of on-site groundwater wells determined to have SSLs over GWPSs to appropriate health-protective screening criteria. For residential receptors, concentrations in groundwater were compared to residential screening levels which included drinking water Maximum Contaminant Levels (MCLs), USEPA RSLs for tap water, and alternative screening levels established for the FAP and BAP in accordance with the Federal CCR Rule. For industrial workers concentrations in groundwater were compared to site-specific industrial worker groundwater screening levels. If the maximum concentration of an evaluated constituent exceeded the screening criterion, the constituent was identified as a chemical of potential interest (COPI) for further evaluation in the refined risk evaluation.

3.1 Data Used in Risk Evaluation Screening

This section provides information on the groundwater datasets used in the risk evaluation screening presented in Section 3.2, and the refined risk evaluation presented in Section 4.

3.1.1 FAP Groundwater Data

For the initial risk screening evaluation, groundwater data from samples collected between 2015 and 2020 from the on-site wells that were identified to have SSLs over GWPSs were screened against relevant health-protective screening criteria. The wells that were previously identified to have SSLs over GWPSs for the FAP included well M-51A for arsenic, cobalt, and fluoride, well W-123 for molybdenum, and wells M-50A, M-51A, and W-123 for lithium (Wood, 2020a).

For the refined risk evaluation presented in Section 4, FAP groundwater data collected from the monitoring network wells between 2015 and 2020 were used in the risk evaluation. The monitoring well network for the FAP includes the three on-site wells identified with SSLs of GWPSs (M-50A, M-51A, and W-123), plus an additional six downgradient on-site wells (M-46A, M-63A, M-65A, M-66A, M-67A, and W-126). The location of the FAP monitoring wells are noted on **Figure 1** in the Risk Mitigation Plan.

3.1.2 BAP Groundwater Data

Groundwater data collected from the BAP between 2015 and 2020 were evaluated as on-site groundwater and off-site groundwater. Data from the on-site wells that were identified to have SSLs over GWPSs were used in the initial risk screening evaluation. The wells that were previously identified to have SSLs over GWPSs for the BAP included well W-306 for lithium and wells M-52A, M-53A, W-305, and W-314 for cobalt (Wood, 2020a). In addition, groundwater data from the eight downgradient off-site wells (M-55A, W-301, W-302, W-303, W-307, W-308, W-309, and W-317) were also evaluated in the initial risk screen for the two constituents identified with SSLs over GWPSs in on-site groundwater (i.e., cobalt and lithium).

For the refined risk evaluation presented in Section 4, BAP groundwater data collected between 2015 and 2020 were again evaluated as on-site groundwater and off-site groundwater. The on-site monitoring well network for the BAP includes the five on-site wells with SSLs over GWPSs (wells M-52A, M-53A, W-305, W-306, and W-314) plus an additional three downgradient on-site wells (MW-69A, MW-70M and W-304). The off-site monitoring well network includes the eight downgradient off-site wells. Note that for the purposes of this evaluation well W-317, which is located on APS property, was treated as an off-site well due its location and distance from the BAP. The locations of the BAP monitoring wells are located on **Figure 1** of the Risk Mitigation Plan.

3.1.3 Background Groundwater Quality

The GWPS for lithium was established at its background threshold value which was developed using the data collected from the background monitoring well (M-64A), which was installed in Little Colorado River alluvium in February 2017. The statistical evaluation of the lithium data in the background well resulted in a calculated background threshold value equal to 0.31 milligrams per liter (mg/L) and this value represents the GWPS for this constituent (Wood, 2018a). The statistical methods used to derive this value are detailed in the Statistical Data Analysis Work Plan for the Cholla Power Plant (Wood, 2018b).

3.1.4 Surface Water Data

The surface water data are those samples collected from the Petroglyph Seep and Tanner Wash Seep, which are downgradient of the BAP. For the Petroglyph Seep there are three samples collected in December of 2019. For the Tanner Wash Seep there was a single sample collected in May of 2020. The surface water samples from the Petroglyph Seep were analyzed for total concentrations of arsenic, boron, chromium, cobalt, and lithium. The surface water sample from the Tanner Wash Seep was analyzed for total concentrations of the majority of the Appendix IV constituents plus boron, but excluded antimony, mercury, radium, and thallium. The locations of the seep samples associated with the BAP are presented in **Figure 3** of the Risk Mitigation Plan.

3.2 Groundwater Screening Evaluation

The process of screening the evaluated constituents detected in groundwater against human health screening levels for groundwater is discussed below.

3.2.1 Hypothetical Off-Site Downgradient Residential Receptor

As discussed above, the wells identified with SSLs over GWPSs are on-site wells at both the FAP and the BAP. The FAP and the BAP are industrial property and there is no potential for exposure to residential receptors. The nearest off-site water supply well is located approximately 2,500 feet to the south of the FAP. To allow for the identification of COPI for a hypothetical future off-site residential receptor downgradient of the FAP or BAP, the maximum detected concentration of each evaluated constituent in the identified on-site wells with SSLs over GWPSs were conservatively compared to health-protective screening criteria. Because the SSL wells are located on-site at both the FAP and the BAP, it was conservatively assumed for the initial screen that the on-site groundwater without any attenuation or dilution within the aquifer media represented potential concentrations in off-site groundwater for screening purposes only. In addition, as a conservative measure, the maximum detections of cobalt and lithium in the downgradient off-site wells at the BAP were also screened against residential screening levels. Lithium is represented by the background value of 0.31 mg/L as described in Section 3.1.3.

3.2.1.1 FAP

As presented in **Table 1**, concentrations of arsenic, fluoride, lithium, and molybdenum in on-site FAP groundwater exceeded their respective residential screening levels. Arsenic exceeded its residential screening level of 0.01 mg/L in well M-51A. Fluoride exceeded its residential screening level of 4.0 mg/L also in well M-51A. Lithium exceeded its background value of 0.31 mg/L in wells M-50A, M-51A, and W-123. Molybdenum exceeded its residential screening level of 0.1 mg/L in well W-123.

The identification of cobalt as an SSL over GWPSs at the FAP was determined to be associated with an elevated detection limit issue. It was likely identified based on a false positive result during the initial statistical analysis for Appendix IV data under the CCR rule. Cobalt was detected at concentrations below its residential screening level and cobalt was not retained as a COPI.

Based on this evaluation, concentrations of arsenic, fluoride, lithium, and molybdenum in on-site FAP groundwater are identified as COPIs for the hypothetical future off-site residential receptor and are retained for further evaluation.

3.2.1.2 BAP

As presented in **Table 1**, concentrations of cobalt and lithium in on-site BAP groundwater exceeded their respective residential screening levels. Cobalt exceeded its residential screening level of 0.006 mg/L in wells M-52A, M-53A, W-305, and W-314. Lithium exceeded its background value of 0.31 mg/L in well W-306. Based on this evaluation, concentrations of cobalt and lithium in on-site BAP groundwater are identified as COPIs and are retained for further evaluation. Cobalt and lithium were also identified as COPI in off-site groundwater based on the initial screen in comparison to residential screening levels.

3.2.2 Hypothetical Industrial Workers

The site-specific industrial worker groundwater screening levels were calculated using the USEPA RSL Calculator (USEPA, 2020a) assuming default toxicity factors. The exposure factors used in this calculation were taken from the Arizona Department of Health Services Deterministic Risk Assessment Guidance (ADHS, 2003) with the following exceptions:

- Drinking Water Ingestion Rate - The drinking water ingestion rate of 1 L/day is half the default ADHS residential adult ingestion rate of 2 L/day. This assumption is based on USEPA guidance (USEPA, 1991) that assumes that half of the amount of drinking water an adult consumes per day on a workday is consumed at the place of employment.

- Exposure Time - The default exposure time of 15 minutes per day (0.25 hours/day) for dermal exposure to groundwater is based on best professional judgment assuming the washing of the hands, forearms, and face, and is consistent with the median exposure time for bathing/showering by adults presented in the USEPA Factors Handbook (USEPA, 2011, Table 16-30).

- Target Cancer Risk – Arsenic is the only evaluated constituent that is identified as a carcinogen. While the site-specific industrial screening level for arsenic was calculated using a default target cancer risk of 1×10^{-6} the final value used in the screening evaluation was adjusted to represent a 1×10^{-4} cancer risk in accordance with the Federal CCR Rule which indicates carcinogenic risk may be within the acceptable cancer risk range of 1×10^{-6} to 1×10^{-4}.

- Target Hazard Quotient – the site-specific industrial screening levels for cobalt, fluoride, lithium, and molybdenum were calculated assuming an acceptable hazard quotient of 1.0 for each compound in accordance with the methodology used in the Federal CCR Rule.

The calculated industrial worker groundwater screening levels are presented in **Attachment A** and summarized in **Table 2**. Note that the site-specific industrial worker groundwater screening level for lithium of 0.20 mg/L is below the lithium background value of 0.31 mg/L. As such, the lithium background value of 0.31 mg/L was used for screening purposes.

3.2.2.1 FAP

Table 2 presents the maximum detected concentration of each evaluated constituent in the identified wells with SSLs over GWPSs in comparison to the site-specific industrial screening levels. Cobalt and molybdenum were detected at concentrations below the industrial worker screening levels and were not retained as COPIs.

As presented in **Table 2**, arsenic, fluoride, and lithium in on-site FAP groundwater exceeded their respective site-specific industrial worker screening levels. Arsenic exceeded the industrial worker screening level of 0.019 mg/L in well M-51A. Fluoride exceeded the industrial worker screening level of 4.1 mg/L also in well M-51A. Lithium exceeded its background value of 0.31 mg/L in wells M-50A, M-51A, and W-123. Based on this evaluation, concentrations of arsenic, fluoride, and lithium in on-site FAP groundwater are identified as COPIs and were retained for further evaluation.

3.2.2.2 BAP

As presented in **Table 2**, the maximum detected concentrations of cobalt and lithium in on-site BAP groundwater in the wells with SSLs over GWPSs exceeded their respective site-specific industrial worker screening levels. Cobalt exceeded its industrial worker screening level of 0.031 mg/L in well M-52A. Lithium exceeded its background value of 0.31 mg/L in well W-306. Based on this evaluation, concentrations of cobalt and lithium in on-site BAP groundwater were identified as COPIs and were retained for further evaluation.

The maximum detected concentrations of cobalt and lithium in off-site BAP groundwater also exceeded the site-specific industrial worker screening levels and were identified as COPIs and retained for further evaluation.

3.3 Surface Water Screening Evaluation

A surface water screening evaluation was conducted for the Petroglyph and Tanner Wash Seeps for the constituents analyzed for in the surface water samples. There is considered to be no human receptors with direct contact with surface water due to the presence of the seepage intercept system. Surface water screening values for terrestrial and aquatic ecological receptors were selected from the following order of hierarchy for the COPIs:

Terrestrial ecological receptors:

- Arizona Department of Environmental Quality (ADEQ) Agricultural livestock watering (AgL) Water Quality Standards when available (ADEQ, 2017).
- New Mexico Environment Department Water Quality Standards for Livestock Watering (LW) (NMED, 2020).
- Additional supporting information on water quality standards from the Natural Resources Conservation Service - Montana (NRCS-MT, 2011).
- If values based on livestock water standards were not available irrigation water standards taken from the same hierarchy were used.

Aquatic ecological receptors:

- Arizona Department of Environmental Quality (ADEQ) Chronic Water Quality Standards for Aquatic and Wildlife (cold water)(A&Wc) when available (ADEQ, 2017).
- USEPA Region 4 chronic freshwater screening levels (USEPA, 2018b).

The ADEQ has not established water quality standards for livestock watering (AgL) for boron, barium, beryllium, cobalt, fluoride, lithium, or molybdenum. To evaluate the potential for exposure to cattle through ingestion of seep water, the New Mexico Environment Department water quality standards for livestock watering for boron and cobalt were used (NMED, 2020). Recommended livestock drinking water levels from the NRCS-MT were used for barium and fluoride. Livestock watering standards were not available for beryllium, lithium, and molybdenum. Therefore, for molybdenum the New Mexico irrigation water standard was used (NMED, 2020), and for beryllium and lithium the recommended maximum concentration in irrigation waters (NRCS-MT, 2011) were used as surrogate values even though insufficient seep water is present to be used for irrigation waters.

The ADEQ has also not established water quality standards for aquatic and wildlife receptors (A&Wc) for barium, boron, cobalt, fluoride, lithium, or molybdenum. Therefore, the USEPA Region 4 chronic freshwater screening levels for total concentrations (USEPA, 2018b) were used to screen the seep data for these constituents. The ecological surface water screening levels were compared to the maximum detected concentrations in the seep data.

As shown in **Table 3,** cobalt was detected at concentrations above the screening levels for aquatic receptors from the two seeps with maximum concentrations of 0.02 mg/L (Tanner Wash Seep) and 0.021 mg/L (Petroglyph Seep). These concentrations were virtually equivalent to the cobalt ecological screening level for aquatic receptors (0.019 mg/L) in both seeps, and were less than the livestock watering standard of 1 mg/L. Cobalt was not considered to be present at concentrations of concern in seep water. The maximum detected concentration of fluoride in the Tanner Wash Seep (3.8 mg/L) was less than two times its ecological screening level for aquatic receptors (2.7 mg/L) and less than two times its screening level for livestock (2.0 mg/L). The maximum detected of lead in the Tanner Wash Seep (0.007 mg/L) was approximately two times its ecological screening level for aquatic receptors (0.0032 mg/L) and was less than the livestock watering standard of 0.10 mg/L.

4.0 REFINED RISK EVALUATION

A refined risk evaluation was conducted for the identified groundwater COPIs for the FAP (arsenic, fluoride, and lithium) and the BAP (cobalt and lithium in both on-site and off-site groundwater) that exceeded the health-protective screening criteria for the hypothetical industrial worker. Molybdenum in the FAP was also identified as a COPI along with arsenic, fluoride, and lithium, based on comparison to residential screening levels only. Cobalt and lithium were identified as COPIs in both on-site and off-site BAP groundwater based on comparison to the residential screening levels.

The refined risk evaluation calculated an exposure point concentration (EPC) for potential exposure to these COPIs for the purposes of characterizing potential risk to human receptors. Potential risk associated with exposure to COPIs in groundwater by future hypothetical on-site or off-site industrial workers and hypothetical off-site residential receptors was refined by comparing the calculated EPCs for each COPI to their respective groundwater screening levels. For the refined risk evaluation, groundwater data from samples collected between 2015 and 2020 from the BAP and FAP monitoring well networks were used to develop EPCs.

4.1 Groundwater Exposure Point Calculation

The refined risk evaluation of COPIs included development of an EPC. The EPC is a conservative estimate of potential exposure that is selected to address uncertainty and variability in the dataset (USEPA, 2002). Consistent with EPA's recommended approach for groundwater EPCs, 95 percent upper confidence limits of the arithmetic mean (UCLs) were calculated using USEPA ProUCL 5.1 software (ProUCL) (USEPA, 2016) and ProUCL user's guide (USEPA, 2015), and are in agreement with the USEPA Memorandum for Determining Groundwater Exposure Point Concentrations (USEPA, 2014).

Other assumptions made in the calculation of the UCLs include:

- Primary samples (no duplicates) were used to calculate EPCs as duplicate samples were analyzed for quality assurance purposes.
- For datasets with less than five samples, the maximum detected concentration was used as the EPC. This is a conservative approach and is consistent with the ProUCL User's Guide.
- If the calculated UCL exceeded the maximum detected concentration, then the maximum detected concentration was used as the EPC.

ProUCL software calculates multiple UCLs and provides a recommended UCL that was selected as the EPC. If there were multiple UCLs recommended by ProUCL, the maximum UCL value was selected. **Attachment B-1** provides the input and output files associated with the ProUCL software.

Table 4 summarizes the groundwater EPCs selected for the COPIs. This table shows the number of samples, the maximum detected concentration, the UCL recommended by ProUCL software, and the selected EPC.

4.2 Trend Analysis

Concentration trends over time were evaluated as one line of evidence in the refined risk evaluation for COPI identified at the FAP and the BAP. The Mann-Kendall trend test with an alpha value equal to 0.05 and the Theil-Sen line test were conducted to evaluate the trends in concentrations over time for the data from the wells exhibiting SSLs over GWPSs for arsenic, fluoride, lithium, and molybdenum at the FAP and for cobalt and lithium in on-site groundwater at the BAP. For the off-site groundwater at the BAP, trends were evaluated for those wells with a detected concentration above residential screening levels. W-317 was not evaluated as it did not have an exceedance of the residential screening levels. The tests were conducted using the USEPA ProUCL 5.1 software (USEPA, 2016).

The Mann-Kendall and Theil-Sen test results as summarized on **Table 5** and presented on time series graphs in **Appendix B-3** indicated that at the FAP:

- There is no trend in arsenic, cobalt, and fluoride concentrations over time at M-51A;
- A statistically significant decreasing trend in lithium concentrations over time at M-50A and M-51A; and a statistically significant increasing trend in lithium concentrations over time at W-123.
- A statistically significant increasing trend in molybdenum concentrations over time at W-123.

The well identified with an increasing trend at the FAP, W-123, is located near the base of the FAP on the north side of I-40 on APS property.

The Mann-Kendall and Theil-Sen test results for the on-site groundwater at the BAP indicated:

- There is no trend in cobalt concentrations over time at M-52A and W-314. There is a statistically significant decreasing trend in cobalt concentrations over time at M-53A, and a statistically significant increasing trend at W-305.
- There is a statistically significant increasing trend in lithium concentrations over time at the BAP at W-306.

The wells identified with an increasing trend at the BAP, W-305 and W-306, are located near the base of the BAP on APS property.

The Mann-Kendall and Theil-Sen test results for the off-site groundwater at the BAP indicated:

- There is no trend in cobalt concentrations over time at W-301 and W-302, and W-303 or in lithium concentrations over time at W-301, W-302, W-308 and W-309; and
- There is a statistically significant increasing trend in cobalt data over time at W-307 and in lithium data over time at M-55A.

4.3 Refined Risk Evaluation Results - Groundwater

In the refined groundwater evaluation, comparison of the calculated EPCs to the screening levels was used to identify constituents of interest (COIs) that may pose a potential risk to hypothetical future on-site and off-site receptors exposed through the use of groundwater as potable water. If the COPIs have EPCs greater than the respective screening levels, then the constituent is identified as having the potential for risk that warrants additional evaluation.

4.3.1 Hypothetical Downgradient Off-Site Resident

Comparison of EPCs to the health-protective screening criteria for the hypothetical future downgradient off-site residential receptor is presented in **Table 6** and discussed below.

4.3.1.1 FAP Refined Risk Evaluation

The results of the refined risk evaluation for exposure to FAP groundwater by future downgradient off-site residential receptors indicate that the EPC for fluoride (3.2 mg/L) is lower than the GWPS (4.0 mg/L), indicating that fluoride in FAP groundwater is not of a concern. Arsenic, lithium, and molybdenum EPCs are above corresponding screening criteria and these constituents are considered COI for hypothetical off-site residential receptors. The EPC for molybdenum (0.17 mg/L) is less than two times the GWPS (0.10 mg/L), the lithium EPC (0.52 mg/L) is less than two times the background level (0.31 mg/L); and the EPC for arsenic (0.011 mg/L) is essentially equivalent to the GWPS (0.010 mg/L) for the hypothetical future off-site residential receptor. The EPC for arsenic represents the data excluding well M-67A as arsenic at this location has been demonstrated to not be associated with APS operations.

4.3.1.2 BAP Refined Risk Evaluation

Off-Site Groundwater

Only the off-site BAP groundwater was evaluated for potential exposure to the hypothetical future downgradient off-site residential receptor. The results of the refined risk evaluation for this exposure indicates that the EPC for cobalt in off-site BAP groundwater (0.021 mg/L) exceeds the residential screening level for cobalt (0.006 mg/L). The EPC for lithium in off-site BAP groundwater (0.36 mg/L) slightly exceeds the lithium background value (0.31 mg/L). Therefore, cobalt and lithium are identified as COI in off-site BAP groundwater based on potential exposure to a hypothetical future downgradient off-site residential receptor.

4.3.2 Hypothetical Industrial Worker

Comparison of EPCs to site-specific industrial worker screening levels are presented in **Table 7** and discussed below.

4.3.2.1 FAP Refined Risk Evaluation

The results of the refined risk evaluation for exposure to FAP groundwater by hypothetical future industrial workers indicate that the EPCs for arsenic and fluoride are lower than their respective site-specific industrial worker screening levels. The EPC for lithium in FAP groundwater (0.52 mg/L) exceeds but is less than twice the lithium background value of 0.31 mg/L, indicating lithium is a COI in FAP groundwater for industrial worker receptors.

4.3.2.2 BAP Refined Risk Evaluation

On-Site Groundwater

The results of the refined risk evaluation for exposure to on-site BAP groundwater by hypothetical future industrial workers indicate that the EPC for cobalt (0.028 mg/L) does not exceed the site-specific industrial screening level (0.031 mg/L). The EPC for lithium in on-site BAP groundwater (0.38 mg/L) slightly exceeds the lithium background value of 0.31 mg/L indicating that lithium in on-site BAP groundwater is a COI for future industrial worker receptors.

Off-Site Groundwater

The results of the refined risk evaluation for exposure to off-site BAP groundwater by hypothetical future industrial workers indicate that the EPC for cobalt (0.021 mg/L) does not exceed the site-specific industrial screening level (0.031 mg/L). The EPC for lithium in off-site BAP groundwater (0.36 mg/L) slightly exceeds the lithium background value of 0.31 mg/L indicating that lithium in off-site BAP groundwater is a COI for future industrial worker receptors.

4.4 Alternate Source Demonstration

Alternate source demonstrations (ASDs) were prepared for arsenic and cobalt in FAP groundwater, as well as lithium in BAP groundwater. The results of the ASD for FAP groundwater indicated cobalt was likely identified as an SSL over GWPSs based on a false positive result during the initial statistical analysis for Appendix IV data under the CCR rule, and concluded that exceedances of cobalt in the FAP is not attributable to a release from the FAP (Wood, 2020b). The ASD for arsenic in the FAP was inconclusive.

The results of the ASD for BAP groundwater indicated that the presence of lithium in groundwater downgradient of the BAP is not associated with leakage of constituent mass from the BAP. The ASD indicated that the distribution of lithium in the aquifer downgradient of the BAP is not consistent with the distribution of boron, a CCR indicator constituent. Furthermore, the absence of lithium in pond water samples collected from the BAP and the variability of lithium concentrations in Tanner Wash alluvial groundwater suggests that observed lithium concentrations are associated with natural variations due to aquifer heterogeneity (Wood, 2019b).

As the presence of lithium in groundwater at the BAP is associated with natural variations due to aquifer heterogeneity, based on the ASD, lithium is not considered a COI in BAP groundwater. The only COI identified for the BAP, therefore, is cobalt in off-site groundwater based upon the hypothetical future use by a downgradient off-site residential receptor.

5.0 UNCERTAINTY ASSESSMENT

USEPA guidance stresses the importance of providing an analysis of uncertainties so that risk managers are better informed when evaluating risk assessment conclusions (USEPA, 1989). The uncertainty assessment provides a better understanding of the key uncertainties that are most likely to affect the risk assessment results and conclusions. Conservative assumptions were used in the risk evaluation, likely resulting in overestimates of potential exposures and risks. The potential uncertainties associated with the risk evaluation are as follows:

Health-Protective Screening Criteria Uncertainties:

- Screening criteria based on risk-based standards represent the reasonable maximum exposure (RME). The RME is defined as "the highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures" (USEPA, 1989). USEPA (1989) states that the "intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures". Potential receptors will likely have lower exposures than those presented in this risk evaluation (i.e., a majority of the site concentrations will be less than the UCL), and therefore, potential exposures are likely overestimated.
- Recommended water quality criteria for beryllium, lithium, and molybdenum in irrigation water were used as surrogates for water quality standards for livestock watering. There are no readily available standards for these constituents for livestock water and the use of the surrogate is considered reasonable based upon professional judgment.

Exposure Uncertainties:

- The maximum detected concentrations of the evaluated constituents were compared to conservative risk-based screening criteria to identify the COPIs. Use of the maximum detected concentration is consistent with industry standards and practice; however, use of the maximum detected concentration for exposure likely overestimates potential risk.
- The COPIs identified in groundwater occur naturally in the site geologic setting. Although background concentrations were evaluated and used in the screening process, contributions to exposure and risk were assumed to be entirely CCR-related and natural background sources were not quantified. Furthermore, an ASD that has been submitted for the BAP demonstrated that concentrations of lithium in BAP groundwater are naturally occurring. However, as a conservative measure, lithium was carried forward into the refined risk evaluation. Thus, CCR-related exposures were likely overestimated.
- Hypothetical off-site residential exposure was evaluated using on-site groundwater data from wells on the FAP. This comparison makes the conservative assumption that on-site groundwater may potentially migrate to off-site drinking water wells, through advective transport in groundwater without any attenuation or dilution within the aquifer media through factors such as dilution, dispersion, or adsorption, overestimating potential exposure and risk to hypothetical off-site receptors. This assumption is considered to over-estimate risk associated with the off-site receptors.

Concentrations above screening criteria are not migrating off-site as wells located downgradient of the screening level exceedances for lithium have concentrations less than health-protective criteria.

- The alluvial aquifer present at the FAP and BAP is not used as a source of drinking water supply due to poor water quality. In addition, there is no identified connection between the alluvial aquifer and the underlying C-aquifer in the vicinity of these units due the presence of a confining unit. Furthermore, potable water at the site is obtained from the C-aquifer, and as such, future usage of the alluvial aquifer as a source of on-site potable water is unlikely. Based on site conditions, the evaluation of risk associated with potential exposure to the evaluated constituents in groundwater is an overestimate of potential risk.

- EPCs for metals in groundwater were assumed to be 100 percent bioavailable by ingestion and dermal contact. This assumption may tend to overestimate risk.

Toxicity Uncertainties:

- Toxicity factors used to calculate health-protective criteria are established at conservative levels to account for uncertainties and often result in criteria that are many times lower than the levels observed to cause effects in human or animal studies. Therefore, a screening level exceedance does not necessarily equate to an adverse effect.

6.0 CONCLUSIONS

This risk evaluation for the groundwater from the alluvial aquifer at the FAP and the BAP was conducted using methods consistent with the USEPA and Arizona risk assessment guidance. To be conservative, the risk evaluation included all CCR constituents that have been detected at SSLs over GWPSs in groundwater, regardless of whether a successful ASD has excluded the constituent as a Site COC.

The results of the risk evaluation indicated that arsenic, lithium, and molybdenum marginally exceeded screening level risk-based thresholds and were identified as COIs in FAP groundwater due to the conservative evaluation of a future hypothetical downgradient off-site residential receptor. Lithium was the only COI identified based on evaluation of the hypothetical future industrial worker.

Cobalt and lithium were identified as COIs in off-site BAP groundwater due to the conservative evaluation of the future hypothetical downgradient off-site residential receptor. Lithium was the only COI identified in both the on-site and off-site groundwater at the BAP based on the evaluation of the hypothetical future industrial worker exposure to the alluvial groundwater. The ASD that has been submitted for BAP groundwater indicated that lithium is naturally occurring and is not related to leakage from the BAP.

The evaluation of potential future residential or industrial worker exposure to the evaluated constituents in the alluvial aquifer at the FAP and BAP is a conservative evaluation of potential risk as the alluvial aquifer is not used as a source of drinking water supply due to poor water quality (the C-aquifer supplies drinking water for the plant). At this time, there is no complete exposure pathway for contact with alluvial aquifer groundwater, and future usage of groundwater from the alluvial aquifer is unlikely.

Adjacent property owners have been notified of the elevated concentrations of CCR constituents in alluvial groundwater and there is no reasonable expectation that a future water supply well would be installed in the alluvial aquifer on these properties. The nearest off-site water supply well is located approximately 2,500 feet to the south of the FAP and is installed at a depth of 130 feet in the C-aquifer with a water level of 105 feet bgs. There is no identified connection between the alluvial aquifer at the FAP and BAP with the underlying C-aquifer as a confining unit is present between the aquifers. Therefore, the potential for either future residential or industrial worker exposure to the CCR constituents present in the alluvial groundwater at the FAP and BAP is considered negligible.

Compliance groundwater monitoring for the FAP and BAP under the Federal CCR Rule will continue and APS will proactively evaluate the data and update this evaluation, if warranted.

7.0 REFERENCES

ADEQ, 2014. Site Investigation Manual. October 2014. Available at https://static.azdeq.gov/vrp/site_investigation_guidance.pdf

ADEQ, 2017. Chapter 11. Department of Environmental Quality – Water Quality Standards. December 2017. Available at https://www.epa.gov/sites/production/files/2014-12/documents/az-chapter11.pdf

ADHS, 2003. Deterministic Risk Assessment Guidance. May 2003. Available at https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/environmental-toxicology/guidance.pdf

NMED, 2020. New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters, Title 20, Chapter 6, Part 4, Section 900. May 2020. Available at https://www.env.nm.gov/surface-water-quality/wp-content/uploads/sites/25/2017/06/Integrated-Rule-Effective-for-State-Purposes-20200522.pdf

NRCS MT-1, 2011. U.S. Department of Agriculture, Natural Resources Conservation Service Environment Technical Note No. MT-1 (Rev. 2), *Assessing Water Quality for Human Consumption, Agriculture, and Aquatic Life Uses* by Tom Pick, Water Quality Specialist. June 2011.

USEPA, 1989. Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

USEPA, 1991. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors". OSWER Directive 9285.6-03. March 1991. Available at https://rais.ornl.gov/documents/OSWERdirective9285.6-03.pdf

USEPA, 2002. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10. December 2002. Available at

USEPA, 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*. Office of Resource Conservation and Recovery – Program Implementation and Information Division. March.

USEPA, 2011. Exposure Factors Handbook 2011 Edition (Final Report). EPA/600/R-09/052F. September 2011. Available at https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252

USEPA, 2014. Memorandum for Determining Groundwater Exposure Point Concentrations, Supplemental Guidance. OSWER Directive 9283.1-42, February. Available at: https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236917.

USEPA, 2015. ProUCL Version 5.1 User Guide. Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations, Office of Research and Development, EPA/600/R-07/041, October.

USEPA, 2016. Statistical Software ProUCL 5.1.00 for Environmental Applications for Data Sets with and without Nondetect Observations, last updated June 20, 2016.

USEPA. 2018a. "Hazardous and solid waste management system: Disposal of coal combustion residuals from electric utilities; Amendments to the national minimum criteria (Phase One) (Final rule)." Fed. Reg.83(146):36435-36456. 40 CFR 257, July 30.

USEPA, 2018b. Region 4 Ecological Risk Assessment Supplemental Guidance. March 2018 update. Available at: https://www.epa.gov/risk/regional-ecological-risk-assessment-era-supplemental-guidance.

USEPA, 2020a. Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 40 CFR Part 257. Effective Date October 14, 2015. Last amended August 28, 2020 with a final Effective Date of September 28, 2020.

USEPA, 2020b. USEPA Regional Screening Levels and supporting online RSL Calculator. Revised May 2020. Available at: www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

USEPA, 2020c. National Primary Drinking Water Regulations. Accessed March 2020. Available at: www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations.

Wood Environment & Infrastructure Solutions (Wood), 2018a. *Technical Memorandum, CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Bottom Ash Pond. Arizona Public Service Cholla Power Plant – Navajo County, Arizona.* October 15, 2018.

Wood Environment & Infrastructure Solutions (Wood), 2018b. Statistical Data Analysis Work Plan. Coal Combustion Residual Rule Groundwater Monitoring System Compliance. Cholla Power Plan, Joseph City, AZ. October 15, 2018.

Wood, 2019. Alternative Source Demonstration for Lithium at the BAP. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Technical Memorandum. June 6, 2019.

Wood, 2020a. Risk Mitigation Plan for the Fly Ash Pond and the Bottom Ash Pond. May 2020.

Wood, 2020b. Alternative Source Demonstration for Arsenic and Cobalt at the FAP. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Technical Memorandum. January 31, 2020.

Wood, 2020c. Hydrogeologic Investigation of the Fly Ash Pond and Bottom Ash Pond. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Prepared on behalf of APS. January 31, 2020

TABLES

Table 1 - Residential Shallow Groundwater Screening Using Maximum Detected Concentrations

CCR Unit	Constituent	CAS No.	Units	Detection Frequency	Exceedance Frequency	Maximum Detected Concentration	Screening Level	Screening Level Source[1]	COPI? (Y/N)	Rationale[2]
FAP[3]	Arsenic	7440-38-2	mg/L	20 / 20	19 / 20	0.035	0.010	EPA MCL	Y	ASL
	Cobalt	7440-48-4	mg/L	6 / 20	0 / 20	0.0025	0.0060	EPA RSL (nc)	N	BSL
	Fluoride	16984-48-8	mg/L	21 / 21	21 / 21	6.0	4.0	EPA MCL	Y	ASL
	Lithium	7439-93-2	mg/L	60 / 60	60 / 60	0.83	0.31	Background[4]	Y	ASL
	Molybdenum	7439-98-7	mg/L	20 / 20	20 / 20	0.41	0.10	EPA RSL (nc)	Y	ASL
BAP	Cobalt	7440-48-4	mg/L	85 / 85	85 / 85	0.10	0.0060	EPA RSL (nc)	Y	ASL
(on-site)[5]	Lithium	7439-93-2	mg/L	20 / 20	20 / 20	1.3	0.31	Background[4]	Y	ASL
BAP	Cobalt	7440-48-4	mg/L	26 / 48	13 / 48	0.084	0.0060	EPA RSL (nc)	Y	ASL
(off-site)[6]	Lithium	7439-93-2	mg/L	41 / 48	31 / 48	0.59	0.31	Background[4]	Y	ASL

Notes:

1) EPA Regional Screening Levels - Generic Tables (May 2020; TR = 1E-6, THQ = 1.0), unless indicated otherwise.
2) Rationale for classification of constituent as a constituent of potential interest (COPI) or exclusion as a COPI:

ASL = Above respective screening level
BSL = Equal to or below respective screening level

3) Evaluation of the fly ash pond (FAP) includes 2015-2020 groundwater analytical data from monitoring wells M-51A for arsenic, cobalt, and fluoride; M-50A, M-51A, and W-123 for lithium; and W-123 for molybdenum.
4) The USEPA Regional Screening Level (RSL) for tapwater for lithium is 0.04 mg/L. The background value for lithium was selected as the screening level in accordance with the Federal CCR Rule because background is greater than the RSL.
5) Evaluation of the on-site bottom ash pond (BAP) includes 2015-2020 groundwater analytical data from monitoring wells M-52A, M-53A, W-305, and W-314 for cobalt; and W-306 for lithium.
6) Evaluation of the off-site BAP groundwater includes 2015-2020 groundwater analytical data from downgradient monitoring wells M-55A, W-301, W-302, W-303, W-307, W-308, W-309, and W-317.

BAP = Bottom Ash Pond
CAS = Chemical Abstract Service
CCR = Coal Combustion Residuals
COPI = Constituent of Potential Interest
EPA = United States Environmental Protection Agency

FAP = Fly Ash Pond
RSL = Regional Screening Level
MCL = maximum contaminant level
mg/L = milligrams per liter
nc = noncarcinogen

Prepared by/Date: LO 10/09/20
Checked by/Date: IMR 10/09/20

Table 2 - Industrial Worker Shallow Groundwater Screening Using Maximum Detected Concentrations

CCR Unit	Constituent	CAS No.	Units	Detection Frequency	Exceedance Frequency	Maximum Detected Concentration	Screening Level	Screening Level Source[1]	COPI? (Y/N)	Rationale[2]
FAP[3]	Arsenic	7440-38-2	mg/L	20 / 20	15 / 20	0.035	0.019	EPA RSL (ca)	Y	ASL
	Cobalt	7440-48-4	mg/L	6 / 20	0 / 20	0.0025	0.031	EPA RSL (nc)	N	BSL
	Fluoride	16984-48-8	mg/L	21 / 21	21 / 21	6.0	4.1	EPA RSL (nc)	Y	ASL
	Lithium	7439-93-2	mg/L	60 / 60	60 / 60	0.83	0.31	Background[4]	Y	ASL
	Molybdenum	7439-98-7	mg/L	20 / 20	0 / 20	0.41	0.51	EPA RSL (nc)	N	BSL
BAP	Cobalt	7440-48-4	mg/L	85 / 85	20 / 85	0.10	0.031	EPA RSL (nc)	Y	ASL
(on-site)[5]	Lithium	7439-93-2	mg/L	20 / 20	20 / 20	1.3	0.31	Background[4]	Y	ASL
BAP	Cobalt	7440-48-4	mg/L	26 / 48	5 / 48	0.084	0.031	EPA RSL (nc)	Y	ASL
(off-site)[6]	Lithium	7439-93-2	mg/L	41 / 48	31 / 48	0.59	0.31	Background[4]	Y	ASL

Notes:

1) Based on EPA RSL calculator using industrial worker exposure factor inputs from the 2003 Arizona Deterministic Risk Assessment Guidance. Target hazard index of 1 for non-carcinogens (nc) and target risk of 1E-04 for carcinogens (ca).

2) Rationale for classification of constituent as a constituent of potential interest (COPI) or exclusion as a COPI:

ASL = Above respective screening level

BSL = Equal to or below respective screening level

3) Evaluation of the fly ash pond (FAP) includes 2015-2020 groundwater analytical data from monitoring wells M-51A for arsenic, cobalt, and fluoride; M-50A, M-51A, and W-123 for lithium; and W-123 for molybdenum.

4) The site-specific industrial worker screening level for lithium is 0.2 mg/L. The background value for lithium was selected as the screening level in accordance with the Federal CCR Rule because it is greater than the site-specific industrial worker screening level for lithium.

5) Evaluation of the on-site bottom ash pond (BAP) includes 2015-2020 groundwater analytical data from monitoring wells M-52A, M-53A, W-305, and W-314 for cobalt; and W-306 for lithium.

6) Evaluation of the off-site BAP groundwater includes 2015-2020 groundwater analytical data from downgradient monitoring wells M-55A, W-301, W-302, W-303, W-307, W-308, W-309, and W-317.

BAP = Bottom Ash Pond
ca = carcinogen
CAS = Chemical Abstract Service
CCR = Coal Combustion Residuals
COPI = Constituent of Potential Interest
EPA = United States Environmental Protection Agency

FAP = Fly Ash Pond
RSL = Regional Screening Level
MCL = maximum contaminant level
mg/L = milligrams per liter
nc = noncarcinogen

Prepared by/Date: LO 10/09/20
Checked by/Date: IMR 10/09/20

Table 3 - Freshwater Surface Water Ecological Screening Using Maximum Detected Concentrations

Unit	StationName	Parameter (Total)	Units	Detection Frequency	Exceedance Frequency	Detected Concentration	Screening Level Total	Screening Level Dissolved	Screening Level Source[1]	COPI? (Y/N)	Rationale[2]
Terrestrial Receptors											
BAP	Petroglyph Seep	Arsenic	mg/L	0 / 3	0 / 3	ND (0.1)	0.20	--	ADEQ	N	BSL
		Boron	mg/L	3 / 3	0 / 3	3.5	5.0	--	NMED	N	BSL
		Chromium	mg/L	0 / 3	0 / 3	ND (0.01)	1.0	--	ADEQ	N	BSL
		Cobalt	mg/L	3 / 3	0 / 3	0.021	--	1.0	NMED	N	BSL
		Lithium	mg/L	3 / 3	0 / 3	0.19	2.5	--	NRCS-MT[3]	N	BSL
BAP	Tanner Wash Seep	Arsenic	mg/L	1 / 1	0 / 1	0.0015	0.20	--	ADEQ	N	BSL
		Barium	mg/L	1 / 1	0 / 1	0.058	10	--	NRCS-MT[4]	N	BSL
		Beryllium	mg/L	0 / 1	0 / 1	ND (0.001)	0.10	--	NRCS-MT[3]	N	BSL
		Boron	mg/L	1 / 1	0 / 1	4	5.0	--	NMED	N	BSL
		Cadmium	mg/L	1 / 1	0 / 1	0.00033	0.05	--	ADEQ	N	BSL
		Chromium	mg/L	1 / 1	0 / 1	0.0021	1.0	--	ADEQ	N	BSL
		Cobalt	mg/L	1 / 1	0 / 1	0.02	--	1.0	NMED	N	BSL
		Fluoride	mg/L	1 / 1	1 / 1	3.8	2.0	--	NRCS-MT[4]	Y	ASL
		Lead	mg/L	1 / 1	0 / 1	0.007	0.10	--	ADEQ	N	BSL
		Lithium	mg/L	1 / 1	0 / 1	0.33	2.5	--	NRCS-MT[3]	N	BSL
		Molybdenum	mg/L	1 / 1	0 / 1	0.036	--	1.0	NMED[5]	N	BSL
		Selenium	mg/L	1 / 1	0 / 1	0.00054	0.05	--	ADEQ	N	BSL
Aquatic Receptors											
BAP	Petroglyph Seep	Arsenic	mg/L	0 / 3	0 / 3	ND (0.1)	--	0.15	ADEQ	N	ND
		Boron	mg/L	3 / 3	0 / 3	3.5	7.2	--	EPA Reg. 4	N	BSL
		Chromium	mg/L	0 / 3	0 / 3	ND (0.01)	0.086	0.074	ADEQ[6]	N	ND
		Cobalt	mg/L	3 / 3	2 / 3	0.021	0.019	--	EPA Reg. 4	Y	ASL
		Lithium	mg/L	3 / 3	0 / 3	0.19	0.44	--	EPA Reg. 4	N	BSL
BAP	Tanner Wash Seep	Arsenic	mg/L	1 / 1	0 / 1	0.0015	--	0.15	ADEQ	N	BSL
		Barium	mg/L	1 / 1	0 / 1	0.058	0.22	--	EPA Reg. 4	N	BSL
		Beryllium	mg/L	0 / 1	0 / 1	ND (0.001)	--	0.0053	ADEQ	N	ND
		Boron	mg/L	1 / 1	0 / 1	4.0	7.2	--	EPA Reg. 4	N	BSL
		Cadmium	mg/L	1 / 1	0 / 1	0.00033	0.00079	0.00072	ADEQ[6]	N	BSL
		Chromium	mg/L	1 / 1	0 / 1	0.0021	0.086	0.074	ADEQ[6]	N	BSL
		Cobalt	mg/L	1 / 1	1 / 1	0.02	0.019	--	EPA Reg. 4	Y	ASL
		Fluoride	mg/L	1 / 1	1 / 1	3.8	2.7	--	EPA Reg. 4	Y	ASL
		Lead	mg/L	1 / 1	1 / 1	0.007	0.0032	0.0025	ADEQ[6]	Y	ASL
		Lithium	mg/L	1 / 1	0 / 1	0.33	0.44	--	EPA Reg. 4	N	BSL
		Molybdenum	mg/L	1 / 1	0 / 1	0.036	0.80	--	EPA Reg. 4	N	BSL
		Selenium	mg/L	1 / 1	0 / 1	0.00054	0.0020	--	ADEQ	N	BSL

Notes:

1) Selected exceedance frequency is for the specific constituent that exceeds the first screening value in the hierarchy of screening values.

- The hierarchy of screening value sources for terrestrial receptors is ADEQ agricultural livestock watering (AgL) standards > New Mexico livestock watering standards (LW) > additional information from the Natural Resources Conservation Service-Montana. If only irrigation standards are available for a constituent the same hierarchy using irrigation standards will be used.

- The hierarchy of screening value sources for aquatic receptors is ADEQ chronic ecological screening levels (Aquatic & Wildlife, cold water) > EPA Region 4 (No values are available for EPA Region 9)

2) Rationale for classification of constituent as a constituent of potential interest (COPI) or exclusion as a COPI:
   ASL = Above respective screening level
   BSL = Equal to or below respective screening level

3) Based on the NRSC-MT Recommended Maximum Concentrations of Trace Elements in Irrigation Waters

4) Based on the NRSC-MT Recommendations for Livestock Drinking Water

5) Based on the NMED Irrigation Water Standards

6) Conversion from total and dissolved concentrations outlined using a hardness value of 100 mg/L and equations presented in Table 3 (cadmium), Table 4 (chromium III), Table 6 (lead) of the ADEQ Water Quality Standards

Definitions:

-- = Not applicable, no data available
ADEQ = Arizona Department of Environmental Quality
BAP = Bottom Ash Pond
COPI = Constituent of Potential Interest
EPA Reg. 4 = United States Environmental Protection Agency Region 4
NMED = New Mexico Environment Department
NRSC-MT = Natural Resources Conservation Service - Montana

Prepared by/Date: LO 11/24/20
Checked by/Date: IMR 11/24/20

Table 4 - Groundwater Exposure Point Concentration Summary

CCR Unit	Constituent	CAS No.	Units	Detection Frequency	Maximum Detected Concentration	95% UCL	Recommended UCL Statistic	Selected EPC[1]
FAP[2]	Arsenic	7440-38-2	mg/L	87 / 94	0.035	0.012	95% KM (Chebyshev) UCL	0.012
	Arsenic[3]	7440-38-2	mg/L	82 / 89	0.035	0.011	95% KM (Chebyshev) UCL	0.011
	Fluoride	16984-48-8	mg/L	85 / 104	6.0	3.2	95% KM (t) UCL	3.2
	Lithium	7439-93-2	mg/L	77 / 94	1.1	0.52	95% KM (t) UCL	0.52
	Molybdenum	7439-98-7	mg/L	93 / 94	0.41	0.17	95% KM (Chebyshev) UCL	0.17
BAP[4] (on-site)	Cobalt	7440-48-4	mg/L	110 / 112	0.10	0.028	95% KM (Chebyshev) UCL	0.028
	Lithium	7439-93-2	mg/L	99 / 112	1.3	0.38	95% KM (t) UCL	0.38
BAP[5] (off-site)	Cobalt	7440-48-4	mg/L	26 / 48	0.084	0.021	95% Gamma Adjusted KM-UCL	0.021
	Lithium	7439-93-2	mg/L	41 / 48	0.59	0.36	95% KM (t) UCL	0.36

Notes:

1) EPCs calculated in accordance with USEPA, 2014. Memorandum for Determining Groundwater Exposure Point Concentrations, Supplemental Guidance. OSWER Directive 9283.1-42, February 2014. For further detail on the selected EPC, refer to Attachment B-1.

2) Evaluation of the fly ash pond (FAP) includes 2015-2020 groundwater analytical data from downgradient monitoring wells M-46A, M-50A, M-51A, M-63A, M-65A, M-66A, M-67A, W-123, and W-126.

3) Monitoring well M-67A not included.

4) Evaluation of the on-site BAP monitoring wells includes 2015-2020 groundwater analytical data from M-52A, M-53A, MW-69A, MW-70M, W-304, W-305, W-306, and W-314.

5) Evaluation of the off-site BAP monitoring wells includes 2015-2020 groundwater analytical data from M-55A, W-301, W-302, W-303, W-307, W-308, W-309, and W-317.

BAP = Bottom Ash Pond
CAS = Chemical Abstract Service
CCR = Coal Combustion Residuals
COPI = Constituent of Potential Interest
EPA = United States Environmental Protection Agency
EPC = exposure point concentration
FAP = Fly Ash Pond
mg/L = milligrams per liter
UCL = 95% upper confidence limit of the mean

Prepared by/Date: LO 10/12/20
Checked by/Date: IMR 10/12/20

Table 5. Summary of Mann-Kendall Trend Test Results for Shallow Groundwater Evaluated Constituents

CCR Unit	Location_Group	Parameter	StationName	Residential SL Exceedances	M-K Test Value (S)	M-K Test p-value	M-K Test Comments
FAP	on-site	Arsenic	M-51A	19 / 20	28	0.19	No sufficient evidence of any trends
FAP	on-site	Cobalt	M-51A	0 / 20	-13	0.36	[5]No sufficient evidence of any trends; multiple non-detects with varying reporting limits (RL) - replaced with half of the lowest RL.
FAP	on-site	Fluoride	M-51A	21 / 21	12	0.37	No sufficient evidence of any trends
FAP	on-site	Lithium	M-50A	20 / 20	-67	0.017	Statistically significant downward/decreasing trend
FAP	on-site	Lithium	M-51A	20 / 20	-92	0.0010	Statistically significant downward/decreasing trend
FAP	on-site	Lithium	W-123	20 / 20	103	0.00044	Statistically significant upward/increasing trend
FAP	on-site	Molybdenum	W-123	20 / 20	63	0.023	Statistically significant upward/increasing trend
BAP	on-site	Cobalt	M-52A	22 / 22	-19	0.31	No sufficient evidence of any trends
BAP	on-site	Cobalt	M-53A	21 / 21	-138	0.000015	Statistically significant downward/decreasing trend
BAP	on-site	Cobalt	W-305	21 / 21	84	0.0050	Statistically significant upward/increasing trend
BAP	on-site	Cobalt	W-314	21 / 21	29	0.21	No sufficient evidence of any trends
BAP	on-site	Lithium	W-306	20 / 20	67	0.017	Statistically significant upward/increasing trend
BAP	off-site	Cobalt	W-301	5 / 5	3	0.41	No sufficient evidence of any trends
BAP	off-site	Cobalt	W-302	2 / 5	4	0.24	No sufficient evidence of any trends
BAP	off-site	Cobalt	W-303	1 / 1	--	--	n<4; trend test not performed
BAP	off-site	Cobalt	W-307	5 / 5	8	0.042	Statistically significant upward/increasing trend
BAP	off-site	Lithium	M-55A	16 / 18	58	0.013	Statistically significant upward/increasing trend, 1 ND with elevated
BAP	off-site	Lithium	W-301	5 / 5	-2	0.41	No sufficient evidence of any trends
BAP	off-site	Lithium	W-302	3 / 5	-5	0.24	No sufficient evidence of any trends, 1 ND with elevated RL --
BAP	off-site	Lithium	W-308	5 / 5	3	0.41	No sufficient evidence of any trends
BAP	off-site	Lithium	W-309	2 / 5	6	0.12	No sufficient evidence of any trends, 1 ND

Notes:

1) Mann Kendall (M-K) trend test performed on parameters identified as COPIs using data from monitoring wells with one or more exceedances of respective residential screening levels.

2) The M-K test statistic, S, equals the sum of scores assigned to all pairs. The following conclusions are derived based upon the values of the M-K statistic, S on monitoring wells

A positive value of S implies that a majority of the differences between earlier and later measurements are positive suggesting the presence of a potential upward and increasing trend over time.

A negative value for S implies that a majority of the differences between earlier and later measurements are negative suggesting the presence of a potential downward/decreasing trend.

A value of S close to zero indicates a roughly equal number of positive and negative scores assigned to all possible distinct pairs, suggesting that the data do not exhibit any evidence of an increasing or decreasing trend.

3) A target significance level of 0.05 (i.e., 95 percent confidence) is used to determine the presence of a statistically significant trend.

4) The minimum number of samples that can be analyzed using the M-K test is four.

5) The reporting limit for cobalt at M-51A is in exceedance of the GWPS; potential false positive SSL over the GWPS (Wood 2020). Frequency of detection is 30% (6/20).

Updated by/Date: LO 10/13/20
Checked by/Date: IMR 10/13/20

Table 6 - Residential Screen of Shallow Groundwater Using 95% UCLs

CCR Unit	Constituent	CAS No.	Units	95 UCL	Screening Level	Screening Level Source[1]	COPI? (Y/N)	Rationale[2]
FAP[3]	Arsenic	7440-38-2	mg/L	0.012	0.010	EPA MCL	Y	ASL
	Arsenic[4]	7440-38-2	mg/L	0.011	0.010	EPA MCL	Y	ASL
	Fluoride	16984-48-8	mg/L	3.2	4.0	EPA MCL	N	BSL
	Lithium	7439-93-2	mg/L	0.52	0.31	Background[5]	Y	ASL
	Molybdenum	7439-98-7	mg/L	0.17	0.10	EPA RSL (nc)	Y	ASL
BAP	Cobalt	7440-48-4	mg/L	0.021	0.0060	EPA RSL (nc)	Y	ASL
(off-site)[6]	Lithium	7439-93-2	mg/L	0.36	0.31	Background[5]	Y	ASL

Notes:

1) EPA Regional Screening Levels - Generic Tables (May 2020; TR = 1E-6, THQ = 1.0), unless indicated otherwise.

2) Rationale for classification of constituent as a constituent of potential interest (COPI) or exclusion as a COPI:

ASL = Above respective screening level

BSL = Equal to or below respective screening level

3) Evaluation of the fly ash pond (FAP) includes 2015-2020 groundwater analytical data from downgradient monitoring wells M-46A, M-50A, M-51A, M-63A, M-65A, M-66A, M-67A, W-123, and W-126.

4) Monitoring well M-67A not included.

5) The USEPA Regional Screening Level (RSL) for tapwater for lithium is 0.04 mg/L. The background value for lithium was selected as the screening level in accordance with the Federal CCR Rule because background is greater than the RSL.

6) Evaluation of the off-site BAP monitoring wells includes 2015-2020 groundwater analytical data from M-55A, W-301, W-302, W-303, W-307, W-308, W-309, and W-317.

BAP = Bottom Ash Pond
CAS = Chemical Abstract Service
CCR = Coal Combustion Residuals
COPI = Constituent of Potential Interest
EPA = United States Environmental Protection Agency

FAP = Fly Ash Pond
RSL = Regional Screening Level
MCL = maximum contaminant level
mg/L = milligrams per liter
nc = noncarcinogen
95 UCL - 95% upper confidence limit of the mean

Prepared by/Date: LO 09/24/20
Checked by/Date: IMR 09/24/20

Table 7 - Industrial Worker Screen of Shallow Groundwater Using 95% UCLs

CCR Unit	Constituent	CAS No.	Units	95 UCL	Screening Level	Screening Level Source[1]	COPI? (Y/N)	Rationale[2]
FAP[3]	Arsenic	7440-38-2	mg/L	0.012	0.019	EPA RSL (ca)	N	BSL
	Arsenic[4]	7440-38-2	mg/L	0.011	0.019	EPA RSL (ca)	N	BSL
	Fluoride	16984-48-8	mg/L	3.2	4.1	EPA RSL (nc)	N	BSL
	Lithium	7439-93-2	mg/L	0.52	0.31	Background[5]	Y	ASL
BAP (on-site)[6]	Cobalt	7440-48-4	mg/L	0.028	0.031	EPA RSL (nc)	N	BSL
	Lithium	7439-93-2	mg/L	0.38	0.31	Background[5]	Y	ASL
BAP (off-site)[7]	Cobalt	7440-48-4	mg/L	0.021	0.031	EPA RSL (nc)	N	BSL
	Lithium	7439-93-2	mg/L	0.36	0.31	Background[5]	Y	ASL

Notes:

1) Based on EPA RSL calculator using industrial worker exposure factor inputs from the 2003 Arizona Deterministic Risk Assessment Guidance. Target hazard index of 1 for non-carcinogens (nc) and target risk of 1E-04 for carcinogens (ca).

2) Rationale for classification of constituent as a constituent of potential interest (COPI) or exclusion as a COPI:

ASL = Above respective screening level

BSL = Equal to or below respective screening level

3) Evaluation of the fly ash pond (FAP) includes 2015-2020 groundwater analytical data from downgradient monitoring wells M-46A, M-50A, M-51A, M-63A, M-65A, M-66A, M-67A, W-123, and W-126.

4) Monitoring well M-67A not included.

5) The site-specific industrial worker screening level for lithium is 0.2 mg/L. The background value for lithium was selected as the screening level in accordance with the Federal CCR Rule because it is greater than the site-specific industrial worker screening level for lithium.

6) Evaluation of the on-site BAP monitoring wells includes 2015-2020 groundwater analytical data from M-52A, M-53A, MW-69A, MW-70M, W-304, W-305, W-306, and W-314.

7) Evaluation of the off-site BAP monitoring wells includes 2015-2020 groundwater analytical data from M-55A, W-301, W-302, W-303, W-307, W-308, W-309, and W-317.

BAP = Bottom Ash Pond
ca = carcinogen
CAS = Chemical Abstract Service
CCR = Coal Combustion Residuals
COPI = Constituent of Potential Interest
EPA = United States Environmental Protection Agency

FAP = Fly Ash Pond
RSL = Regional Screening Level
MCL = maximum contaminant level
mg/L = milligrams per liter
nc = noncarcinogen

Prepared by/Date: LO 09/24/20
Checked by/Date: IMR 09/24/20

ATTACHMENT A

USEPA RSL Calculator Generated
Industrial Worker Screening Levels

Variable	Industrial Worker Tap Water Default Value	Form-input Value
BW_{0-2} (mutagenic body weight) kg	15	0
BW_{2-6} (mutagenic body weight) kg	15	0
BW_{6-16} (mutagenic body weight) kg	80	0
BW_{16-26} (mutagenic body weight) kg	80	70
BW_{res-a} (body weight - adult) kg	80	70
BW_{res-c} (body weight - child) kg	15	0
$DFW_{res-adj}$ (age-adjusted dermal factor) cm^2-event/kg	2610650	294642.857
$DFWM_{res-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	8191633	294642.857
ED_{res} (exposure duration - resident) years	26	25
ED_{0-2} (mutagenic exposure duration first phase) years	2	0
ED_{2-6} (mutagenic exposure duration second phase) years	4	0
ED_{6-16} (mutagenic exposure duration third phase) years	10	0
ED_{16-26} (mutagenic exposure duration fourth phase) years	10	25
ED_{res-a} (exposure duration - adult) years	20	25
ED_{res-c} (exposure duration - child) years	6	0
EF_{res} (exposure frequency) days/year	350	250
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350	0
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350	0
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350	0
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350	250
EF_{res-a} (exposure frequency - adult) days/year	350	250
EF_{res-c} (exposure frequency - child) days/year	350	0
ET_{res} (exposure time) hours/day	24	8
$ET_{event-res-adj}$ (age-adjusted exposure time) hours/event	0.67077	0.25
$ET_{event-res-madj}$ (mutagenic age-adjusted exposure time) hours/event	0.67077	0.25
ET_{0-2} (mutagenic dermal exposure time first phase) hours/event	0.54	0
ET_{2-6} (mutagenic dermal exposure time second phase) hours/event	0.54	0
ET_{6-16} (mutagenic dermal exposure time third phase) hours/event	0.71	0
ET_{16-26} (mutagenic dermal exposure time fourth phase) hours/event	0.71	0.25
ET_{res-a} (dermal exposure time - adult) hours/event	0.71	0.25
ET_{res-c} (dermal exposure time - child) hours/event	0.54	0
ET_{0-2} (mutagenic inhalation exposure time first phase) hours/day	24	0
ET_{2-6} (mutagenic inhalation exposure time second phase) hours/day	24	0
ET_{6-16} (mutagenic inhalation exposure time third phase) hours/day	24	0
ET_{16-26} (mutagenic inhalation exposure time fourth phase) hours/day	24	8
ET_{res-a} (inhalation exposure time - adult) hours/day	24	8
ET_{res-c} (inhalation exposure time - child) hours/day	24	0
EV_{0-2} (mutagenic events) per day	1	0
EV_{2-6} (mutagenic events) per day	1	0
EV_{6-16} (mutagenic events) per day	1	0
EV_{16-26} (mutagenic events) per day	1	1
EV_{res-a} (events - adult) per day	1	1
EV_{res-c} (events - child) per day	1	0
THQ (target hazard quotient) unitless	0.1	1
$IFW_{res-adj}$ (adjusted intake factor) L/kg	327.95	89.286
$IFWM_{res-adj}$ (mutagenic adjusted intake factor) L/kg	1019.9	89.286
IRW_{0-2} (mutagenic water intake rate) L/day	0.78	0
IRW_{2-6} (mutagenic water intake rate) L/day	0.78	0
IRW_{6-16} (mutagenic water intake rate) L/day	2.5	0
IRW_{16-26} (mutagenic water intake rate) L/day	2.5	1
IRW_{res-a} (water intake rate - adult) L/day	2.5	1
IRW_{res-c} (water intake rate - child) L/day	0.78	0
K (volatilization factor of Andelman) L/m^3	0.5	0.5
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2	6365	0
SA_{2-6} (mutagenic skin surface area) cm^2	6365	0
SA_{6-16} (mutagenic skin surface area) cm^2	19652	0
SA_{16-26} (mutagenic skin surface area) cm^2	19652	3300
SA_{res-a} (skin surface area - adult) cm^2	19652	3300
SA_{res-c} (skin surface area - child) cm^2	6365	0
l_{sc} (apparent thickness of stratum corneum) cm	0.001	0.001
TR (target risk) unitless	0.000001	0.000001

Attachment A-2

Industrial Worker Regional Screening Levels (RSL) for Tap Water

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see us

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_oRef	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C
Cobalt	7440-48-4	No	No	Inorganics	-		9.00E-03	P	3.00E-04	P	6.00E-06	P
Fluoride	16984-48-8	No	No	Inorganics	-		-		4.00E-02	C	1.30E-02	C
Lithium	7439-93-2	No	No	Inorganics	-		-		2.00E-03	P	-	
Molybdenum	7439-98-7	No	No	Inorganics	-		-		5.00E-03	I	-	

Attachment A-2

Industrial Worker

Key: I = IRIS; P = PPRTV;ser's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL v

Chemical	GIABS	K_p (cm/hr)	MW	B (unitless)	t^*(hr)	τ_{event}(hr/event)	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$
Arsenic, Inorganic	1.00E+00	1.00E-03	7.49E+01	3.33E-03	6.63E-01	2.76E-01	1.00E+00	Yes	5.78E-05	-
Cobalt	1.00E+00	4.00E-04	5.89E+01	1.18E-03	5.40E-01	2.25E-01	1.00E+00	Yes	-	-
Fluoride	1.00E+00	1.00E-03	3.80E+01	2.37E-03	4.12E-01	1.72E-01	1.00E+00	Yes	-	-
Lithium	1.00E+00	1.00E-03	6.94E+00	1.01E-03	2.76E-01	1.15E-01	1.00E+00	Yes	-	-
Molybdenum	1.00E+00	1.00E-03	9.59E+01	3.77E-03	8.70E-01	3.62E-01	1.00E+00	Yes	-	-

Attachment A-2

Industrial Worker

Key: I = IRIS; P = PPRTV; values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	$DA_{event\ (nc\ adult)}$	MCL (ug/L)	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=1 (ug/L)	Dermal SL Child THQ=1 (ug/L)
Arsenic, Inorganic	9.29E-03	1.00E+01	1.91E-01	2.31E+02	-	1.91E-01	-	-
Cobalt	9.29E-03	-	-	-	-	-	-	-
Fluoride	1.24E+00	4.00E+03	-	-	-	-	-	-
Lithium	6.19E-02	-	-	-	-	-	-	-
Molybdenum	1.55E-01	-	-	-	-	-	-	-

Attachment A-2

Industrial Worker

Key: I = IRIS; P = PPRTV;

Chemical	Inhalation SL Child THQ=1 (ug/L)	Noncarcinogenic SL Child THI=1 (ug/L)	Ingestion SL Adult THQ=1 (ug/L)	Dermal SL Adult THQ=1 (ug/L)	Inhalation SL Adult THQ=1 (ug/L)	Noncarcinogenic SL Adult THI=1 (ug/L)	Screening Level (ug/L)
Arsenic, Inorganic	-	-	3.07E+01	3.72E+04	-	3.06E+01	1.91E-01 ca
Cobalt	-	-	3.07E+01	9.29E+04	-	3.06E+01	3.06E+01 nc
Fluoride	-	-	4.09E+03	4.96E+06	-	4.08E+03	4.08E+03 nc
Lithium	-	-	2.04E+02	2.48E+05	-	2.04E+02	2.04E+02 nc
Molybdenum	-	-	5.11E+02	6.19E+05	-	5.11E+02	5.11E+02 nc

ATTACHMENT B

Support for Refined Risk Evaluations

ATTACHMENT B-1

ProUCL Input/Output Files

StationName	SampDate	FieldSampleID	Units	Arsenic	D_Arsenic	Fluoride	D_Fluoride	Lithium	D_Lithium	Molybdenum	D_Molybdenum
M-46A	11/26/19	CH-CCR-M46A-112619	mg/l	0.0042	1	0.8	0	0.23	1	0.026	1
M-46A	05/05/20	CH-CCR-M46-0520	mg/l	0.0013	1	0.8	0	0.35	1	0.0068	1
M-50A	12/02/15	7792	mg/l	0.0023	1	2	1	0.51	1	0.005	1
M-50A	03/08/16	CH-M-50A-0316	mg/l	0.01	0	2	1	0.47	1	0.0059	1
M-50A	05/05/16	CH-CCR-M50A-516	mg/l	0.0025	1	2.2	1	0.47	1	0.0056	1
M-50A	08/25/16	CH-CCR-M50A-816	mg/l	0.0025	1	2.3	1	0.45	1	0.0059	1
M-50A	09/23/16	CH-CCR-M50A-916	mg/l	0.0024	1	2.2	1	0.5	1	0.0075	1
M-50A	02/21/17	CH-CCR-M50A-217	mg/l	0.0026	1	2.4	1	0.5	1	0.0091	1
M-50A	04/13/17	CH-CCR-M50A-41317	mg/l	0.003	1	2	1	0.46	1	0.0083	1
M-50A	04/26/17	CH-CCR-M50A-42617	mg/l	0.0024	1	2	1	0.48	1	0.0067	1
M-50A	05/18/17	CH-CCR-M50A-51817	mg/l	0.0023	1	2.2	1	0.48	1	0.0059	1
M-50A	05/24/17	CH-CCR-M50A-52417	mg/l	0.0026	1	2.3	1	0.49	1	0.0061	1
M-50A	06/30/17	CH-CCR-M50A-63017	mg/l	0.0025	1	2.4	1	0.45	1	0.028	1
M-50A	07/27/17	CH-CCR-M50A-72717	mg/l	0.0025	1	2.5	1	0.46	1	0.0077	1
M-50A	09/07/17	CH-CCR-M50A-90717	mg/l	0.0026	1	2.2	1	0.48	1	0.0091	1
M-50A	12/08/17	CH-CCR-M50A-120817	mg/l			2.2	1				
M-50A	02/14/18	CH-CCR-M50A-21418	mg/l	0.0027	1	2.6	1	0.44	1	0.0085	1
M-50A	05/21/18	CH-CCR-M-50A-52118	mg/l	0.0025	1	2.4	1	0.43	1	0.007	1
M-50A	10/24/18	CH-CCR-M-50A-102418	mg/l	0.0028	1	2.3	1	0.43	1	0.0071	1
M-50A	02/13/19	CH-CCR-M50A-21319	mg/l	0.0028	1	2.2	1	0.46	1	0.007	1
M-50A	04/11/19	CH-CCR-M50A-41119	mg/l	0.003	1	2	1	0.44	1	0.0071	1
M-50A	11/25/19	CH-CCR-M50A-112519	mg/l	0.0027	1	2.1	1	0.43	1	0.0083	1
M-50A	05/06/20	CH-CCR-M50A-0520	mg/l	0.0027	1	2.3	1	0.55	1	0.0065	1
M-51A	12/02/15	7880	mg/l	0.02	1	4.8	1	0.6	1	0.034	1
M-51A	03/09/16	CH-M-51A-0316	mg/l	0.016	1	5.2	1	0.54	1	0.031	1
M-51A	05/05/16	CH-CCR-M51A-0516	mg/l	0.0029	1	5.5	1	0.57	1	0.029	1
M-51A	08/25/16	CH-CCR-M51A-816	mg/l	0.029	1	6	1	0.56	1	0.042	1
M-51A	09/23/16	CH-CCR-M51A-916	mg/l	0.025	1	5.6	1	0.61	1	0.043	1
M-51A	02/21/17	CH-CCR-M51A-217	mg/l	0.023	1	5.3	1	0.58	1	0.038	1
M-51A	04/13/17	CH-CCR-M51A-41317	mg/l	0.02	1	4.1	1	0.49	1	0.038	1
M-51A	04/26/17	CH-CCR-M51A-42617	mg/l	0.024	1	4.7	1	0.57	1	0.036	1
M-51A	05/18/17	CH-CCR-M51A-51817	mg/l	0.024	1	5	1	0.56	1	0.03	1
M-51A	05/24/17	CH-CCR-M51A-52417	mg/l	0.028	1	5.4	1	0.54	1	0.036	1
M-51A	06/30/17	CH-CCR-M51A-63017	mg/l	0.029	1	4.9	1	0.54	1	0.038	1
M-51A	07/27/17	CH-CCR-M51A-72717	mg/l	0.026	1	6	1	0.54	1	0.054	1
M-51A	09/07/17	CH-CCR-M51A-90717	mg/l	0.035	1	5.7	1	0.55	1	0.054	1
M-51A	12/08/17	CH-CCR-M51A-120817	mg/l			5.1	1				
M-51A	02/14/18	CH-CCR-M51A-21418	mg/l	0.015	1	5.4	1	0.49	1	0.046	1
M-51A	05/21/18	CH-CCR-M-51A-52118	mg/l	0.022	1	5.7	1	0.48	1	0.057	1
M-51A	10/24/18	CH-CCR-M-51A-102418	mg/l	0.032	1	5.5	1	0.46	1	0.092	1
M-51A	02/13/19	CH-CCR-M51A-21319	mg/l	0.025	1	4.5	1	0.49	1	0.082	1
M-51A	04/10/19	CH-CCR-M51A-41119	mg/l	0.032	1	5.4	1	0.45	1	0.09	1
M-51A	11/25/19	CH-CCR-M51A-112519	mg/l	0.018	1	4.8	1	0.45	1	0.11	1

StationName	SampDate	FieldSampleID	Units	Arsenic	D_Arsenic	Fluoride	D_Fluoride	Lithium	D_Lithium	Molybdenum	D_Molybdenum
M-51A	05/06/20	CH-CCR-M51A-0520	mg/l	0.015	1	5.6	1	0.65	1	0.09	1
M-63A	11/30/15	7871	mg/l	0.00086	1	0.4	0	0.2	0	0.011	1
M-63A	03/10/16	CH-M-63A-0316	mg/l	0.01	0	0.4	0	0.2	0	0.01	0
M-63A	05/05/16	CH-CCR-M63A-050516	mg/l	0.00083	1	0.4	0	0.2	0	0.0021	1
M-63A	08/24/16	CH-CCR-M63A-816	mg/l	0.00057	1	0.4	0	0.2	0	0.0044	1
M-63A	09/21/16	CH-CCR-M63A-916	mg/l	0.00057	1	0.4	0	0.2	0	0.0039	1
M-63A	02/20/17	CH-CCR-M63A-217	mg/l	0.00054	1	0.4	0	0.2	0	0.0021	1
M-63A	04/13/17	CH-CCR-M63A-41317	mg/l	0.00079	1	0.4	0	0.2	0	0.0022	1
M-63A	04/26/17	CH-CCR-M63A-42617	mg/l	0.00073	1	0.4	0	0.2	0	0.0022	1
M-63A	05/22/17	CH-CCR-M63A-52217	mg/l	0.00062	1	0.4	0	0.2	0	0.0019	1
M-63A	05/24/17	CH-CCR-M63A-52417	mg/l	0.00087	1	0.4	0	0.2	0	0.0022	1
M-63A	06/30/17	CH-CCR-M63A-63017	mg/l	0.001	1	0.4	0	0.2	0	0.0022	1
M-63A	07/28/17	CH-CCR-M63A-72817	mg/l	0.001	0	0.4	0	0.2	0	0.0021	1
M-63A	09/07/17	CH-CCR-M63A-90717	mg/l	0.002	0	0.4	0	0.2	0	0.0022	1
M-63A	06/24/19	CH-APP-M63A-62419	mg/l			0.4	0				
M-65A	12/05/18	CH-CCR-MW65A-2518	mg/l	0.0025	1	1.9	1	0.54	1	0.059	1
M-65A	02/14/19	CH-CCR-M65A-21419	mg/l	0.0017	1	1.7	1	0.58	1	0.059	1
M-65A	04/11/19	CH-CCR-M65A-41119	mg/l	0.0018	1	1.9	1	0.52	1	0.067	1
M-65A	11/26/19	CH-CCR-M65A-112619	mg/l	0.002	0	1.7	1	0.52	1	0.08	1
M-65A	05/05/20	CH-CCR-M65-0520	mg/l	0.0016	1	1.8	1	0.67	1	0.065	1
M-66A	12/05/18	CH-CCR-MW66A-2518	mg/l	0.0034	1	0.93	1	0.51	1	0.016	1
M-66A	02/14/19	CH-CCR-M66A-21419	mg/l	0.0021	1	1.1	1	0.55	1	0.014	1
M-66A	04/11/19	CH-CCR-M66A-41119	mg/l	0.0025	1	1.4	1	0.5	1	0.039	1
M-66A	11/26/19	CH-CCR-M66A-112619	mg/l	0.0039	1	1.1	1	0.48	1	0.016	1
M-66A	05/05/20	CH-CCR-M66-0520	mg/l	0.0017	1	1.1	1	0.68	1	0.014	1
M-67A	12/05/18	CH-CCR-MW67A-2518	mg/l	0.018	1	1	1	0.2	0	0.0061	1
M-67A	02/14/19	CH-CCR-M67A-21419	mg/l	0.016	1	0.8	0	0.2	0	0.005	1
M-67A	04/11/19	CH-CCR-M67A-41119	mg/l	0.016	1	0.8	0	0.2	0	0.0052	1
M-67A	11/26/19	CH-CCR-M67A-112619	mg/l	0.015	1	0.8	0	0.2	0	0.0052	1
M-67A	05/05/20	CH-CCR-M67-0520	mg/l	0.017	1	0.95	1	0.25	1	0.0043	1
W-123	12/03/15	7800	mg/l	0.0027	1	3.7	1	0.6	1	0.35	1
W-123	03/08/16	CH-W-123-0316	mg/l	0.01	0	4.8	1	0.58	1	0.34	1
W-123	05/06/16	CH-CCR-W123-0516	mg/l	0.0021	1	3.6	1	0.6	1	0.33	1
W-123	08/25/16	CH-CCR-W123-816	mg/l	0.0025	1	4.1	1	0.62	1	0.36	1
W-123	09/22/16	CH-CCR-W123-916	mg/l	0.0019	1	4.1	1	0.64	1	0.34	1
W-123	02/20/17	CH-CCR-W123-217	mg/l	0.0017	1	4.1	1	0.66	1	0.34	1
W-123	04/13/17	CH-CCR-W123-41317	mg/l	0.002	1	4.2	1	0.59	1	0.36	1
W-123	04/26/17	CH-CCR-W123-42617	mg/l	0.0017	1	3.7	1	0.64	1	0.35	1
W-123	05/22/17	CH-CCR-W123-52217	mg/l	0.0014	1	4	1	0.65	1	0.3	1
W-123	05/24/17	CH-CCR-W123-52417	mg/l	0.002	1	3.8	1	0.68	1	0.35	1
W-123	06/30/17	CH-CCR-W123-63017	mg/l	0.002	1	3.8	1	0.63	1	0.33	1
W-123	07/27/17	CH-CCR-W123-72717	mg/l	0.0015	1	3.7	1	0.66	1	0.33	1
W-123	09/07/17	CH-CCR-W123-90717	mg/l	0.002	0	3.7	1	0.7	1	0.36	1

StationName	SampDate	FieldSampleID	Units	Arsenic	D_Arsenic	Fluoride	D_Fluoride	Lithium	D_Lithium	Molybdenum	D_Molybdenum
W-123	12/08/17	CH-CCR-W123-120817	mg/l			4.1	1				
W-123	02/14/18	CH-CCR-W123-21418	mg/l	0.0018	1	4.2	1	0.63	1	0.37	1
W-123	05/21/18	CH-CCR-W-123-52118	mg/l	0.003	1	4.3	1	0.63	1	0.38	1
W-123	10/24/18	CH-CCR-W-123-102418	mg/l	0.0026	1	4	1	0.65	1	0.37	1
W-123	02/13/19	CH-CCR-W123-21319	mg/l	0.0024	1	3.7	1	0.75	1	0.37	1
W-123	04/11/19	CH-CCR-w123-41119	mg/l	0.0019	1	3.9	1	0.67	1	0.41	1
W-123	11/25/19	CH-CCR-W123-112519	mg/l	0.0023	1	3.6	1	0.66	1	0.41	1
W-123	05/06/20	CH-CCR-W123-0520	mg/l	0.0012	1	4.8	1	0.83	1	0.3	1
W-126	01/03/18	CH-APP-W126-010318	mg/l			3.7	1				
W-126	12/05/18	CH-CCR-W-126-125128	mg/l	0.0027	1	3.5	1	0.78	1	0.2	1
W-126	04/11/19	CH-CCR-W126-41119	mg/l	0.0017	1	3.7	1	0.73	1	0.22	1
W-126	05/15/19	CH-APP-W126-51519	mg/l			4	1				
W-126	06/24/19	CH-APP-W126-62419	mg/l			3.8	1				
W-126	07/11/19	CH-APP-W126-71119	mg/l			3.7	1				
W-126	08/19/19	CH-APP-W126-81919	mg/l			2.8	1				
W-126	11/14/19	CH-APP-W126-111419	mg/l			4	1				
W-126	11/26/19	CH-CCR-W126-112619	mg/l	0.0023	1	3.6	1	0.7	1	0.21	1
W-126	05/05/20	CH-CCR-W126-0520	mg/l	0.0014	1	4.1	1	1.1	1	0.22	1

WellGroup	StationName	SampDate	FieldSampleID	Units	Cobalt	D_Cobalt	Lithium	D_Lithium
on-site	M-52A	12/01/15	7879	mg/l	0.06	1	0.27	1
on-site	M-52A	03/09/16	CH-M-52A-0316	mg/l	0.054	1	0.25	1
on-site	M-52A	05/10/16	CH-CCR-M52A-516	mg/l	0.043	1	0.28	1
on-site	M-52A	08/26/16	CH-CCR-M52A-816	mg/l	0.061	1	0.24	1
on-site	M-52A	09/22/16	CH-CCR-M52A-916	mg/l	0.054	1	0.24	1
on-site	M-52A	02/21/17	CH-CCR-M52A-217	mg/l	0.043	1	0.26	1
on-site	M-52A	04/11/17	CH-CCR-M52A-41117	mg/l	0.045	1	0.24	1
on-site	M-52A	04/25/17	CH-CCR-M52A-42517	mg/l	0.041	1	0.26	1
on-site	M-52A	05/18/17	CH-CCR-M52A-51817	mg/l	0.037	1	0.27	1
on-site	M-52A	05/24/17	CH-CCR-M52A-52417	mg/l	0.044	1	0.26	1
on-site	M-52A	06/30/17	CH-CCR-M52A-63017	mg/l	0.051	1	0.23	1
on-site	M-52A	07/28/17	CH-CCR-M52A-72817	mg/l	0.063	1	0.21	1
on-site	M-52A	09/07/17	CH-CCR-M52A-90717	mg/l	0.066	1	0.22	1
on-site	M-52A	02/15/18	CH-CCR-M52A-21518	mg/l	0.052	1	0.25	1
on-site	M-52A	05/20/18	CH-CCR-M-52A-52018	mg/l	0.1	1	0.25	1
on-site	M-52A	06/07/18	CH-CCR-M52A-6718	mg/l	0.062	1	0.24	1
on-site	M-52A	10/24/18	CH-CCR-M-52A-102418	mg/l	0.055	1	0.24	1
on-site	M-52A	12/08/18	CH-CCR-M52A-12818	mg/l	0.036	1	0.29	1
on-site	M-52A	02/15/19	CH-CCR-M52A-21519	mg/l	0.029	1	0.32	1
on-site	M-52A	04/16/19	CH-CCR-M52A-41619	mg/l	0.027	1	0.3	1
on-site	M-52A	10/24/19	CH-CCR-M52A-102419	mg/l	0.07	1	0.22	1
on-site	M-52A	04/19/20	CH-CCR-M52-0420	mg/l	0.039	1	1	0
on-site	M-53A	12/01/15	7878	mg/l	0.024	1	0.21	1
on-site	M-53A	03/09/16	CH-M-53A-0316	mg/l	0.023	1	0.2	0
on-site	M-53A	05/10/16	CH-CCR-M53A-516	mg/l	0.023	1	0.2	0
on-site	M-53A	08/26/16	CH-CCR-M53A-816	mg/l	0.018	1	0.2	1
on-site	M-53A	09/22/16	CH-CCR-M53A-916	mg/l	0.017	1	0.21	1
on-site	M-53A	02/21/17	CH-CCR-M53A-217	mg/l	0.018	1	0.21	1
on-site	M-53A	04/12/17	CH-CCR-M53A-41217	mg/l	0.018	1	0.2	0
on-site	M-53A	04/25/17	CH-CCR-M53A-42517	mg/l	0.015	1	0.2	0
on-site	M-53A	05/18/17	CH-CCR-M53A-51817	mg/l	0.016	1	0.21	1
on-site	M-53A	05/24/17	CH-CCR-M53A-52417	mg/l	0.016	1	0.2	1
on-site	M-53A	07/01/17	CH-CCR-M53A-70117	mg/l	0.016	1	0.2	1
on-site	M-53A	07/28/17	CH-CCR-M53A-72817	mg/l	0.017	1	0.2	1
on-site	M-53A	09/07/17	CH-CCR-M53A-90717	mg/l	0.017	1	0.2	1
on-site	M-53A	02/15/18	CH-CCR-M53A-21518	mg/l	0.011	1	0.2	0
on-site	M-53A	05/20/18	CH-CCR-M-53A-52018	mg/l	0.016	1	0.2	0
on-site	M-53A	10/26/18	CH-CCR-M-53A-102618	mg/l	0.013	1	0.2	0
on-site	M-53A	12/07/18	CH-CCR-M53A-12718	mg/l	0.014	1	0.2	1
on-site	M-53A	02/15/19	CH-CCR-M53A-21519	mg/l	0.011	1	0.21	1
on-site	M-53A	04/17/19	CH-CCR-M53A-41719	mg/l	0.014	1	0.2	0
on-site	M-53A	10/23/19	CH-CCR-M53A-102319	mg/l	0.013	1	0.2	0
on-site	M-53A	04/19/20	CH-CCR-M53-0420	mg/l	0.014	1	1	0
off-site	M-55A	12/01/15	7877	mg/l	0.00071	1	0.33	1
off-site	M-55A	03/09/16	CH-M-55A-0316	mg/l	0.01	0	0.31	1
off-site	M-55A	05/10/16	CH-CCR-M55A-516	mg/l	0.001	0	0.34	1
off-site	M-55A	08/26/16	CH-CCR-M55A-816	mg/l	0.0005	0	0.33	1
off-site	M-55A	09/22/16	CH-CCR-M55A-916	mg/l	0.00074	1	0.36	1
off-site	M-55A	02/21/17	CH-CCR-M55A-217	mg/l	0.00057	1	0.38	1
off-site	M-55A	04/12/17	CH-CCR-M55A-41217	mg/l	0.0005	0	0.35	1
off-site	M-55A	04/25/17	CH-CCR-M55A-42517	mg/l	0.0005	0	0.37	1
off-site	M-55A	05/18/17	CH-CCR-M55A-51817	mg/l	0.0005	0	0.37	1
off-site	M-55A	05/24/17	CH-CCR-M55A-52417	mg/l	0.0005	0	0.37	1
off-site	M-55A	07/01/17	CH-CCR-M55A-70117	mg/l	0.0016	1	0.35	1
off-site	M-55A	07/28/17	CH-CCR-M55A-72817	mg/l	0.004	1	0.35	1
off-site	M-55A	09/07/17	CH-CCR-M55A-90717	mg/l	0.002	0	0.37	1

WellGroup	StationName	SampDate	FieldSampleID	Units	Cobalt	D_Cobalt	Lithium	D_Lithium
off-site	M-55A	12/08/18	CH-CCR-M55A-12818	mg/l	0.002	0	0.39	1
off-site	M-55A	02/15/19	CH-CCR-M55A-21519	mg/l	0.00095	1	0.43	1
off-site	M-55A	04/16/19	CH-CCR-M55A-41619	mg/l	0.00083	1	0.37	1
off-site	M-55A	10/24/19	CH-CCR-M55A-102419	mg/l	0.001	0	0.38	1
off-site	M-55A	04/17/20	CH-CCR-M55-0420	mg/l	0.0025	0	1	0
on-site	MW-69A	04/19/20	CH-CCR-M69-0420	mg/l	0.027	1	1	0
on-site	MW-70M	04/19/20	CH-CCR-M70-0420	mg/l	0.025	1	1	0
off-site	W-301	12/07/18	CH-CCR-W301-12718	mg/l	0.017	1	0.43	1
off-site	W-301	02/15/19	CH-CCR-W301-21519	mg/l	0.018	1	0.59	1
off-site	W-301	04/16/19	CH-CCR-W301-41619	mg/l	0.018	1	0.5	1
off-site	W-301	10/23/19	CH-CCR-W301-102319	mg/l	0.016	1	0.52	1
off-site	W-301	04/18/20	CH-CCR-W301-0420	mg/l	0.021	1	0.41	1
off-site	W-302	12/07/18	CH-CCR-W302-12718	mg/l	0.0049	1	0.32	1
off-site	W-302	02/15/19	CH-CCR-W302-21519	mg/l	0.022	1	0.37	1
off-site	W-302	04/17/19	CH-CCR-W302-41719	mg/l	0.0054	1	0.31	1
off-site	W-302	10/23/19	CH-CCR-W302-102319	mg/l	0.0055	1	0.32	1
off-site	W-302	04/17/20	CH-CCR-W302-0420	mg/l	0.0064	1	1	0
off-site	W-303	04/18/20	CH-CCR-W303-0420	mg/l	0.027	1	1	0
on-site	W-304	12/07/18	CH-CCR-W304-12718	mg/l	0.0034	1	0.4	1
on-site	W-304	02/15/19	CH-CCR-W304-21519	mg/l	0.0029	1	0.48	1
on-site	W-304	04/16/19	CH-CCR-W304-41619	mg/l	0.002	1	0.41	1
on-site	W-304	10/24/19	CH-CCR-W304-102419	mg/l	0.0028	1	0.45	1
on-site	W-304	04/17/20	CH-CCR-W304-0420	mg/l	0.003	1	0.46	1
on-site	W-305	12/02/15	7796	mg/l	0.01	1	0.23	1
on-site	W-305	03/09/16	CH-W-305-0316	mg/l	0.016	1	0.21	1
on-site	W-305	05/11/16	CH-CCR-W305-516	mg/l	0.014	1	0.21	1
on-site	W-305	08/27/16	CH-CCR-W305-816	mg/l	0.019	1	0.21	1
on-site	W-305	09/22/16	CH-CCR-W305-916	mg/l	0.016	1	0.22	1
on-site	W-305	02/21/17	CH-CCR-W305-217	mg/l	0.018	1	0.22	1
on-site	W-305	04/11/17	CH-CCR-W305-41117	mg/l	0.019	1	0.2	1
on-site	W-305	04/24/17	CH-CCR-W305-42417	mg/l	0.017	1	0.21	1
on-site	W-305	05/22/17	CH-CCR-W305-52217	mg/l	0.015	1	0.2	1
on-site	W-305	05/24/17	CH-CCR-W305-52417	mg/l	0.017	1	0.23	1
on-site	W-305	06/29/17	CH-CCR-W305-62917	mg/l	0.018	1	0.21	1
on-site	W-305	07/28/17	CH-CCR-W305-72817	mg/l	0.017	1	0.21	1
on-site	W-305	09/06/17	CH-CCR-W305-90617	mg/l	0.018	1	0.2	1
on-site	W-305	02/15/18	CH-CCR-W305-21518	mg/l	0.017	1	0.21	1
on-site	W-305	05/19/18	CH-CCR-W-305-51918	mg/l	0.017	1	0.21	1
on-site	W-305	10/26/18	CH-CCR-W-305-102618	mg/l	0.018	1	0.68	1
on-site	W-305	12/07/18	CH-CCR-W305-12718	mg/l	0.018	1	0.21	1
on-site	W-305	02/15/19	CH-CCR-W305-21519	mg/l	0.018	1	0.22	1
on-site	W-305	04/17/19	CH-CCR-W305-41719	mg/l	0.018	1	0.2	1
on-site	W-305	10/23/19	CH-CCR-W305-102319	mg/l	0.018	1	0.2	1
on-site	W-305	04/18/20	CH-CCR-W305-0420	mg/l	0.02	1	0.3	1
on-site	W-306	12/02/15	7797	mg/l	0.03	1	0.43	1
on-site	W-306	03/09/16	CH-W-306-0316	mg/l	0.0099	1	0.51	1
on-site	W-306	05/11/16	CH-CCR-W306-516	mg/l	0.0082	1	0.56	1
on-site	W-306	08/26/16	CH-CCR-W306-816	mg/l	0.0043	1	0.67	1
on-site	W-306	09/22/16	CH-CCR-W306-916	mg/l	0.0038	1	0.72	1
on-site	W-306	02/21/17	CH-CCR-W306-217	mg/l	0.0021	1	0.78	1
on-site	W-306	04/12/17	CH-CCR-W306-41217	mg/l	0.0021	1	0.7	1
on-site	W-306	04/25/17	CH-CCR-W306-42517	mg/l	0.002	1	0.71	1
on-site	W-306	05/22/17	CH-CCR-W306-52217	mg/l	0.0018	1	0.65	1
on-site	W-306	05/24/17	CH-CCR-W306-52417	mg/l	0.0022	1	0.74	1
on-site	W-306	07/01/17	CH-CCR-W306-70117	mg/l	0.0023	1	0.64	1
on-site	W-306	07/28/17	CH-CCR-W306-72817	mg/l	0.0024	1	0.64	1

WellGroup	StationName	SampDate	FieldSampleID	Units	Cobalt	D_Cobalt	Lithium	D_Lithium
on-site	W-306	09/06/17	CH-CCR-W306-90617	mg/l	0.0023	1	0.62	1
on-site	W-306	02/15/18	CH-CCR-W306-21518	mg/l	0.0014	1	0.69	1
on-site	W-306	05/19/18	CH-CCR-W-306-51918	mg/l	0.0014	1	0.68	1
on-site	W-306	12/07/18	CH-CCR-W306-12718	mg/l	0.002	0	0.73	1
on-site	W-306	02/15/19	CH-CCR-W306-21519	mg/l	0.00097	1	0.8	1
on-site	W-306	04/16/19	CH-CCR-W306-41619	mg/l	0.00094	1	0.68	1
on-site	W-306	10/23/19	CH-CCR-W306-102319	mg/l	0.0029	1	0.7	1
on-site	W-306	04/19/20	CH-CCR-W306-0420	mg/l	0.0025	0	1.3	1
off-site	W-307	12/08/18	CH-CCR-W307-12818	mg/l	0.076	1	0.24	1
off-site	W-307	02/15/19	CH-CCR-W307-21519	mg/l	0.073	1	0.26	1
off-site	W-307	04/16/19	CH-CCR-W307-41619	mg/l	0.08	1	0.22	1
off-site	W-307	10/24/19	CH-CCR-W307-102419	mg/l	0.082	1	0.23	1
off-site	W-307	04/17/20	CH-CCR-W307-0420	mg/l	0.084	1	0.29	1
off-site	W-308	12/08/18	CH-CCR-W308-12818	mg/l	0.0033	1	0.37	1
off-site	W-308	02/15/19	CH-CCR-W308-21519	mg/l	0.00079	1	0.39	1
off-site	W-308	04/16/19	CH-CCR-W308-41619	mg/l	0.0005	0	0.35	1
off-site	W-308	10/24/19	CH-CCR-W308-102419	mg/l	0.002	0	0.37	1
off-site	W-308	04/17/20	CH-CCR-W308-0420	mg/l	0.0025	0	0.46	1
off-site	W-309	12/08/18	CH-CCR-W309-12818	mg/l	0.002	0	0.2	0
off-site	W-309	02/15/19	CH-CCR-W309-21519	mg/l	0.0005	0	0.35	1
off-site	W-309	04/16/19	CH-CCR-W309-41619	mg/l	0.0005	0	0.3	1
off-site	W-309	10/24/19	CH-CCR-W309-102419	mg/l	0.001	0	0.31	1
off-site	W-309	05/04/20	CH-CCR-W309-0520	mg/l	0.0005	0	0.5	1
on-site	W-314	12/02/15	7798	mg/l	0.016	1	0.35	1
on-site	W-314	03/10/16	CH-W-314-0316	mg/l	0.018	1	0.32	1
on-site	W-314	05/11/16	CH-CCR-W314-516	mg/l	0.015	1	0.33	1
on-site	W-314	08/26/16	CH-CCR-W314-816	mg/l	0.015	1	0.32	1
on-site	W-314	09/22/16	CH-CCR-W314-916	mg/l	0.013	1	0.34	1
on-site	W-314	02/21/17	CH-CCR-W314-217	mg/l	0.013	1	0.35	1
on-site	W-314	04/11/17	CH-CCR-W314-41117	mg/l	0.014	1	0.31	1
on-site	W-314	04/25/17	CH-CCR-W314-42517	mg/l	0.013	1	0.33	1
on-site	W-314	05/22/17	CH-CCR-W314-52217	mg/l	0.011	1	0.32	1
on-site	W-314	05/24/17	CH-CCR-W314-52417	mg/l	0.014	1	0.34	1
on-site	W-314	06/30/17	CH-CCR-W314-63017	mg/l	0.012	1	0.3	1
on-site	W-314	07/28/17	CH-CCR-W314-72817	mg/l	0.012	1	0.3	1
on-site	W-314	09/07/17	CH-CCR-W314-90717	mg/l	0.013	1	0.31	1
on-site	W-314	02/15/18	CH-CCR-W314-21518	mg/l	0.013	1	0.32	1
on-site	W-314	05/20/18	CH-CCR-W-314-52018	mg/l	0.013	1	0.32	1
on-site	W-314	10/24/18	CH-CCR-W-314-102418	mg/l	0.015	1	0.3	1
on-site	W-314	12/08/18	CH-CCR-W314-12818	mg/l	0.014	1	0.32	1
on-site	W-314	02/15/19	CH-CCR-W314-21519	mg/l	0.016	1	0.34	1
on-site	W-314	04/16/19	CH-CCR-W314-41619	mg/l	0.016	1	0.29	1
on-site	W-314	10/24/19	CH-CCR-W314-102419	mg/l	0.019	1	0.3	1
on-site	W-314	04/19/20	CH-CCR-W314-0420	mg/l	0.022	1	0.44	1
off-site	W-317	03/30/19	CH-CCR-W317-33019	mg/l	0.00085	1	0.2	0
off-site	W-317	04/17/19	CH-CCR-W317-41719	mg/l	0.0005	0	0.2	0
off-site	W-317	10/24/19	CH-CCR-W317-102419	mg/l	0.0005	0	0.2	0
off-site	W-317	04/16/20	CH-CCR-W317-0420	mg/l	0.0025	0	0.042	1

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.19/23/2020 1:49:19 PM
From File	ProUCL_inputs_v1.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic (fap)

General Statistics

Total Number of Observations	94	Number of Distinct Observations	45
		Number of Missing Observations	10
Number of Detects	87	Number of Non-Detects	7
Number of Distinct Detects	44	Number of Distinct Non-Detects	3
Minimum Detect	5.4000E-4	Minimum Non-Detect	0.001
Maximum Detect	0.035	Maximum Non-Detect	0.01
Variance Detects	9.4721E-5	Percent Non-Detects	7.447%
Mean Detects	0.00771	SD Detects	0.00973
Median Detects	0.0025	CV Detects	1.262
Skewness Detects	1.365	Kurtosis Detects	0.403
Mean of Logged Detects	-5.599	SD of Logged Detects	1.184

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.678	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.376	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0951	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00725	KM Standard Error of Mean	9.8086E-4
KM SD	0.00945	95% KM (BCA) UCL	0.00893
95% KM (t) UCL	0.00888	95% KM (Percentile Bootstrap) UCL	0.0089
95% KM (z) UCL	0.00887	95% KM Bootstrap t UCL	0.00904
90% KM Chebyshev UCL	0.0102	95% KM Chebyshev UCL	0.0115
97.5% KM Chebyshev UCL	0.0134	99% KM Chebyshev UCL	0.017

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.061	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.791	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.322	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0994	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.807	k star (bias corrected MLE)	0.787
Theta hat (MLE)	0.00956	Theta star (bias corrected MLE)	0.00981
nu hat (MLE)	140.4	nu star (bias corrected)	136.9
Mean (detects)	0.00771		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.4000E-4	Mean	0.00788
Maximum	0.035	Median	0.0026
SD	0.00938	CV	1.189
k hat (MLE)	0.861	k star (bias corrected MLE)	0.841
Theta hat (MLE)	0.00916	Theta star (bias corrected MLE)	0.00938
nu hat (MLE)	161.9	nu star (bias corrected)	158.1
Adjusted Level of Significance (β)	0.0474		
Approximate Chi Square Value (158.06, α)	130	Adjusted Chi Square Value (158.06, β)	129.6
95% Gamma Approximate UCL (use when n>=50)	0.00959	95% Gamma Adjusted UCL (use when n<50)	0.00962

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00725	SD (KM)	0.00945
Variance (KM)	8.9365E-5	SE of Mean (KM)	9.8086E-4
k hat (KM)	0.589	k star (KM)	0.577
nu hat (KM)	110.6	nu star (KM)	108.4
theta hat (KM)	0.0123	theta star (KM)	0.0126
80% gamma percentile (KM)	0.012	90% gamma percentile (KM)	0.019
95% gamma percentile (KM)	0.0265	99% gamma percentile (KM)	0.0445

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (108.44, α)	85.41	Adjusted Chi Square Value (108.44, β)	85.09
95% Gamma Approximate KM-UCL (use when n>=50)	0.00921	95% Gamma Adjusted KM-UCL (use when n<50)	0.00924

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.851	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.651E-12	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.26	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0951	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00726	Mean in Log Scale	-5.676
SD in Original Scale	0.0095	SD in Log Scale	1.183
95% t UCL (assumes normality of ROS data)	0.00889	95% Percentile Bootstrap UCL	0.00885

95% BCA Bootstrap UCL	0.009	95% Bootstrap t UCL	0.00903
95% H-UCL (Log ROS)	0.0093		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.677	KM Geo Mean	0.00342
KM SD (logged)	1.175	95% Critical H Value (KM-Log)	2.426
KM Standard Error of Mean (logged)	0.123	95% H-UCL (KM -Log)	0.00917
KM SD (logged)	1.175	95% Critical H Value (KM-Log)	2.426
KM Standard Error of Mean (logged)	0.123		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00734	Mean in Log Scale	-5.653
SD in Original Scale	0.00947	SD in Log Scale	1.181
95% t UCL (Assumes normality)	0.00896	95% H-Stat UCL	0.00948

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0115

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Fluoride (fap)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	40
Number of Detects	85	Number of Non-Detects	19
Number of Distinct Detects	38	Number of Distinct Non-Detects	2
Minimum Detect	0.93	Minimum Non-Detect	0.4
Maximum Detect	6	Maximum Non-Detect	0.8
Variance Detects	1.999	Percent Non-Detects	18.27%
Mean Detects	3.463	SD Detects	1.414
Median Detects	3.7	CV Detects	0.408
Skewness Detects	-0.0372	Kurtosis Detects	-1.094
Mean of Logged Detects	1.141	SD of Logged Detects	0.484

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.93	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.2215E-4	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**

5% Lilliefors Critical Value	0.0962	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.904	KM Standard Error of Mean	0.171
KM SD	1.737	95% KM (BCA) UCL	3.185
95% KM (t) UCL	3.188	95% KM (Percentile Bootstrap) UCL	3.178
95% KM (z) UCL	3.185	95% KM Bootstrap t UCL	3.201
90% KM Chebyshev UCL	3.418	95% KM Chebyshev UCL	3.65
97.5% KM Chebyshev UCL	3.973	99% KM Chebyshev UCL	4.608

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.008	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.181	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0972	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.078	k star (bias corrected MLE)	4.907
Theta hat (MLE)	0.682	Theta star (bias corrected MLE)	0.706
nu hat (MLE)	863.3	nu star (bias corrected)	834.2
Mean (detects)	3.463		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.475	Mean	3.04
Maximum	6	Median	2.7
SD	1.567	CV	0.516
k hat (MLE)	3.229	k star (bias corrected MLE)	3.142
Theta hat (MLE)	0.942	Theta star (bias corrected MLE)	0.968
nu hat (MLE)	671.6	nu star (bias corrected)	653.5
Adjusted Level of Significance (β)	0.0477		
Approximate Chi Square Value (653.52, α)	595.2	Adjusted Chi Square Value (653.52, β)	594.4
95% Gamma Approximate UCL (use when n>=50)	3.338	95% Gamma Adjusted UCL (use when n<50)	3.343

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.904	SD (KM)	1.737
Variance (KM)	3.016	SE of Mean (KM)	0.171
k hat (KM)	2.795	k star (KM)	2.721
nu hat (KM)	581.4	nu star (KM)	566
theta hat (KM)	1.039	theta star (KM)	1.067

80% gamma percentile (KM)	4.19	90% gamma percentile (KM)	5.263
95% gamma percentile (KM)	6.269	99% gamma percentile (KM)	8.461

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (566.01, α)	511.8	Adjusted Chi Square Value (566.01, β)	511.1
95% Gamma Approximate KM-UCL (use when n>=50)	3.211	95% Gamma Adjusted KM-UCL (use when n<50)	3.216

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.897	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.2327E-7	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.202	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0962	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.041	Mean in Log Scale	0.954
SD in Original Scale	1.563	SD in Log Scale	0.596
95% t UCL (assumes normality of ROS data)	3.296	95% Percentile Bootstrap UCL	3.29
95% BCA Bootstrap UCL	3.275	95% Bootstrap t UCL	3.293
95% H-UCL (Log ROS)	3.467		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.765	KM Geo Mean	2.149
KM SD (logged)	0.906	95% Critical H Value (KM-Log)	2.125
KM Standard Error of Mean (logged)	0.0894	95% H-UCL (KM -Log)	3.915
KM SD (logged)	0.906	95% Critical H Value (KM-Log)	2.125
KM Standard Error of Mean (logged)	0.0894		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.877	Mean in Log Scale	0.671
SD in Original Scale	1.785	SD in Log Scale	1.096
95% t UCL (Assumes normality)	3.167	95% H-Stat UCL	4.576

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.188	KM H-UCL	3.915
95% KM (BCA) UCL	3.185		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lithium (fap)

General Statistics

Total Number of Observations	94	Number of Distinct Observations	35
		Number of Missing Observations	10
Number of Detects	77	Number of Non-Detects	17
Number of Distinct Detects	34	Number of Distinct Non-Detects	1
Minimum Detect	0.23	Minimum Non-Detect	0.2
Maximum Detect	1.1	Maximum Non-Detect	0.2
Variance Detects	0.0154	Percent Non-Detects	18.09%
Mean Detects	0.557	SD Detects	0.124
Median Detects	0.54	CV Detects	0.223
Skewness Detects	0.919	Kurtosis Detects	4.35
Mean of Logged Detects	-0.611	SD of Logged Detects	0.228

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.942	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.00277	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.101	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.492	KM Standard Error of Mean	0.0184
KM SD	0.177	95% KM (BCA) UCL	0.522
95% KM (t) UCL	0.523	95% KM (Percentile Bootstrap) UCL	0.523
95% KM (z) UCL	0.522	95% KM Bootstrap t UCL	0.522
90% KM Chebyshev UCL	0.547	95% KM Chebyshev UCL	0.572
97.5% KM Chebyshev UCL	0.607	99% KM Chebyshev UCL	0.675

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.955	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.75	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.11	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.101	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	20.37	k star (bias corrected MLE)	19.59
Theta hat (MLE)	0.0273	Theta star (bias corrected MLE)	0.0284
nu hat (MLE)	3137	nu star (bias corrected)	3016
Mean (detects)	0.557		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.221	Mean	0.514
Maximum	1.1	Median	0.505
SD	0.146	CV	0.285
k hat (MLE)	11.95	k star (bias corrected MLE)	11.57
Theta hat (MLE)	0.043	Theta star (bias corrected MLE)	0.0444
nu hat (MLE)	2246	nu star (bias corrected)	2176
Adjusted Level of Significance (β)	0.0474		
Approximate Chi Square Value (N/A, α)	2068	Adjusted Chi Square Value (N/A, β)	2067
95% Gamma Approximate UCL (use when n>=50)	0.54	95% Gamma Adjusted UCL (use when n<50)	0.541

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.492	SD (KM)	0.177
Variance (KM)	0.0313	SE of Mean (KM)	0.0184
k hat (KM)	7.74	k star (KM)	7.5
nu hat (KM)	1455	nu star (KM)	1410
theta hat (KM)	0.0636	theta star (KM)	0.0656
80% gamma percentile (KM)	0.634	90% gamma percentile (KM)	0.732
95% gamma percentile (KM)	0.82	99% gamma percentile (KM)	1.003

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1324	Adjusted Chi Square Value (N/A, β)	1323
95% Gamma Approximate KM-UCL (use when n>=50)	0.524	95% Gamma Adjusted KM-UCL (use when n<50)	0.525

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.938	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.00143	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.101	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.517	Mean in Log Scale	-0.698
SD in Original Scale	0.142	SD in Log Scale	0.283
95% t UCL (assumes normality of ROS data)	0.541	95% Percentile Bootstrap UCL	0.541
95% BCA Bootstrap UCL	0.541	95% Bootstrap t UCL	0.543
95% H-UCL (Log ROS)	0.545		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.791	KM Geo Mean	0.453
KM SD (logged)	0.436	95% Critical H Value (KM-Log)	1.813
KM Standard Error of Mean (logged)	0.0453	95% H-UCL (KM -Log)	0.541
KM SD (logged)	0.436	95% Critical H Value (KM-Log)	1.813

KM Standard Error of Mean (logged)	0.0453		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.474	Mean in Log Scale	-0.917
SD in Original Scale	0.209	SD in Log Scale	0.687
95% t UCL (Assumes normality)	0.51	95% H-Stat UCL	0.584

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.523	KM H-UCL	0.541
95% KM (BCA) UCL	0.522		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (fap)

General Statistics

Total Number of Observations	94	Number of Distinct Observations	58
		Number of Missing Observations	10
Number of Detects	93	Number of Non-Detects	1
Number of Distinct Detects	57	Number of Distinct Non-Detects	1
Minimum Detect	0.0019	Minimum Non-Detect	0.01
Maximum Detect	0.41	Maximum Non-Detect	0.01
Variance Detects	0.0193	Percent Non-Detects	1.064%
Mean Detects	0.104	SD Detects	0.139
Median Detects	0.034	CV Detects	1.338
Skewness Detects	1.165	Kurtosis Detects	-0.385
Mean of Logged Detects	-3.494	SD of Logged Detects	1.746

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.686	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.283	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0921	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.103	KM Standard Error of Mean	0.0143
KM SD	0.138	95% KM (BCA) UCL	0.126

95% KM (t) UCL	0.127	95% KM (Percentile Bootstrap) UCL	0.127
95% KM (z) UCL	0.126	95% KM Bootstrap t UCL	0.128
90% KM Chebyshev UCL	0.146	95% KM Chebyshev UCL	0.165
97.5% KM Chebyshev UCL	0.192	99% KM Chebyshev UCL	0.245

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.096	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.817	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.162	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.098	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.514	k star (bias corrected MLE)	0.505
Theta hat (MLE)	0.202	Theta star (bias corrected MLE)	0.206
nu hat (MLE)	95.69	nu star (bias corrected)	93.94
Mean (detects)	0.104		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0019	Mean	0.103
Maximum	0.41	Median	0.0325
SD	0.138	CV	1.346
k hat (MLE)	0.515	k star (bias corrected MLE)	0.505
Theta hat (MLE)	0.2	Theta star (bias corrected MLE)	0.204
nu hat (MLE)	96.74	nu star (bias corrected)	94.98
Adjusted Level of Significance (β)	0.0474		
Approximate Chi Square Value (94.98, α)	73.51	Adjusted Chi Square Value (94.98, β)	73.21
95% Gamma Approximate UCL (use when n>=50)	0.133	95% Gamma Adjusted UCL (use when n<50)	0.133

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.103	SD (KM)	0.138
Variance (KM)	0.019	SE of Mean (KM)	0.0143
k hat (KM)	0.557	k star (KM)	0.546
nu hat (KM)	104.6	nu star (KM)	102.6
theta hat (KM)	0.185	theta star (KM)	0.188
80% gamma percentile (KM)	0.169	90% gamma percentile (KM)	0.273
95% gamma percentile (KM)	0.383	99% gamma percentile (KM)	0.65

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (102.64, α)	80.26	Adjusted Chi Square Value (102.64, β)	79.95
95% Gamma Approximate KM-UCL (use when n>=50)	0.131	95% Gamma Adjusted KM-UCL (use when n<50)	0.132

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.891	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	4.2482E-9	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.142	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0921	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.103	Mean in Log Scale	-3.51
SD in Original Scale	0.139	SD in Log Scale	1.744
95% t UCL (assumes normality of ROS data)	0.127	95% Percentile Bootstrap UCL	0.126
95% BCA Bootstrap UCL	0.128	95% Bootstrap t UCL	0.128
95% H-UCL (Log ROS)	0.239		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.514	KM Geo Mean	0.0298
KM SD (logged)	1.739	95% Critical H Value (KM-Log)	3.074
KM Standard Error of Mean (logged)	0.18	95% H-UCL (KM -Log)	0.235
KM SD (logged)	1.739	95% Critical H Value (KM-Log)	3.074
KM Standard Error of Mean (logged)	0.18		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.103	Mean in Log Scale	-3.513
SD in Original Scale	0.139	SD in Log Scale	1.747
95% t UCL (Assumes normality)	0.127	95% H-Stat UCL	0.24

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.165

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (fap) w.out M-67A

General Statistics

Total Number of Observations	89	Number of Distinct Observations	44
		Number of Missing Observations	10
Number of Detects	82	Number of Non-Detects	7

Number of Distinct Detects	43	Number of Distinct Non-Detects	3
Minimum Detect	5.4000E-4	Minimum Non-Detect	0.001
Maximum Detect	0.035	Maximum Non-Detect	0.01
Variance Detects	9.5563E-5	Percent Non-Detects	7.865%
Mean Detects	0.00719	SD Detects	0.00978
Median Detects	0.0025	CV Detects	1.361
Skewness Detects	1.553	Kurtosis Detects	0.853
Mean of Logged Detects	-5.69	SD of Logged Detects	1.159

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.63	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.397	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00674	KM Standard Error of Mean	0.00101
KM SD	0.00945	95% KM (BCA) UCL	0.00837
95% KM (t) UCL	0.00841	95% KM (Percentile Bootstrap) UCL	0.00842
95% KM (z) UCL	0.0084	95% KM Bootstrap t UCL	0.00863
90% KM Chebyshev UCL	0.00976	95% KM Chebyshev UCL	0.0111
97.5% KM Chebyshev UCL	0.013	99% KM Chebyshev UCL	0.0168

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.928	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.342	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.102	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.788	k star (bias corrected MLE)	0.768
Theta hat (MLE)	0.00912	Theta star (bias corrected MLE)	0.00936
nu hat (MLE)	129.3	nu star (bias corrected)	125.9
Mean (detects)	0.00719		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.4000E-4	Mean	0.00741
Maximum	0.035	Median	0.0025
SD	0.00941	CV	1.27

k hat (MLE)	0.843	k star (bias corrected MLE)	0.822
Theta hat (MLE)	0.00879	Theta star (bias corrected MLE)	0.00901
nu hat (MLE)	150	nu star (bias corrected)	146.3
Adjusted Level of Significance (β)	0.0473		
Approximate Chi Square Value (146.29, α)	119.3	Adjusted Chi Square Value (146.29, β)	118.9
95% Gamma Approximate UCL (use when n>=50)	0.00908	95% Gamma Adjusted UCL (use when n<50)	0.00911

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00674	SD (KM)	0.00945
Variance (KM)	8.9362E-5	SE of Mean (KM)	0.00101
k hat (KM)	0.508	k star (KM)	0.498
nu hat (KM)	90.44	nu star (KM)	88.72
theta hat (KM)	0.0133	theta star (KM)	0.0135
80% gamma percentile (KM)	0.0111	90% gamma percentile (KM)	0.0182
95% gamma percentile (KM)	0.0259	99% gamma percentile (KM)	0.0448

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (88.72, α)	68.01	Adjusted Chi Square Value (88.72, β)	67.71
95% Gamma Approximate KM-UCL (use when n>=50)	0.00879	95% Gamma Adjusted KM-UCL (use when n<50)	0.00883

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.836	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	8.695E-13	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.273	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00675	Mean in Log Scale	-5.764
SD in Original Scale	0.0095	SD in Log Scale	1.154
95% t UCL (assumes normality of ROS data)	0.00842	95% Percentile Bootstrap UCL	0.00849
95% BCA Bootstrap UCL	0.00861	95% Bootstrap t UCL	0.00871
95% H-UCL (Log ROS)	0.0082		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.765	KM Geo Mean	0.00313
KM SD (logged)	1.146	95% Critical H Value (KM-Log)	2.387
KM Standard Error of Mean (logged)	0.123	95% H-UCL (KM -Log)	0.00808
KM SD (logged)	1.146	95% Critical H Value (KM-Log)	2.387
KM Standard Error of Mean (logged)	0.123		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00683	Mean in Log Scale	-5.739
SD in Original Scale	0.00948	SD in Log Scale	1.154
95% t UCL (Assumes normality)	0.0085	95% H-Stat UCL	0.0084

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0111

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.19/24/2020 10:35:02 AM
From File	ProUCL_inputs_v1_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cobalt (off-site)

General Statistics

Total Number of Observations	48	Number of Distinct Observations	30
Number of Detects	26	Number of Non-Detects	22
Number of Distinct Detects	25	Number of Distinct Non-Detects	5
Minimum Detect	5.7000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.084	Maximum Non-Detect	0.01
Variance Detects	8.7081E-4	Percent Non-Detects	45.83%
Mean Detects	0.0219	SD Detects	0.0295
Median Detects	0.00595	CV Detects	1.345
Skewness Detects	1.412	Kurtosis Detects	0.402
Mean of Logged Detects	-4.958	SD of Logged Detects	1.727

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.696	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.268	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0122	KM Standard Error of Mean	0.0035
KM SD	0.0238	95% KM (BCA) UCL	0.0191
95% KM (t) UCL	0.018	95% KM (Percentile Bootstrap) UCL	0.0184
95% KM (z) UCL	0.0179	95% KM Bootstrap t UCL	0.0195
90% KM Chebyshev UCL	0.0227	95% KM Chebyshev UCL	0.0274
97.5% KM Chebyshev UCL	0.034	99% KM Chebyshev UCL	0.047

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.956	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.804	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.15	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.181	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.55	k star (bias corrected MLE)	0.512
Theta hat (MLE)	0.0399	Theta star (bias corrected MLE)	0.0429
nu hat (MLE)	28.6	nu star (bias corrected)	26.63
Mean (detects)	0.0219		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.7000E-4	Mean	0.0165
Maximum	0.084	Median	0.01
SD	0.0223	CV	1.357
k hat (MLE)	0.853	k star (bias corrected MLE)	0.814
Theta hat (MLE)	0.0193	Theta star (bias corrected MLE)	0.0202
nu hat (MLE)	81.91	nu star (bias corrected)	78.12
Adjusted Level of Significance (β)	0.045		
Approximate Chi Square Value (78.12, α)	58.76	Adjusted Chi Square Value (78.12, β)	58.24
95% Gamma Approximate UCL (use when n>=50)	0.0219	95% Gamma Adjusted UCL (use when n<50)	0.0221

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0122	SD (KM)	0.0238
Variance (KM)	5.6669E-4	SE of Mean (KM)	0.0035
k hat (KM)	0.261	k star (KM)	0.259
nu hat (KM)	25.06	nu star (KM)	24.83
theta hat (KM)	0.0466	theta star (KM)	0.047
80% gamma percentile (KM)	0.0179	90% gamma percentile (KM)	0.0364
95% gamma percentile (KM)	0.0583	99% gamma percentile (KM)	0.116

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (24.83, α)	14.48	Adjusted Chi Square Value (24.83, β)	14.23
95% Gamma Approximate KM-UCL (use when n>=50)	0.0209	95% Gamma Adjusted KM-UCL (use when n<50)	0.0212

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.904	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.012	Mean in Log Scale	-6.708
SD in Original Scale	0.0241	SD in Log Scale	2.453
95% t UCL (assumes normality of ROS data)	0.0179	95% Percentile Bootstrap UCL	0.018
95% BCA Bootstrap UCL	0.0196	95% Bootstrap t UCL	0.0198
95% H-UCL (Log ROS)	0.113		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.116	KM Geo Mean	0.00221
KM SD (logged)	1.783	95% Critical H Value (KM-Log)	3.302
KM Standard Error of Mean (logged)	0.264	95% H-UCL (KM -Log)	0.0255
KM SD (logged)	1.783	95% Critical H Value (KM-Log)	3.302
KM Standard Error of Mean (logged)	0.264		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0122	Mean in Log Scale	-6.165
SD in Original Scale	0.024	SD in Log Scale	1.915
95% t UCL (Assumes normality)	0.0181	95% H-Stat UCL	0.0348

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ıma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.0212

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (on-site)

General Statistics

Total Number of Observations	112	Number of Distinct Observations	54
Number of Detects	110	Number of Non-Detects	2
Number of Distinct Detects	53	Number of Distinct Non-Detects	2
Minimum Detect	9.4000E-4	Minimum Non-Detect	0.002
Maximum Detect	0.1	Maximum Non-Detect	0.0025
Variance Detects	3.2388E-4	Percent Non-Detects	1.786%
Mean Detects	0.0208	SD Detects	0.018

Median Detects	0.016	CV Detects	0.865
Skewness Detects	1.729	Kurtosis Detects	3.385
Mean of Logged Detects	-4.277	SD of Logged Detects	1.021

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.808	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0848	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0205	KM Standard Error of Mean	0.0017
KM SD	0.0179	95% KM (BCA) UCL	0.0233
95% KM (t) UCL	0.0233	95% KM (Percentile Bootstrap) UCL	0.0234
95% KM (z) UCL	0.0233	95% KM Bootstrap t UCL	0.0237
90% KM Chebyshev UCL	0.0256	95% KM Chebyshev UCL	0.0279
97.5% KM Chebyshev UCL	0.0311	99% KM Chebyshev UCL	0.0374

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.202	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.773	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.16	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0887	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.379	k star (bias corrected MLE)	1.348
Theta hat (MLE)	0.0151	Theta star (bias corrected MLE)	0.0154
nu hat (MLE)	303.4	nu star (bias corrected)	296.5
Mean (detects)	0.0208		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	9.4000E-4	Mean	0.0206
Maximum	0.1	Median	0.016
SD	0.0179	CV	0.868
k hat (MLE)	1.39	k star (bias corrected MLE)	1.359
Theta hat (MLE)	0.0148	Theta star (bias corrected MLE)	0.0152
nu hat (MLE)	311.4	nu star (bias corrected)	304.4

Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (304.37, α)	265	Adjusted Chi Square Value (304.37, β)	264.5
95% Gamma Approximate UCL (use when n>=50)	0.0237	95% Gamma Adjusted UCL (use when n<50)	0.0237

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0205	SD (KM)	0.0179
Variance (KM)	3.2170E-4	SE of Mean (KM)	0.0017
k hat (KM)	1.301	k star (KM)	1.272
nu hat (KM)	291.4	nu star (KM)	284.9
theta hat (KM)	0.0157	theta star (KM)	0.0161
80% gamma percentile (KM)	0.0322	90% gamma percentile (KM)	0.0444
95% gamma percentile (KM)	0.0564	99% gamma percentile (KM)	0.0837

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (284.93, α)	246.8	Adjusted Chi Square Value (284.93, β)	246.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.0236	95% Gamma Adjusted KM-UCL (use when n<50)	0.0237

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.89	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.962E-11	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.22	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0848	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0205	Mean in Log Scale	-4.309
SD in Original Scale	0.018	SD in Log Scale	1.039
95% t UCL (assumes normality of ROS data)	0.0233	95% Percentile Bootstrap UCL	0.0233
95% BCA Bootstrap UCL	0.0237	95% Bootstrap t UCL	0.0237
95% H-UCL (Log ROS)	0.0288		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.317	KM Geo Mean	0.0133
KM SD (logged)	1.051	95% Critical H Value (KM-Log)	2.263
KM Standard Error of Mean (logged)	0.0998	95% H-UCL (KM -Log)	0.029
KM SD (logged)	1.051	95% Critical H Value (KM-Log)	2.263
KM Standard Error of Mean (logged)	0.0998		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0204	Mean in Log Scale	-4.322
SD in Original Scale	0.018	SD in Log Scale	1.066
95% t UCL (Assumes normality)	0.0233	95% H-Stat UCL	0.0295

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0279

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lithium (off-site)

General Statistics

Total Number of Observations	48	Number of Distinct Observations	24
Number of Detects	41	Number of Non-Detects	7
Number of Distinct Detects	22	Number of Distinct Non-Detects	2
Minimum Detect	0.042	Minimum Non-Detect	0.2
Maximum Detect	0.59	Maximum Non-Detect	1
Variance Detects	0.00817	Percent Non-Detects	14.58%
Mean Detects	0.356	SD Detects	0.0904
Median Detects	0.36	CV Detects	0.254
Skewness Detects	-0.482	Kurtosis Detects	3.469
Mean of Logged Detects	-1.084	SD of Logged Detects	0.391

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.941	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.137	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.328	KM Standard Error of Mean	0.0186
KM SD	0.124	95% KM (BCA) UCL	0.37
95% KM (t) UCL	0.359	95% KM (Percentile Bootstrap) UCL	0.364
95% KM (z) UCL	0.359	95% KM Bootstrap t UCL	0.355
90% KM Chebyshev UCL	0.384	95% KM Chebyshev UCL	0.409
97.5% KM Chebyshev UCL	0.445	99% KM Chebyshev UCL	0.514

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.414	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.748	Detected Data Not Gamma Distributed at 5% Significance Level

K-S Test Statistic	0.204	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.138	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	9.941	k star (bias corrected MLE)	9.23
Theta hat (MLE)	0.0358	Theta star (bias corrected MLE)	0.0386
nu hat (MLE)	815.2	nu star (bias corrected)	756.9
Mean (detects)	0.356		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.042	Mean	0.342
Maximum	0.59	Median	0.35
SD	0.0946	CV	0.276
k hat (MLE)	9.281	k star (bias corrected MLE)	8.714
Theta hat (MLE)	0.0369	Theta star (bias corrected MLE)	0.0393
nu hat (MLE)	890.9	nu star (bias corrected)	836.6
Adjusted Level of Significance (β)	0.045		
Approximate Chi Square Value (836.59, α)	770.5	Adjusted Chi Square Value (836.59, β)	768.5
95% Gamma Approximate UCL (use when n>=50)	0.372	95% Gamma Adjusted UCL (use when n<50)	0.373

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.328	SD (KM)	0.124
Variance (KM)	0.0153	SE of Mean (KM)	0.0186
k hat (KM)	7.063	k star (KM)	6.635
nu hat (KM)	678	nu star (KM)	637
theta hat (KM)	0.0465	theta star (KM)	0.0495
80% gamma percentile (KM)	0.428	90% gamma percentile (KM)	0.498
95% gamma percentile (KM)	0.562	99% gamma percentile (KM)	0.695

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (637.00, α)	579.4	Adjusted Chi Square Value (637.00, β)	577.8
95% Gamma Approximate KM-UCL (use when n>=50)	0.361	95% Gamma Adjusted KM-UCL (use when n<50)	0.362

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.65	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.941	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.241	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.137	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.339	Mean in Log Scale	-1.141
SD in Original Scale	0.0985	SD in Log Scale	0.407
95% t UCL (assumes normality of ROS data)	0.363	95% Percentile Bootstrap UCL	0.363
95% BCA Bootstrap UCL	0.36	95% Bootstrap t UCL	0.362
95% H-UCL (Log ROS)	0.387		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.269	KM Geo Mean	0.281
KM SD (logged)	0.699	95% Critical H Value (KM-Log)	2.034
KM Standard Error of Mean (logged)	0.106	95% H-UCL (KM -Log)	0.442
KM SD (logged)	0.699	95% Critical H Value (KM-Log)	2.034
KM Standard Error of Mean (logged)	0.106		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.344	Mean in Log Scale	-1.161
SD in Original Scale	0.117	SD in Log Scale	0.51
95% t UCL (Assumes normality)	0.372	95% H-Stat UCL	0.411

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.359	KM H-UCL	0.442
95% KM (BCA) UCL	0.37		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lithium (on-site)

General Statistics

Total Number of Observations	112	Number of Distinct Observations	40
Number of Detects	99	Number of Non-Detects	13
Number of Distinct Detects	39	Number of Distinct Non-Detects	2
Minimum Detect	0.2	Minimum Non-Detect	0.2
Maximum Detect	1.3	Maximum Non-Detect	1
Variance Detects	0.0401	Percent Non-Detects	11.61%

Mean Detects	0.359	SD Detects	0.2
Median Detects	0.29	CV Detects	0.557
Skewness Detects	1.817	Kurtosis Detects	3.991
Mean of Logged Detects	-1.14	SD of Logged Detects	0.457

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.76	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0893	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.346	KM Standard Error of Mean	0.0188
KM SD	0.195	95% KM (BCA) UCL	0.378
95% KM (t) UCL	0.377	95% KM (Percentile Bootstrap) UCL	0.378
95% KM (z) UCL	0.377	95% KM Bootstrap t UCL	0.383
90% KM Chebyshev UCL	0.402	95% KM Chebyshev UCL	0.428
97.5% KM Chebyshev UCL	0.463	99% KM Chebyshev UCL	0.533

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	6.01	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.19	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0902	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.443	k star (bias corrected MLE)	4.315
Theta hat (MLE)	0.0809	Theta star (bias corrected MLE)	0.0833
nu hat (MLE)	879.8	nu star (bias corrected)	854.5
Mean (detects)	0.359		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.332
Maximum	1.3	Median	0.265
SD	0.208	CV	0.626
k hat (MLE)	2.466	k star (bias corrected MLE)	2.406
Theta hat (MLE)	0.135	Theta star (bias corrected MLE)	0.138

nu hat (MLE)	552.4	nu star (bias corrected)	538.9
Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (538.89, α)	486.1	Adjusted Chi Square Value (538.89, β)	485.4
95% Gamma Approximate UCL (use when n>=50)	0.369	95% Gamma Adjusted UCL (use when n<50)	0.369

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.346	SD (KM)	0.195
Variance (KM)	0.038	SE of Mean (KM)	0.0188
k hat (KM)	3.144	k star (KM)	3.066
nu hat (KM)	704.3	nu star (KM)	686.8
theta hat (KM)	0.11	theta star (KM)	0.113
80% gamma percentile (KM)	0.492	90% gamma percentile (KM)	0.611
95% gamma percentile (KM)	0.721	99% gamma percentile (KM)	0.961

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (686.81, α)	627	Adjusted Chi Square Value (686.81, β)	626.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.379	95% Gamma Adjusted KM-UCL (use when n<50)	0.379

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.849	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	8.216E-15	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.156	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0893	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.338	Mean in Log Scale	-1.225
SD in Original Scale	0.2	SD in Log Scale	0.517
95% t UCL (assumes normality of ROS data)	0.369	95% Percentile Bootstrap UCL	0.37
95% BCA Bootstrap UCL	0.374	95% Bootstrap t UCL	0.374
95% H-UCL (Log ROS)	0.367		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.18	KM Geo Mean	0.307
KM SD (logged)	0.454	95% Critical H Value (KM-Log)	1.808
KM Standard Error of Mean (logged)	0.0438	95% H-UCL (KM -Log)	0.368
KM SD (logged)	0.454	95% Critical H Value (KM-Log)	1.808
KM Standard Error of Mean (logged)	0.0438		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.344	Mean in Log Scale	-1.218
SD in Original Scale	0.203	SD in Log Scale	0.543
95% t UCL (Assumes normality)	0.375	95% H-Stat UCL	0.378

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.377	KM H-UCL	0.368
95% KM (BCA) UCL	0.378		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

wood.

ATTACHMENT B-2

Groundwater Trend Graphs

CCR Unit	StationName	SampDate	Year	FieldSampleID	Units	Parameter	Group	RES_RL	D_RES_RL
FAP	M-51A	12/2/15 7:45	2015.917808	7880	mg/l	Arsenic	Arsenic_M-51A	0.02	1
FAP	M-51A	3/9/16 16:35	2016.185792	CH-M-51A-0316	mg/l	Arsenic	Arsenic_M-51A	0.016	1
FAP	M-51A	5/5/16 13:59	2016.34153	CH-CCR-M51A-0516	mg/l	Arsenic	Arsenic_M-51A	0.0029	1
FAP	M-51A	8/25/16 8:34	2016.647541	CH-CCR-M51A-816	mg/l	Arsenic	Arsenic_M-51A	0.029	1
FAP	M-51A	9/23/16 12:19	2016.726776	CH-CCR-M51A-916	mg/l	Arsenic	Arsenic_M-51A	0.025	1
FAP	M-51A	2/21/17 7:52	2017.139726	CH-CCR-M51A-217	mg/l	Arsenic	Arsenic_M-51A	0.023	1
FAP	M-51A	4/13/17 10:00	2017.279452	CH-CCR-M51A-41317	mg/l	Arsenic	Arsenic_M-51A	0.02	1
FAP	M-51A	4/26/17 8:51	2017.315068	CH-CCR-M51A-42617	mg/l	Arsenic	Arsenic_M-51A	0.024	1
FAP	M-51A	5/18/17 14:57	2017.375342	CH-CCR-M51A-51817	mg/l	Arsenic	Arsenic_M-51A	0.024	1
FAP	M-51A	5/24/17 17:05	2017.391781	CH-CCR-M51A-52417	mg/l	Arsenic	Arsenic_M-51A	0.028	1
FAP	M-51A	6/30/17 13:18	2017.493151	CH-CCR-M51A-63017	mg/l	Arsenic	Arsenic_M-51A	0.029	1
FAP	M-51A	7/27/17 14:35	2017.567123	CH-CCR-M51A-72717	mg/l	Arsenic	Arsenic_M-51A	0.026	1
FAP	M-51A	9/7/17 13:39	2017.682192	CH-CCR-M51A-90717	mg/l	Arsenic	Arsenic_M-51A	0.035	1
FAP	M-51A	2/14/18 0:00	2018.120548	CH-CCR-M51A-21418	mg/l	Arsenic	Arsenic_M-51A	0.015	1
FAP	M-51A	5/21/18 0:00	2018.383562	CH-CCR-M-51A-52118	mg/l	Arsenic	Arsenic_M-51A	0.022	1
FAP	M-51A	10/24/18 0:00	2018.810959	CH-CCR-M-51A-102418	mg/l	Arsenic	Arsenic_M-51A	0.032	1
FAP	M-51A	2/13/19 0:00	2019.117808	CH-CCR-M51A-21319	mg/l	Arsenic	Arsenic_M-51A	0.025	1
FAP	M-51A	4/10/19 0:00	2019.271233	CH-CCR-M51A-41119	mg/l	Arsenic	Arsenic_M-51A	0.032	1
FAP	M-51A	11/25/19 0:00	2019.89863	CH-CCR-M51A-112519	mg/l	Arsenic	Arsenic_M-51A	0.018	1
FAP	M-51A	5/6/20 0:00	2020.344262	CH-CCR-M51A-0520	mg/l	Arsenic	Arsenic_M-51A	0.015	1
FAP	M-51A	12/2/15 7:45	2015.917808	7880	mg/l	Fluoride	Fluoride_M-51A	4.8	1
FAP	M-51A	3/9/16 16:35	2016.185792	CH-M-51A-0316	mg/l	Fluoride	Fluoride_M-51A	5.2	1
FAP	M-51A	5/5/16 13:59	2016.34153	CH-CCR-M51A-0516	mg/l	Fluoride	Fluoride_M-51A	5.5	1
FAP	M-51A	8/25/16 8:34	2016.647541	CH-CCR-M51A-816	mg/l	Fluoride	Fluoride_M-51A	6	1
FAP	M-51A	9/23/16 12:19	2016.726776	CH-CCR-M51A-916	mg/l	Fluoride	Fluoride_M-51A	5.6	1
FAP	M-51A	2/21/17 7:52	2017.139726	CH-CCR-M51A-217	mg/l	Fluoride	Fluoride_M-51A	5.3	1
FAP	M-51A	4/13/17 10:00	2017.279452	CH-CCR-M51A-41317	mg/l	Fluoride	Fluoride_M-51A	4.1	1
FAP	M-51A	4/26/17 8:51	2017.315068	CH-CCR-M51A-42617	mg/l	Fluoride	Fluoride_M-51A	4.7	1
FAP	M-51A	5/18/17 14:57	2017.375342	CH-CCR-M51A-51817	mg/l	Fluoride	Fluoride_M-51A	5	1
FAP	M-51A	5/24/17 17:05	2017.391781	CH-CCR-M51A-52417	mg/l	Fluoride	Fluoride_M-51A	5.4	1
FAP	M-51A	6/30/17 13:18	2017.493151	CH-CCR-M51A-63017	mg/l	Fluoride	Fluoride_M-51A	4.9	1
FAP	M-51A	7/27/17 14:35	2017.567123	CH-CCR-M51A-72717	mg/l	Fluoride	Fluoride_M-51A	6	1
FAP	M-51A	9/7/17 13:39	2017.682192	CH-CCR-M51A-90717	mg/l	Fluoride	Fluoride_M-51A	5.7	1
FAP	M-51A	12/8/17 12:25	2017.934247	CH-CCR-M51A-120817	mg/l	Fluoride	Fluoride_M-51A	5.1	1
FAP	M-51A	2/14/18 0:00	2018.120548	CH-CCR-M51A-21418	mg/l	Fluoride	Fluoride_M-51A	5.4	1
FAP	M-51A	5/21/18 0:00	2018.383562	CH-CCR-M-51A-52118	mg/l	Fluoride	Fluoride_M-51A	5.7	1
FAP	M-51A	10/24/18 0:00	2018.810959	CH-CCR-M-51A-102418	mg/l	Fluoride	Fluoride_M-51A	5.5	1
FAP	M-51A	2/13/19 0:00	2019.117808	CH-CCR-M51A-21319	mg/l	Fluoride	Fluoride_M-51A	4.5	1
FAP	M-51A	4/10/19 0:00	2019.271233	CH-CCR-M51A-41119	mg/l	Fluoride	Fluoride_M-51A	5.4	1
FAP	M-51A	11/25/19 0:00	2019.89863	CH-CCR-M51A-112519	mg/l	Fluoride	Fluoride_M-51A	4.8	1
FAP	M-51A	5/6/20 0:00	2020.344262	CH-CCR-M51A-0520	mg/l	Fluoride	Fluoride_M-51A	5.6	1
FAP	M-50A	12/2/15 8:32	2015.917808	7792	mg/l	Lithium	Lithium_M-50A	0.51	1
FAP	M-50A	3/8/16 18:10	2016.18306	CH-M-50A-0316	mg/l	Lithium	Lithium_M-50A	0.47	1
FAP	M-50A	5/5/16 16:55	2016.34153	CH-CCR-M50A-516	mg/l	Lithium	Lithium_M-50A	0.47	1
FAP	M-50A	8/25/16 9:25	2016.647541	CH-CCR-M50A-816	mg/l	Lithium	Lithium_M-50A	0.45	1
FAP	M-50A	9/23/16 12:47	2016.726776	CH-CCR-M50A-916	mg/l	Lithium	Lithium_M-50A	0.5	1
FAP	M-50A	2/21/17 8:49	2017.139726	CH-CCR-M50A-217	mg/l	Lithium	Lithium_M-50A	0.5	1
FAP	M-50A	4/13/17 10:41	2017.279452	CH-CCR-M50A-41317	mg/l	Lithium	Lithium_M-50A	0.46	1
FAP	M-50A	4/26/17 9:22	2017.315068	CH-CCR-M50A-42617	mg/l	Lithium	Lithium_M-50A	0.48	1
FAP	M-50A	5/18/17 15:27	2017.375342	CH-CCR-M50A-51817	mg/l	Lithium	Lithium_M-50A	0.48	1
FAP	M-50A	5/24/17 17:31	2017.391781	CH-CCR-M50A-52417	mg/l	Lithium	Lithium_M-50A	0.49	1
FAP	M-50A	6/30/17 14:05	2017.493151	CH-CCR-M50A-63017	mg/l	Lithium	Lithium_M-50A	0.45	1
FAP	M-50A	7/27/17 15:03	2017.567123	CH-CCR-M50A-72717	mg/l	Lithium	Lithium_M-50A	0.46	1
FAP	M-50A	9/7/17 14:11	2017.682192	CH-CCR-M50A-90717	mg/l	Lithium	Lithium_M-50A	0.48	1
FAP	M-50A	2/14/18 0:00	2018.120548	CH-CCR-M50A-21418	mg/l	Lithium	Lithium_M-50A	0.44	1
FAP	M-50A	5/21/18 0:00	2018.383562	CH-CCR-M-50A-52118	mg/l	Lithium	Lithium_M-50A	0.43	1
FAP	M-50A	10/24/18 0:00	2018.810959	CH-CCR-M-50A-102418	mg/l	Lithium	Lithium_M-50A	0.43	1
FAP	M-50A	2/13/19 0:00	2019.117808	CH-CCR-M50A-21319	mg/l	Lithium	Lithium_M-50A	0.46	1

CCR Unit	StationName	SampDate	Year	FieldSampleID	Units	Parameter	Group	RES_RL	D_RES_RL
FAP	M-50A	4/11/19 0:00	2019.273973	CH-CCR-M50A-41119	mg/l	Lithium	Lithium_M-50A	0.44	1
FAP	M-50A	11/25/19 0:00	2019.89863	CH-CCR-M50A-112519	mg/l	Lithium	Lithium_M-50A	0.43	1
FAP	M-50A	5/6/20 0:00	2020.344262	CH-CCR-M50A-0520	mg/l	Lithium	Lithium_M-50A	0.55	1
FAP	M-51A	12/2/15 7:45	2015.917808	7880	mg/l	Lithium	Lithium_M-51A	0.6	1
FAP	M-51A	3/9/16 16:35	2016.185792	CH-M-51A-0316	mg/l	Lithium	Lithium_M-51A	0.54	1
FAP	M-51A	5/5/16 13:59	2016.34153	CH-CCR-M51A-0516	mg/l	Lithium	Lithium_M-51A	0.57	1
FAP	M-51A	8/25/16 8:34	2016.647541	CH-CCR-M51A-816	mg/l	Lithium	Lithium_M-51A	0.56	1
FAP	M-51A	9/23/16 12:19	2016.726776	CH-CCR-M51A-916	mg/l	Lithium	Lithium_M-51A	0.61	1
FAP	M-51A	2/21/17 7:52	2017.139726	CH-CCR-M51A-217	mg/l	Lithium	Lithium_M-51A	0.58	1
FAP	M-51A	4/13/17 10:00	2017.279452	CH-CCR-M51A-41317	mg/l	Lithium	Lithium_M-51A	0.49	1
FAP	M-51A	4/26/17 8:51	2017.315068	CH-CCR-M51A-42617	mg/l	Lithium	Lithium_M-51A	0.57	1
FAP	M-51A	5/18/17 14:57	2017.375342	CH-CCR-M51A-51817	mg/l	Lithium	Lithium_M-51A	0.56	1
FAP	M-51A	5/24/17 17:05	2017.391781	CH-CCR-M51A-52417	mg/l	Lithium	Lithium_M-51A	0.54	1
FAP	M-51A	6/30/17 13:18	2017.493151	CH-CCR-M51A-63017	mg/l	Lithium	Lithium_M-51A	0.54	1
FAP	M-51A	7/27/17 14:35	2017.567123	CH-CCR-M51A-72717	mg/l	Lithium	Lithium_M-51A	0.54	1
FAP	M-51A	9/7/17 13:39	2017.682192	CH-CCR-M51A-90717	mg/l	Lithium	Lithium_M-51A	0.55	1
FAP	M-51A	2/14/18 0:00	2018.120548	CH-CCR-M51A-21418	mg/l	Lithium	Lithium_M-51A	0.49	1
FAP	M-51A	5/21/18 0:00	2018.383562	CH-CCR-M-51A-52118	mg/l	Lithium	Lithium_M-51A	0.48	1
FAP	M-51A	10/24/18 0:00	2018.810959	CH-CCR-M-51A-102418	mg/l	Lithium	Lithium_M-51A	0.46	1
FAP	M-51A	2/13/19 0:00	2019.117808	CH-CCR-M51A-21319	mg/l	Lithium	Lithium_M-51A	0.49	1
FAP	M-51A	4/10/19 0:00	2019.271233	CH-CCR-M51A-41119	mg/l	Lithium	Lithium_M-51A	0.45	1
FAP	M-51A	11/25/19 0:00	2019.89863	CH-CCR-M51A-112519	mg/l	Lithium	Lithium_M-51A	0.45	1
FAP	M-51A	5/6/20 0:00	2020.344262	CH-CCR-M51A-0520	mg/l	Lithium	Lithium_M-51A	0.65	1
FAP	W-123	12/3/15 10:10	2015.920548	7800	mg/l	Lithium	Lithium_W-123	0.6	1
FAP	W-123	3/8/16 16:55	2016.18306	CH-W-123-0316	mg/l	Lithium	Lithium_W-123	0.58	1
FAP	W-123	5/6/16 9:05	2016.344262	CH-CCR-W123-0516	mg/l	Lithium	Lithium_W-123	0.6	1
FAP	W-123	8/25/16 10:39	2016.647541	CH-CCR-W123-816	mg/l	Lithium	Lithium_W-123	0.62	1
FAP	W-123	9/22/16 11:45	2016.724044	CH-CCR-W123-916	mg/l	Lithium	Lithium_W-123	0.64	1
FAP	W-123	2/20/17 16:40	2017.136986	CH-CCR-W123-217	mg/l	Lithium	Lithium_W-123	0.66	1
FAP	W-123	4/13/17 11:55	2017.279452	CH-CCR-W123-41317	mg/l	Lithium	Lithium_W-123	0.59	1
FAP	W-123	4/26/17 10:14	2017.315068	CH-CCR-W123-42617	mg/l	Lithium	Lithium_W-123	0.64	1
FAP	W-123	5/22/17 11:25	2017.386301	CH-CCR-W123-52217	mg/l	Lithium	Lithium_W-123	0.65	1
FAP	W-123	5/24/17 18:18	2017.391781	CH-CCR-W123-52417	mg/l	Lithium	Lithium_W-123	0.68	1
FAP	W-123	6/30/17 14:46	2017.493151	CH-CCR-W123-63017	mg/l	Lithium	Lithium_W-123	0.63	1
FAP	W-123	7/27/17 16:09	2017.567123	CH-CCR-W123-72717	mg/l	Lithium	Lithium_W-123	0.66	1
FAP	W-123	9/7/17 14:59	2017.682192	CH-CCR-W123-90717	mg/l	Lithium	Lithium_W-123	0.7	1
FAP	W-123	2/14/18 0:00	2018.120548	CH-CCR-W123-21418	mg/l	Lithium	Lithium_W-123	0.63	1
FAP	W-123	5/21/18 0:00	2018.383562	CH-CCR-W-123-52118	mg/l	Lithium	Lithium_W-123	0.63	1
FAP	W-123	10/24/18 0:00	2018.810959	CH-CCR-W-123-102418	mg/l	Lithium	Lithium_W-123	0.65	1
FAP	W-123	2/13/19 0:00	2019.117808	CH-CCR-W123-21319	mg/l	Lithium	Lithium_W-123	0.75	1
FAP	W-123	4/11/19 0:00	2019.273973	CH-CCR-w123-41119	mg/l	Lithium	Lithium_W-123	0.67	1
FAP	W-123	11/25/19 0:00	2019.89863	CH-CCR-W123-112519	mg/l	Lithium	Lithium_W-123	0.66	1
FAP	W-123	5/6/20 0:00	2020.344262	CH-CCR-W123-0520	mg/l	Lithium	Lithium_W-123	0.83	1
FAP	W-123	12/3/15 10:10	2015.920548	7800	mg/l	Molybdenum	Molybdenum_W-123	0.35	1
FAP	W-123	3/8/16 16:55	2016.18306	CH-W-123-0316	mg/l	Molybdenum	Molybdenum_W-123	0.34	1
FAP	W-123	5/6/16 9:05	2016.344262	CH-CCR-W123-0516	mg/l	Molybdenum	Molybdenum_W-123	0.33	1
FAP	W-123	8/25/16 10:39	2016.647541	CH-CCR-W123-816	mg/l	Molybdenum	Molybdenum_W-123	0.36	1
FAP	W-123	9/22/16 11:45	2016.724044	CH-CCR-W123-916	mg/l	Molybdenum	Molybdenum_W-123	0.34	1
FAP	W-123	2/20/17 16:40	2017.136986	CH-CCR-W123-217	mg/l	Molybdenum	Molybdenum_W-123	0.34	1
FAP	W-123	4/13/17 11:55	2017.279452	CH-CCR-W123-41317	mg/l	Molybdenum	Molybdenum_W-123	0.36	1
FAP	W-123	4/26/17 10:14	2017.315068	CH-CCR-W123-42617	mg/l	Molybdenum	Molybdenum_W-123	0.35	1
FAP	W-123	5/22/17 11:25	2017.386301	CH-CCR-W123-52217	mg/l	Molybdenum	Molybdenum_W-123	0.3	1
FAP	W-123	5/24/17 18:18	2017.391781	CH-CCR-W123-52417	mg/l	Molybdenum	Molybdenum_W-123	0.35	1
FAP	W-123	6/30/17 14:46	2017.493151	CH-CCR-W123-63017	mg/l	Molybdenum	Molybdenum_W-123	0.33	1
FAP	W-123	7/27/17 16:09	2017.567123	CH-CCR-W123-72717	mg/l	Molybdenum	Molybdenum_W-123	0.33	1
FAP	W-123	9/7/17 14:59	2017.682192	CH-CCR-W123-90717	mg/l	Molybdenum	Molybdenum_W-123	0.36	1
FAP	W-123	2/14/18 0:00	2018.120548	CH-CCR-W123-21418	mg/l	Molybdenum	Molybdenum_W-123	0.37	1
FAP	W-123	5/21/18 0:00	2018.383562	CH-CCR-W-123-52118	mg/l	Molybdenum	Molybdenum_W-123	0.38	1

CCR Unit	StationName	SampDate	Year	FieldSampleID	Units	Parameter	Group	RES_RL	D_RES_RL
FAP	W-123	10/24/18 0:00	2018.810959	CH-CCR-W-123-102418	mg/l	Molybdenum	Molybdenum_W-123	0.37	1
FAP	W-123	2/13/19 0:00	2019.117808	CH-CCR-W123-21319	mg/l	Molybdenum	Molybdenum_W-123	0.37	1
FAP	W-123	4/11/19 0:00	2019.273973	CH-CCR-w123-41119	mg/l	Molybdenum	Molybdenum_W-123	0.41	1
FAP	W-123	11/25/19 0:00	2019.89863	CH-CCR-W123-112519	mg/l	Molybdenum	Molybdenum_W-123	0.41	1
FAP	W-123	5/6/20 0:00	2020.344262	CH-CCR-W123-0520	mg/l	Molybdenum	Molybdenum_W-123	0.3	1
BAP	M-52A	12/1/15 14:08	2015.915068	7879	mg/l	Cobalt	Cobalt_M-52A	0.06	1
BAP	M-52A	3/9/16 17:17	2016.185792	CH-M-52A-0316	mg/l	Cobalt	Cobalt_M-52A	0.054	1
BAP	M-52A	5/10/16 13:36	2016.355191	CH-CCR-M52A-516	mg/l	Cobalt	Cobalt_M-52A	0.043	1
BAP	M-52A	8/26/16 13:16	2016.650273	CH-CCR-M52A-816	mg/l	Cobalt	Cobalt_M-52A	0.061	1
BAP	M-52A	9/22/16 13:36	2016.724044	CH-CCR-M52A-916	mg/l	Cobalt	Cobalt_M-52A	0.054	1
BAP	M-52A	2/21/17 11:10	2017.139726	CH-CCR-M52A-217	mg/l	Cobalt	Cobalt_M-52A	0.043	1
BAP	M-52A	4/11/17 14:10	2017.273973	CH-CCR-M52A-41117	mg/l	Cobalt	Cobalt_M-52A	0.045	1
BAP	M-52A	4/25/17 14:06	2017.312329	CH-CCR-M52A-42517	mg/l	Cobalt	Cobalt_M-52A	0.041	1
BAP	M-52A	5/18/17 13:45	2017.375342	CH-CCR-M52A-51817	mg/l	Cobalt	Cobalt_M-52A	0.037	1
BAP	M-52A	5/24/17 14:49	2017.391781	CH-CCR-M52A-52417	mg/l	Cobalt	Cobalt_M-52A	0.044	1
BAP	M-52A	6/30/17 19:05	2017.493151	CH-CCR-M52A-63017	mg/l	Cobalt	Cobalt_M-52A	0.051	1
BAP	M-52A	7/28/17 13:56	2017.569863	CH-CCR-M52A-72817	mg/l	Cobalt	Cobalt_M-52A	0.063	1
BAP	M-52A	9/7/17 16:09	2017.682192	CH-CCR-M52A-90717	mg/l	Cobalt	Cobalt_M-52A	0.066	1
BAP	M-52A	2/15/18 0:00	2018.123288	CH-CCR-M52A-21518	mg/l	Cobalt	Cobalt_M-52A	0.052	1
BAP	M-52A	5/20/18 0:00	2018.380822	CH-CCR-M-52A-52018	mg/l	Cobalt	Cobalt_M-52A	0.1	1
BAP	M-52A	6/7/18 13:13	2018.430137	CH-CCR-M52A-6718	mg/l	Cobalt	Cobalt_M-52A	0.062	1
BAP	M-52A	10/24/18 0:00	2018.810959	CH-CCR-M-52A-102418	mg/l	Cobalt	Cobalt_M-52A	0.055	1
BAP	M-52A	12/8/18 0:00	2018.934247	CH-CCR-M52A-12818	mg/l	Cobalt	Cobalt_M-52A	0.036	1
BAP	M-52A	2/15/19 0:00	2019.123288	CH-CCR-M52A-21519	mg/l	Cobalt	Cobalt_M-52A	0.029	1
BAP	M-52A	4/16/19 0:00	2019.287671	CH-CCR-M52A-41619	mg/l	Cobalt	Cobalt_M-52A	0.027	1
BAP	M-52A	10/24/19 0:00	2019.810959	CH-CCR-M52A-102419	mg/l	Cobalt	Cobalt_M-52A	0.07	1
BAP	M-52A	4/19/20 0:00	2020.297814	CH-CCR-M52-0420	mg/l	Cobalt	Cobalt_M-52A	0.039	1
BAP	M-53A	12/1/15 10:25	2015.915068	7878	mg/l	Cobalt	Cobalt_M-53A	0.024	1
BAP	M-53A	3/9/16 9:00	2016.185792	CH-M-53A-0316	mg/l	Cobalt	Cobalt_M-53A	0.023	1
BAP	M-53A	5/10/16 12:36	2016.355191	CH-CCR-M53A-516	mg/l	Cobalt	Cobalt_M-53A	0.023	1
BAP	M-53A	8/26/16 11:03	2016.650273	CH-CCR-M53A-816	mg/l	Cobalt	Cobalt_M-53A	0.018	1
BAP	M-53A	9/22/16 15:37	2016.724044	CH-CCR-M53A-916	mg/l	Cobalt	Cobalt_M-53A	0.017	1
BAP	M-53A	2/21/17 13:34	2017.139726	CH-CCR-M53A-217	mg/l	Cobalt	Cobalt_M-53A	0.018	1
BAP	M-53A	4/12/17 15:15	2017.276712	CH-CCR-M53A-41217	mg/l	Cobalt	Cobalt_M-53A	0.018	1
BAP	M-53A	4/25/17 15:30	2017.312329	CH-CCR-M53A-42517	mg/l	Cobalt	Cobalt_M-53A	0.015	1
BAP	M-53A	5/18/17 14:17	2017.375342	CH-CCR-M53A-51817	mg/l	Cobalt	Cobalt_M-53A	0.016	1
BAP	M-53A	5/24/17 16:23	2017.391781	CH-CCR-M53A-52417	mg/l	Cobalt	Cobalt_M-53A	0.016	1
BAP	M-53A	7/1/17 11:48	2017.49589	CH-CCR-M53A-70117	mg/l	Cobalt	Cobalt_M-53A	0.016	1
BAP	M-53A	7/28/17 16:18	2017.569863	CH-CCR-M53A-72817	mg/l	Cobalt	Cobalt_M-53A	0.017	1
BAP	M-53A	9/7/17 16:35	2017.682192	CH-CCR-M53A-90717	mg/l	Cobalt	Cobalt_M-53A	0.017	1
BAP	M-53A	2/15/18 0:00	2018.123288	CH-CCR-M53A-21518	mg/l	Cobalt	Cobalt_M-53A	0.011	1
BAP	M-53A	5/20/18 0:00	2018.380822	CH-CCR-M-53A-52018	mg/l	Cobalt	Cobalt_M-53A	0.016	1
BAP	M-53A	10/26/18 0:00	2018.816438	CH-CCR-M-53A-102618	mg/l	Cobalt	Cobalt_M-53A	0.013	1
BAP	M-53A	12/7/18 0:00	2018.931507	CH-CCR-M53A-12718	mg/l	Cobalt	Cobalt_M-53A	0.014	1
BAP	M-53A	2/15/19 0:00	2019.123288	CH-CCR-M53A-21519	mg/l	Cobalt	Cobalt_M-53A	0.011	1
BAP	M-53A	4/17/19 0:00	2019.290411	CH-CCR-M53A-41719	mg/l	Cobalt	Cobalt_M-53A	0.014	1
BAP	M-53A	10/23/19 0:00	2019.808219	CH-CCR-M53A-102319	mg/l	Cobalt	Cobalt_M-53A	0.013	1
BAP	M-53A	4/19/20 0:00	2020.297814	CH-CCR-M53-0420	mg/l	Cobalt	Cobalt_M-53A	0.014	1
BAP	W-305	12/2/15 15:30	2015.917808	7796	mg/l	Cobalt	Cobalt_W-305	0.01	1
BAP	W-305	3/9/16 12:55	2016.185792	CH-W-305-0316	mg/l	Cobalt	Cobalt_W-305	0.016	1
BAP	W-305	5/11/16 10:40	2016.357923	CH-CCR-W305-516	mg/l	Cobalt	Cobalt_W-305	0.014	1
BAP	W-305	8/27/16 9:55	2016.653005	CH-CCR-W305-816	mg/l	Cobalt	Cobalt_W-305	0.019	1
BAP	W-305	9/22/16 14:36	2016.724044	CH-CCR-W305-916	mg/l	Cobalt	Cobalt_W-305	0.016	1
BAP	W-305	2/21/17 14:51	2017.139726	CH-CCR-W305-217	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	4/11/17 15:44	2017.273973	CH-CCR-W305-41117	mg/l	Cobalt	Cobalt_W-305	0.019	1
BAP	W-305	4/24/17 16:06	2017.309589	CH-CCR-W305-42417	mg/l	Cobalt	Cobalt_W-305	0.017	1
BAP	W-305	5/22/17 14:37	2017.386301	CH-CCR-W305-52217	mg/l	Cobalt	Cobalt_W-305	0.015	1
BAP	W-305	5/24/17 15:53	2017.391781	CH-CCR-W305-52417	mg/l	Cobalt	Cobalt_W-305	0.017	1

CCR Unit	StationName	SampDate	Year	FieldSampleID	Units	Parameter	Group	RES_RL	D_RES_RL
BAP	W-305	6/29/17 13:36	2017.490411	CH-CCR-W305-62917	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	7/28/17 15:40	2017.569863	CH-CCR-W305-72817	mg/l	Cobalt	Cobalt_W-305	0.017	1
BAP	W-305	9/6/17 14:17	2017.679452	CH-CCR-W305-90617	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	2/15/18 0:00	2018.123288	CH-CCR-W305-21518	mg/l	Cobalt	Cobalt_W-305	0.017	1
BAP	W-305	5/19/18 0:00	2018.378082	CH-CCR-W-305-51918	mg/l	Cobalt	Cobalt_W-305	0.017	1
BAP	W-305	10/26/18 0:00	2018.816438	CH-CCR-W-305-102618	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	12/7/18 0:00	2018.931507	CH-CCR-W305-12718	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	2/15/19 0:00	2019.123288	CH-CCR-W305-21519	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	4/17/19 0:00	2019.290411	CH-CCR-W305-41719	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	10/23/19 0:00	2019.808219	CH-CCR-W305-102319	mg/l	Cobalt	Cobalt_W-305	0.018	1
BAP	W-305	4/18/20 0:00	2020.295082	CH-CCR-W305-0420	mg/l	Cobalt	Cobalt_W-305	0.02	1
BAP	W-314	12/2/15 15:50	2015.917808	7798	mg/l	Cobalt	Cobalt_W-314	0.016	1
BAP	W-314	3/10/16 11:40	2016.188525	CH-W-314-0316	mg/l	Cobalt	Cobalt_W-314	0.018	1
BAP	W-314	5/11/16 8:36	2016.357923	CH-CCR-W314-516	mg/l	Cobalt	Cobalt_W-314	0.015	1
BAP	W-314	8/26/16 12:17	2016.650273	CH-CCR-W314-816	mg/l	Cobalt	Cobalt_W-314	0.015	1
BAP	W-314	9/22/16 12:54	2016.724044	CH-CCR-W314-916	mg/l	Cobalt	Cobalt_W-314	0.013	1
BAP	W-314	2/21/17 10:36	2017.139726	CH-CCR-W314-217	mg/l	Cobalt	Cobalt_W-314	0.013	1
BAP	W-314	4/11/17 12:43	2017.273973	CH-CCR-W314-41117	mg/l	Cobalt	Cobalt_W-314	0.014	1
BAP	W-314	4/25/17 13:26	2017.312329	CH-CCR-W314-42517	mg/l	Cobalt	Cobalt_W-314	0.013	1
BAP	W-314	5/22/17 16:24	2017.386301	CH-CCR-W314-52217	mg/l	Cobalt	Cobalt_W-314	0.011	1
BAP	W-314	5/24/17 14:16	2017.391781	CH-CCR-W314-52417	mg/l	Cobalt	Cobalt_W-314	0.014	1
BAP	W-314	6/30/17 18:26	2017.493151	CH-CCR-W314-63017	mg/l	Cobalt	Cobalt_W-314	0.012	1
BAP	W-314	7/28/17 13:17	2017.569863	CH-CCR-W314-72817	mg/l	Cobalt	Cobalt_W-314	0.012	1
BAP	W-314	9/7/17 15:38	2017.682192	CH-CCR-W314-90717	mg/l	Cobalt	Cobalt_W-314	0.013	1
BAP	W-314	2/15/18 0:00	2018.123288	CH-CCR-W314-21518	mg/l	Cobalt	Cobalt_W-314	0.013	1
BAP	W-314	5/20/18 0:00	2018.380822	CH-CCR-W-314-52018	mg/l	Cobalt	Cobalt_W-314	0.013	1
BAP	W-314	10/24/18 0:00	2018.810959	CH-CCR-W-314-102418	mg/l	Cobalt	Cobalt_W-314	0.015	1
BAP	W-314	12/8/18 0:00	2018.934247	CH-CCR-W314-12818	mg/l	Cobalt	Cobalt_W-314	0.014	1
BAP	W-314	2/15/19 0:00	2019.123288	CH-CCR-W314-21519	mg/l	Cobalt	Cobalt_W-314	0.016	1
BAP	W-314	4/16/19 0:00	2019.287671	CH-CCR-W314-41619	mg/l	Cobalt	Cobalt_W-314	0.016	1
BAP	W-314	10/24/19 0:00	2019.810959	CH-CCR-W314-102419	mg/l	Cobalt	Cobalt_W-314	0.019	1
BAP	W-314	4/19/20 0:00	2020.297814	CH-CCR-W314-0420	mg/l	Cobalt	Cobalt_W-314	0.022	1
BAP	W-306	12/2/15 15:40	2015.917808	7797	mg/l	Lithium	Lithium_W-306	0.43	1
BAP	W-306	3/9/16 14:25	2016.185792	CH-W-306-0316	mg/l	Lithium	Lithium_W-306	0.51	1
BAP	W-306	5/11/16 9:32	2016.357923	CH-CCR-W306-516	mg/l	Lithium	Lithium_W-306	0.56	1
BAP	W-306	8/26/16 10:18	2016.650273	CH-CCR-W306-816	mg/l	Lithium	Lithium_W-306	0.67	1
BAP	W-306	9/22/16 14:03	2016.724044	CH-CCR-W306-916	mg/l	Lithium	Lithium_W-306	0.72	1
BAP	W-306	2/21/17 14:15	2017.139726	CH-CCR-W306-217	mg/l	Lithium	Lithium_W-306	0.78	1
BAP	W-306	4/12/17 9:59	2017.276712	CH-CCR-W306-41217	mg/l	Lithium	Lithium_W-306	0.7	1
BAP	W-306	4/25/17 14:38	2017.312329	CH-CCR-W306-42517	mg/l	Lithium	Lithium_W-306	0.71	1
BAP	W-306	5/22/17 15:39	2017.386301	CH-CCR-W306-52217	mg/l	Lithium	Lithium_W-306	0.65	1
BAP	W-306	5/24/17 15:26	2017.391781	CH-CCR-W306-52417	mg/l	Lithium	Lithium_W-306	0.74	1
BAP	W-306	7/1/17 11:08	2017.49589	CH-CCR-W306-70117	mg/l	Lithium	Lithium_W-306	0.64	1
BAP	W-306	7/28/17 15:07	2017.569863	CH-CCR-W306-72817	mg/l	Lithium	Lithium_W-306	0.64	1
BAP	W-306	9/6/17 14:44	2017.679452	CH-CCR-W306-90617	mg/l	Lithium	Lithium_W-306	0.62	1
BAP	W-306	2/15/18 0:00	2018.123288	CH-CCR-W306-21518	mg/l	Lithium	Lithium_W-306	0.69	1
BAP	W-306	5/19/18 0:00	2018.378082	CH-CCR-W-306-51918	mg/l	Lithium	Lithium_W-306	0.68	1
BAP	W-306	12/7/18 0:00	2018.931507	CH-CCR-W306-12718	mg/l	Lithium	Lithium_W-306	0.73	1
BAP	W-306	2/15/19 0:00	2019.123288	CH-CCR-W306-21519	mg/l	Lithium	Lithium_W-306	0.8	1
BAP	W-306	4/16/19 0:00	2019.287671	CH-CCR-W306-41619	mg/l	Lithium	Lithium_W-306	0.68	1
BAP	W-306	10/23/19 0:00	2019.808219	CH-CCR-W306-102319	mg/l	Lithium	Lithium_W-306	0.7	1
BAP	W-306	4/19/20 0:00	2020.297814	CH-CCR-W306-0420	mg/l	Lithium	Lithium_W-306	1.3	1
FAP	M-51A	12/2/15 7:45	2015.918693	7880	mg/l	Cobalt	Cobalt_M-51A	0.01	0
FAP	M-51A	3/9/16 16:35	2016.18768	CH-M-51A-0316	mg/l	Cobalt	Cobalt_M-51A	0.025	0
FAP	M-51A	5/5/16 13:59	2016.343122	CH-CCR-M51A-0516	mg/l	Cobalt	Cobalt_M-51A	0.002	0
FAP	M-51A	8/25/16 8:34	2016.648516	CH-CCR-M51A-816	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	9/23/16 12:19	2016.728178	CH-CCR-M51A-916	mg/l	Cobalt	Cobalt_M-51A	0.0025	1
FAP	M-51A	2/21/17 7:52	2017.140624	CH-CCR-M51A-217	mg/l	Cobalt	Cobalt_M-51A	0.0023	1

CCR Unit	StationName	SampDate	Year	FieldSampleID	Units	Parameter	Group	RES_RL	D_RES_RL
FAP	M-51A	4/13/17 10:00	2017.280594	CH-CCR-M51A-41317	mg/l	Cobalt	Cobalt_M-51A	0.002	0
FAP	M-51A	4/26/17 8:51	2017.316079	CH-CCR-M51A-42617	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	5/18/17 14:57	2017.377049	CH-CCR-M51A-51817	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	5/24/17 17:05	2017.393731	CH-CCR-M51A-52417	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	6/30/17 13:18	2017.494669	CH-CCR-M51A-63017	mg/l	Cobalt	Cobalt_M-51A	0.01	0
FAP	M-51A	7/27/17 14:35	2017.568788	CH-CCR-M51A-72717	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	9/7/17 13:39	2017.68375	CH-CCR-M51A-90717	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	2/14/18 0:00	2018.120548	CH-CCR-M51A-21418	mg/l	Cobalt	Cobalt_M-51A	0.001	1
FAP	M-51A	5/21/18 0:00	2018.383562	CH-CCR-M-51A-52118	mg/l	Cobalt	Cobalt_M-51A	0.0018	1
FAP	M-51A	10/24/18 0:00	2018.810959	CH-CCR-M-51A-102418	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	2/13/19 0:00	2019.117808	CH-CCR-M51A-21319	mg/l	Cobalt	Cobalt_M-51A	0.002	0
FAP	M-51A	4/10/19 0:00	2019.271233	CH-CCR-M51A-41119	mg/l	Cobalt	Cobalt_M-51A	0.005	0
FAP	M-51A	11/25/19 0:00	2019.89863	CH-CCR-M51A-112519	mg/l	Cobalt	Cobalt_M-51A	0.00076	1
FAP	M-51A	5/6/20 0:00	2020.344262	CH-CCR-M51A-0520	mg/l	Cobalt	Cobalt_M-51A	0.0013	1
BAP	W-301	12/07/18	2018.931507	CH-CCR-W301-12718	mg/l	Cobalt	Cobalt_W-301	0.017	1
BAP	W-301	02/15/19	2019.123288	CH-CCR-W301-21519	mg/l	Cobalt	Cobalt_W-301	0.018	1
BAP	W-301	04/16/19	2019.287671	CH-CCR-W301-41619	mg/l	Cobalt	Cobalt_W-301	0.018	1
BAP	W-301	10/23/19	2019.808219	CH-CCR-W301-102319	mg/l	Cobalt	Cobalt_W-301	0.016	1
BAP	W-301	04/18/20	2020.295082	CH-CCR-W301-0420	mg/l	Cobalt	Cobalt_W-301	0.021	1
BAP	W-302	12/07/18	2018.931507	CH-CCR-W302-12718	mg/l	Cobalt	Cobalt_W-302	0.0049	1
BAP	W-302	02/15/19	2019.123288	CH-CCR-W302-21519	mg/l	Cobalt	Cobalt_W-302	0.022	1
BAP	W-302	04/17/19	2019.290411	CH-CCR-W302-41719	mg/l	Cobalt	Cobalt_W-302	0.0054	1
BAP	W-302	10/23/19	2019.808219	CH-CCR-W302-102319	mg/l	Cobalt	Cobalt_W-302	0.0055	1
BAP	W-302	04/17/20	2020.29235	CH-CCR-W302-0420	mg/l	Cobalt	Cobalt_W-302	0.0064	1
BAP	W-303	04/18/20	2020.295082	CH-CCR-W303-0420	mg/l	Cobalt	Cobalt_W-303	0.027	1
BAP	W-307	12/08/18	2018.934247	CH-CCR-W307-12818	mg/l	Cobalt	Cobalt_W-307	0.076	1
BAP	W-307	02/15/19	2019.123288	CH-CCR-W307-21519	mg/l	Cobalt	Cobalt_W-307	0.073	1
BAP	W-307	04/16/19	2019.287671	CH-CCR-W307-41619	mg/l	Cobalt	Cobalt_W-307	0.08	1
BAP	W-307	10/24/19	2019.810959	CH-CCR-W307-102419	mg/l	Cobalt	Cobalt_W-307	0.082	1
BAP	W-307	04/17/20	2020.29235	CH-CCR-W307-0420	mg/l	Cobalt	Cobalt_W-307	0.084	1
BAP	M-55A	42339.36736	2015.915068	7877	mg/l	Lithium	Lithium_M-55A	0.33	1
BAP	M-55A	42438.67083	2016.185792	CH-M-55A-0316	mg/l	Lithium	Lithium_M-55A	0.31	1
BAP	M-55A	42500.60278	2016.355191	CH-CCR-M55A-516	mg/l	Lithium	Lithium_M-55A	0.34	1
BAP	M-55A	42608.58889	2016.650273	CH-CCR-M55A-816	mg/l	Lithium	Lithium_M-55A	0.33	1
BAP	M-55A	42635.675	2016.724044	CH-CCR-M55A-916	mg/l	Lithium	Lithium_M-55A	0.36	1
BAP	M-55A	42787.41111	2017.139726	CH-CCR-M55A-217	mg/l	Lithium	Lithium_M-55A	0.38	1
BAP	M-55A	42837.38125	2017.276712	CH-CCR-M55A-41217	mg/l	Lithium	Lithium_M-55A	0.35	1
BAP	M-55A	42850.52639	2017.312329	CH-CCR-M55A-42517	mg/l	Lithium	Lithium_M-55A	0.37	1
BAP	M-55A	42873.54792	2017.375342	CH-CCR-M55A-51817	mg/l	Lithium	Lithium_M-55A	0.37	1
BAP	M-55A	42879.56181	2017.391781	CH-CCR-M55A-52417	mg/l	Lithium	Lithium_M-55A	0.37	1
BAP	M-55A	42917.40625	2017.49589	CH-CCR-M55A-70117	mg/l	Lithium	Lithium_M-55A	0.35	1
BAP	M-55A	42944.51111	2017.569863	CH-CCR-M55A-72817	mg/l	Lithium	Lithium_M-55A	0.35	1
BAP	M-55A	42985.71389	2017.682192	CH-CCR-M55A-90717	mg/l	Lithium	Lithium_M-55A	0.37	1
BAP	M-55A	43442	2018.934247	CH-CCR-M55A-12818	mg/l	Lithium	Lithium_M-55A	0.39	1
BAP	M-55A	43511	2019.123288	CH-CCR-M55A-21519	mg/l	Lithium	Lithium_M-55A	0.43	1
BAP	M-55A	43571	2019.287671	CH-CCR-M55A-41619	mg/l	Lithium	Lithium_M-55A	0.37	1
BAP	M-55A	43762	2019.810959	CH-CCR-M55A-102419	mg/l	Lithium	Lithium_M-55A	0.38	1
BAP	M-55A	43938	2020.29235	CH-CCR-M55-0420	mg/l	Lithium	Lithium_M-55A	1	0
BAP	W-301	43441	2018.931507	CH-CCR-W301-12718	mg/l	Lithium	Lithium_W-301	0.43	1
BAP	W-301	43511	2019.123288	CH-CCR-W301-21519	mg/l	Lithium	Lithium_W-301	0.59	1
BAP	W-301	43571	2019.287671	CH-CCR-W301-41619	mg/l	Lithium	Lithium_W-301	0.5	1
BAP	W-301	43761	2019.808219	CH-CCR-W301-102319	mg/l	Lithium	Lithium_W-301	0.52	1
BAP	W-301	43939	2020.295082	CH-CCR-W301-0420	mg/l	Lithium	Lithium_W-301	0.41	1
BAP	W-302	43441	2018.931507	CH-CCR-W302-12718	mg/l	Lithium	Lithium_W-302	0.32	1
BAP	W-302	43511	2019.123288	CH-CCR-W302-21519	mg/l	Lithium	Lithium_W-302	0.37	1
BAP	W-302	43572	2019.290411	CH-CCR-W302-41719	mg/l	Lithium	Lithium_W-302	0.31	1
BAP	W-302	43761	2019.808219	CH-CCR-W302-102319	mg/l	Lithium	Lithium_W-302	0.32	1
BAP	W-302	43938	2020.29235	CH-CCR-W302-0420	mg/l	Lithium	Lithium_W-302	1	0

CCR Unit	StationName	SampDate	Year	FieldSampleID	Units	Parameter	Group	RES_RL	D_RES_RL
BAP	W-308	12/08/18	2018.934247	CH-CCR-W308-12818	mg/l	Lithium	Lithium_W-308	0.37	1
BAP	W-308	02/15/19	2019.123288	CH-CCR-W308-21519	mg/l	Lithium	Lithium_W-308	0.39	1
BAP	W-308	04/16/19	2019.287671	CH-CCR-W308-41619	mg/l	Lithium	Lithium_W-308	0.35	1
BAP	W-308	10/24/19	2019.810959	CH-CCR-W308-102419	mg/l	Lithium	Lithium_W-308	0.37	1
BAP	W-308	04/17/20	2020.29235	CH-CCR-W308-0420	mg/l	Lithium	Lithium_W-308	0.46	1
BAP	W-309	12/08/18	2018.934247	CH-CCR-W309-12818	mg/l	Lithium	Lithium_W-309	0.2	0
BAP	W-309	02/15/19	2019.123288	CH-CCR-W309-21519	mg/l	Lithium	Lithium_W-309	0.35	1
BAP	W-309	04/16/19	2019.287671	CH-CCR-W309-41619	mg/l	Lithium	Lithium_W-309	0.3	1
BAP	W-309	10/24/19	2019.810959	CH-CCR-W309-102419	mg/l	Lithium	Lithium_W-309	0.31	1
BAP	W-309	05/04/20	2020.338798	CH-CCR-W309-0520	mg/l	Lithium	Lithium_W-309	0.5	1

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.110/13/2020 10:58:02 AM
From File	SSL_MK Trend Input.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

RES_RL-arsenic_m-51a

General Statistics

Number of Events Reported (m)	20
Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20
Minimum	0.0029
Maximum	0.035
Mean	0.023
Geometric Mean	0.0211
Median	0.024
Standard Deviation	0.00742
Coefficient of Variation	0.322

Mann-Kendall Test

M-K Test Value (S)	28
Tabulated p-value	0.193
Standard Deviation of S	30.72
Standardized Value of S	0.879
Approximate p-value	0.19

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-cobalt_m-51a

General Statistics

Number of Events Reported (m)	20
Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20
Minimum	7.6000E-4
Maximum	0.0025
Mean	0.00118
Geometric Mean	0.00112
Median	0.001
Standard Deviation	4.6214E-4
Coefficient of Variation	0.391

Mann-Kendall Test

M-K Test Value (S)	-13
Tabulated p-value	0.362
Standard Deviation of S	23.27

Standardized Value of S	-0.516
Approximate p-value	0.303

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-cobalt_m-52a

General Statistics

Number of Events Reported (m)	22
Number of Missing Events	0
Number or Reported Events Used	22
Number Values Reported (n)	22
Minimum	0.027
Maximum	0.1
Mean	0.0515
Geometric Mean	0.0493
Median	0.0515
Standard Deviation	0.016
Coefficient of Variation	0.312

Mann-Kendall Test

M-K Test Value (S)	-19
Tabulated p-value	0.308
Standard Deviation of S	35.44
Standardized Value of S	-0.508
Approximate p-value	0.306

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-cobalt_m-53a

General Statistics

Number of Events Reported (m)	21
Number of Missing Events	0
Number or Reported Events Used	21
Number Values Reported (n)	21
Minimum	0.011
Maximum	0.024
Mean	0.0164
Geometric Mean	0.016
Median	0.016
Standard Deviation	0.00357
Coefficient of Variation	0.218

Mann-Kendall Test

M-K Test Value (S)	-138
Tabulated p-value	0
Standard Deviation of S	32.77
Standardized Value of S	-4.18
Approximate p-value	1.4549E-5

Statistically significant evidence of a decreasing trend at the specified level of significance.

RES_RL-cobalt_w-305

General Statistics

Number of Events Reported (m)	21
Number of Missing Events	0
Number or Reported Events Used	21
Number Values Reported (n)	21
Minimum	0.01
Maximum	0.02
Mean	0.017
Geometric Mean	0.0169
Median	0.018
Standard Deviation	0.00211
Coefficient of Variation	0.124

Mann-Kendall Test

M-K Test Value (S)	84
Tabulated p-value	0.005
Standard Deviation of S	31.82
Standardized Value of S	2.608
Approximate p-value	0.00455

Statistically significant evidence of an increasing trend at the specified level of significance.

RES_RL-cobalt_w-314

General Statistics

Number of Events Reported (m)	21
Number of Missing Events	0
Number or Reported Events Used	21
Number Values Reported (n)	21
Minimum	0.011
Maximum	0.022
Mean	0.0146
Geometric Mean	0.0144
Median	0.014
Standard Deviation	0.0026
Coefficient of Variation	0.178

Mann-Kendall Test

M-K Test Value (S)	29
Tabulated p-value	0.21
Standard Deviation of S	32.5
Standardized Value of S	0.862
Approximate p-value	0.194

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-fluoride_m-51a

General Statistics

Number of Events Reported (m)	21
Number of Missing Events	0
Number or Reported Events Used	21
Number Values Reported (n)	21
Minimum	4.1
Maximum	6
Mean	5.248
Geometric Mean	5.225
Median	5.4
Standard Deviation	0.488
Coefficient of Variation	0.0931

Mann-Kendall Test

M-K Test Value (S)	12
Tabulated p-value	0.371
Standard Deviation of S	32.98
Standardized Value of S	0.333
Approximate p-value	0.369

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-lithium_m-50a

General Statistics

Number of Events Reported (m)	20
Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20
Minimum	0.43
Maximum	0.55
Mean	0.469
Geometric Mean	0.468
Median	0.465
Standard Deviation	0.0309
Coefficient of Variation	0.066

Mann-Kendall Test

M-K Test Value (S)	-67
Tabulated p-value	0.017
Standard Deviation of S	30.58
Standardized Value of S	-2.158
Approximate p-value	0.0154

Statistically significant evidence of a decreasing trend at the specified level of significance.

RES_RL-lithium_m-51a

General Statistics

Number of Events Reported (m)	20

Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20
Minimum	0.45
Maximum	0.65
Mean	0.536
Geometric Mean	0.533
Median	0.54
Standard Deviation	0.0554
Coefficient of Variation	0.103

Mann-Kendall Test

M-K Test Value (S)	-92
Tabulated p-value	0.001
Standard Deviation of S	30.57
Standardized Value of S	-2.977
Approximate p-value	0.00146

Statistically significant evidence of a decreasing trend at the specified level of significance.

RES_RL-lithium_w-123

General Statistics

Number of Events Reported (m)	20
Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20
Minimum	0.58
Maximum	0.83
Mean	0.654
Geometric Mean	0.651
Median	0.645
Standard Deviation	0.0571
Coefficient of Variation	0.0875

Mann-Kendall Test

M-K Test Value (S)	103
Tabulated p-value	0
Standard Deviation of S	30.65
Standardized Value of S	3.327
Approximate p-value	4.3820E-4

Statistically significant evidence of an increasing trend at the specified level of significance.

RES_RL-lithium_w-306

General Statistics

Number of Events Reported (m)	20
Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20

Minimum	0.43
Maximum	1.3
Mean	0.698
Geometric Mean	0.682
Median	0.685
Standard Deviation	0.166
Coefficient of Variation	0.238

Mann-Kendall Test

M-K Test Value (S)	67
Tabulated p-value	0.017
Standard Deviation of S	30.77
Standardized Value of S	2.145
Approximate p-value	0.016

Statistically significant evidence of an increasing trend at the specified level of significance.

RES_RL-molybdenum_w-123

General Statistics

Number of Events Reported (m)	20
Number of Missing Events	0
Number or Reported Events Used	20
Number Values Reported (n)	20
Minimum	0.3
Maximum	0.41
Mean	0.353
Geometric Mean	0.351
Median	0.35
Standard Deviation	0.029
Coefficient of Variation	0.0823

Mann-Kendall Test

M-K Test Value (S)	63
Tabulated p-value	0.023
Standard Deviation of S	30.49
Standardized Value of S	2.033
Approximate p-value	0.021

Statistically significant evidence of an increasing trend at the specified level of significance.

RES_RL-cobalt_w-301

General Statistics

Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0.016

Maximum	0.021
Mean	0.018
Geometric Mean	0.0179
Median	0.018
Standard Deviation	0.00187
Coefficient of Variation	0.104

Mann-Kendall Test

M-K Test Value (S)	3
Tabulated p-value	0.408
Standard Deviation of S	3.958
Standardized Value of S	0.505
Approximate p-value	0.307

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-cobalt_w-302

General Statistics

Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0.0049
Maximum	0.022
Mean	0.00884
Geometric Mean	0.00728
Median	0.0055
Standard Deviation	0.00738
Coefficient of Variation	0.834

Mann-Kendall Test

M-K Test Value (S)	4
Tabulated p-value	0.242
Standard Deviation of S	4.082
Standardized Value of S	0.735
Approximate p-value	0.231

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-cobalt_w-303

General Statistics

Number of Events Reported (m)	1
Number of Missing Events	0
Number or Reported Events Used	1
Number Values Reported (n)	1
Minimum	0.027
Maximum	0.027
Mean	0.027

Geometric Mean	0.027
Median	0.027
Standard Deviation	N/A
Coefficient of Variation	N/A

Not enough reported values (n) to provide Mann-Kendall Statistics!

RES_RL-cobalt_w-307

General Statistics

Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0.073
Maximum	0.084
Mean	0.079
Geometric Mean	0.0789
Median	0.08
Standard Deviation	0.00447
Coefficient of Variation	0.0566

Mann-Kendall Test

M-K Test Value (S)	8
Tabulated p-value	0.042
Standard Deviation of S	4.082
Standardized Value of S	1.715
Approximate p-value	0.0432

Statistically significant evidence of an increasing trend at the specified level of significance.

RES_RL-lithium_m-55a

General Statistics

Number of Events Reported (m)	18
Number of Missing Events	0
Number or Reported Events Used	18
Number Values Reported (n)	18
Minimum	0
Maximum	0.43
Mean	0.342
Geometric Mean	0
Median	0.365
Standard Deviation	0.0893
Coefficient of Variation	0.261

Mann-Kendall Test

M-K Test Value (S)	58
Tabulated p-value	0.013
Standard Deviation of S	25.97
Standardized Value of S	2.194

Approximate p-value	0.0141

Statistically significant evidence of an increasing trend at the specified level of significance.

RES_RL-lithium_w-301

General Statistics	
Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0.41
Maximum	0.59
Mean	0.49
Geometric Mean	0.486
Median	0.5
Standard Deviation	0.0725
Coefficient of Variation	0.148

Mann-Kendall Test	
M-K Test Value (S)	-2
Tabulated p-value	0.408
Standard Deviation of S	4.082
Standardized Value of S	-0.245
Approximate p-value	0.403

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-lithium_w-302

General Statistics	
Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0
Maximum	0.37
Mean	0.264
Geometric Mean	0
Median	0.32
Standard Deviation	0.149
Coefficient of Variation	0.566

Mann-Kendall Test	
M-K Test Value (S)	-5
Tabulated p-value	0.242
Standard Deviation of S	3.958
Standardized Value of S	-1.011
Approximate p-value	0.156

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-lithium_w-308

General Statistics

Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0.35
Maximum	0.46
Mean	0.388
Geometric Mean	0.386
Median	0.37
Standard Deviation	0.0427
Coefficient of Variation	0.11

Mann-Kendall Test

M-K Test Value (S)	3
Tabulated p-value	0.408
Standard Deviation of S	3.958
Standardized Value of S	0.505
Approximate p-value	0.307

Insufficient evidence to identify a significant trend at the specified level of significance.

RES_RL-lithium_w-309

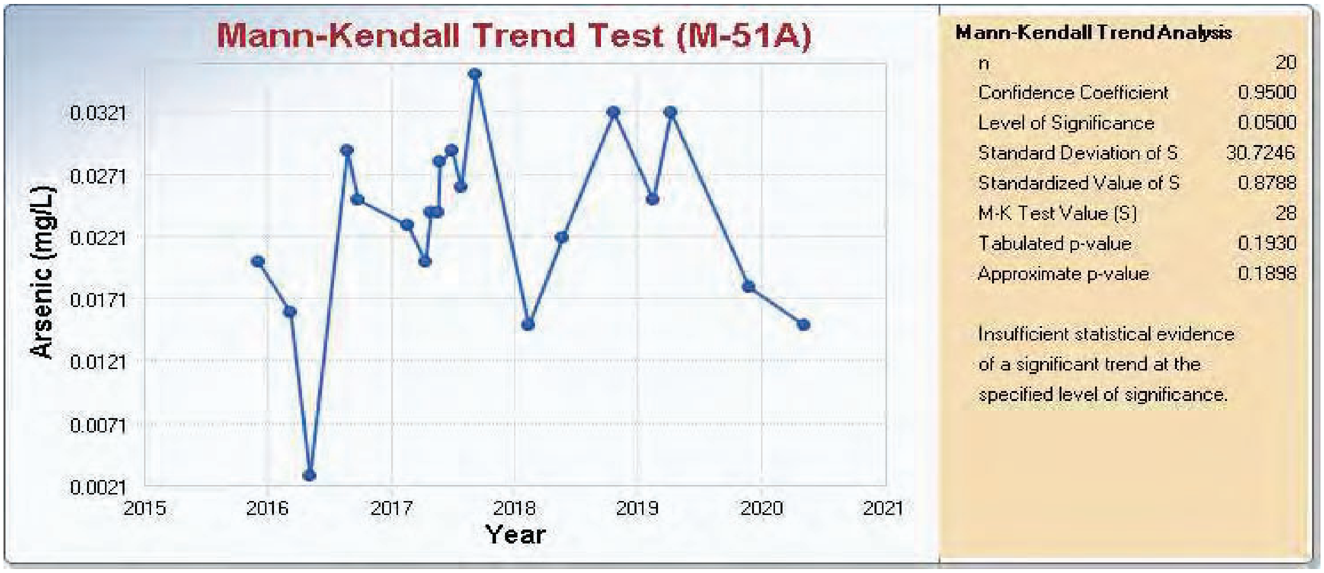
General Statistics

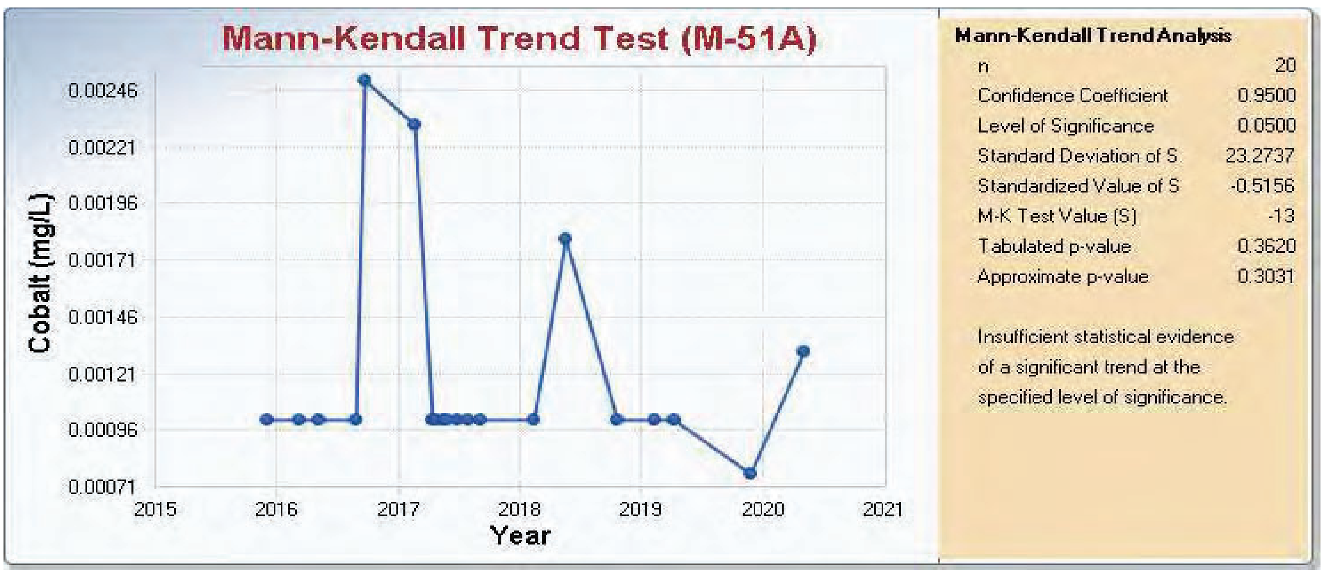
Number of Events Reported (m)	5
Number of Missing Events	0
Number or Reported Events Used	5
Number Values Reported (n)	5
Minimum	0
Maximum	0.5
Mean	0.292
Geometric Mean	0
Median	0.31
Standard Deviation	0.182
Coefficient of Variation	0.623

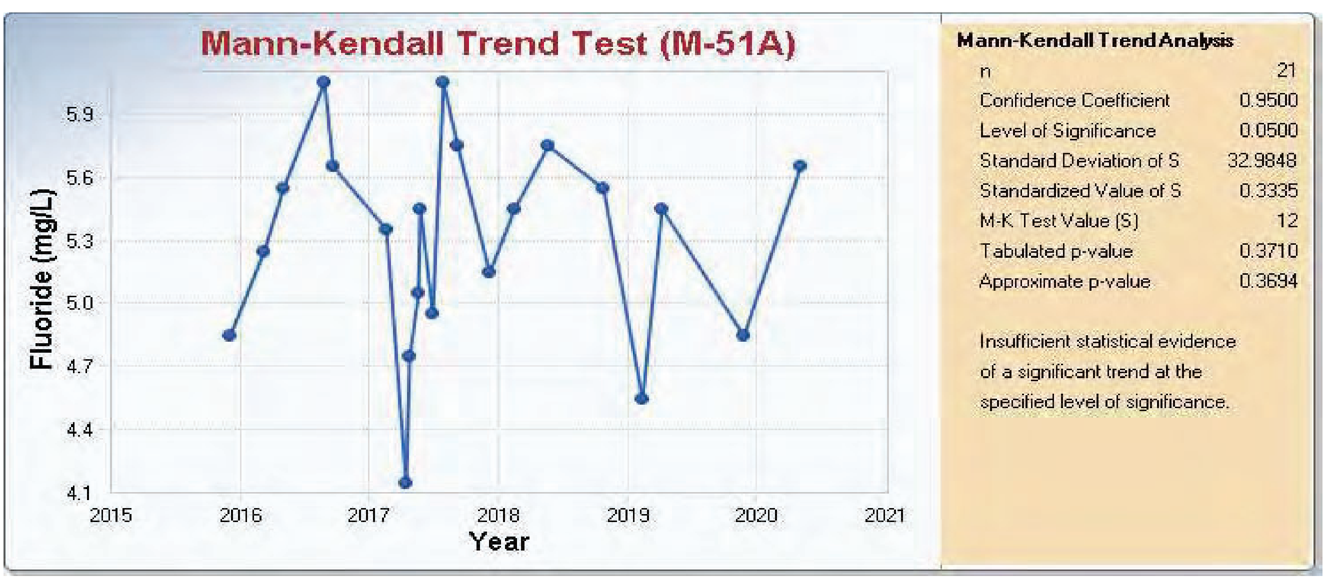
Mann-Kendall Test

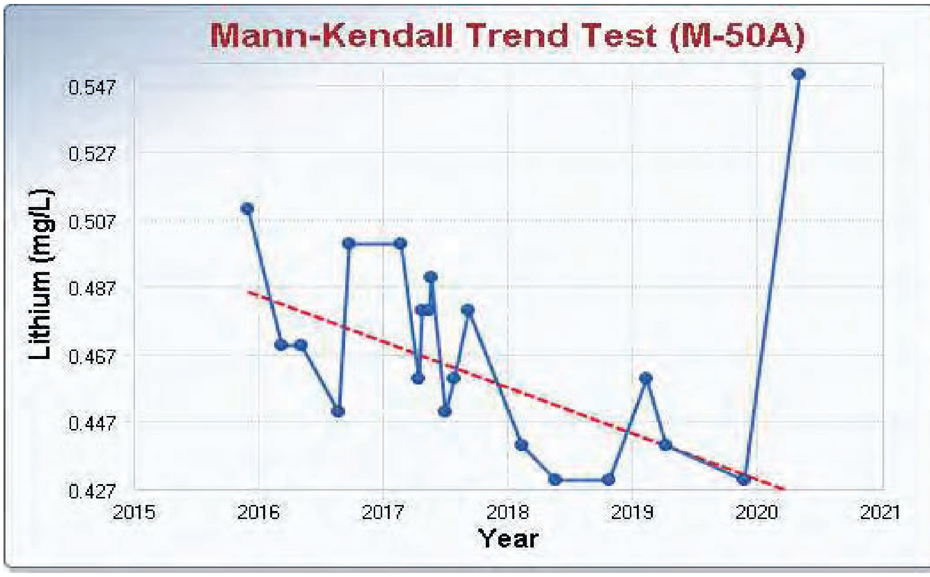
M-K Test Value (S)	6
Tabulated p-value	0.117
Standard Deviation of S	4.082
Standardized Value of S	1.225
Approximate p-value	0.11

Insufficient evidence to identify a significant trend at the specified level of significance.


Mann-Kendall Trend Test (M-51A)
Arsenic (mg/L)
0.0321
0.0271
0.0221
0.0171
0.0121
0.0071
0.0021
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 20
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 30.7246
Standardized Value of S 0.8788
M-K Test Value (S) 28
Tabulated p-value 0.1930
Approximate p-value 0.1898
Insufficient statistical evidence of a significant trend at the specified level of significance.


Mann-Kendall Trend Test (M-51A)
Cobalt (mg/L)
0.00246
0.00221
0.00196
0.00171
0.00146
0.00121
0.00096
0.00071
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 20
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 23.2737
Standardized Value of S -0.5156
M-K Test Value (S) -13
Tabulated p-value 0.3620
Approximate p-value 0.3031
Insufficient statistical evidence of a significant trend at the specified level of significance.


Mann-Kendall Trend Test (M-51A)
Fluoride (mg/L)
5.9
5.6
5.3
5.0
4.7
4.4
4.1
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 21
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 32.9848
Standardized Value of S 0.3335
M-K Test Value (S) 12
Tabulated p-value 0.3710
Approximate p-value 0.3694
Insufficient statistical evidence of a significant trend at the specified level of significance.



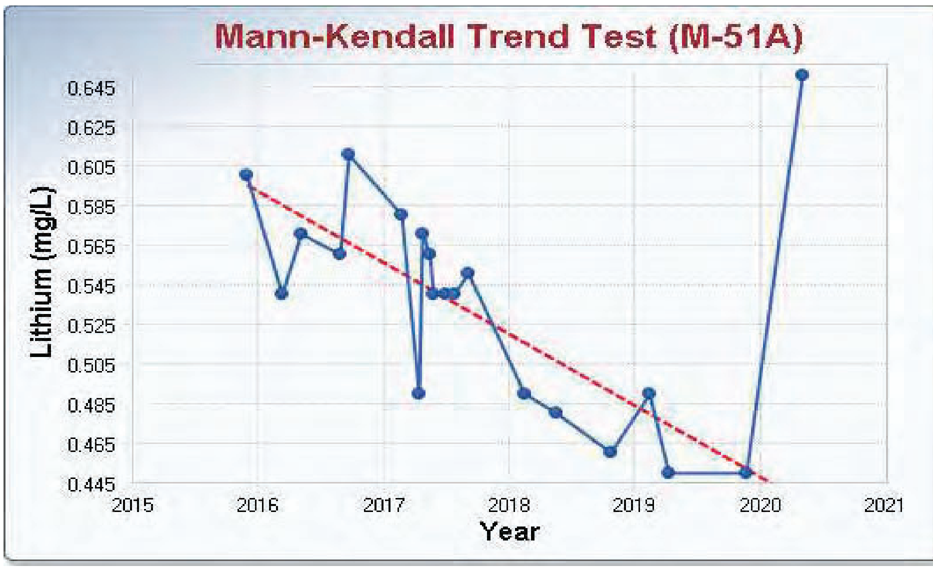
Mann-Kendall Trend Analysis

n	20
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	30.5778
Standardized Value of S	-2.1584
M-K Test Value (S)	-67
Tabulated p-value	0.0170
Approximate p-value	0.0154

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0138
Theil-Sen Intercept	28.2049

Statistically significant evidence of a decreasing trend at the specified level of significance.



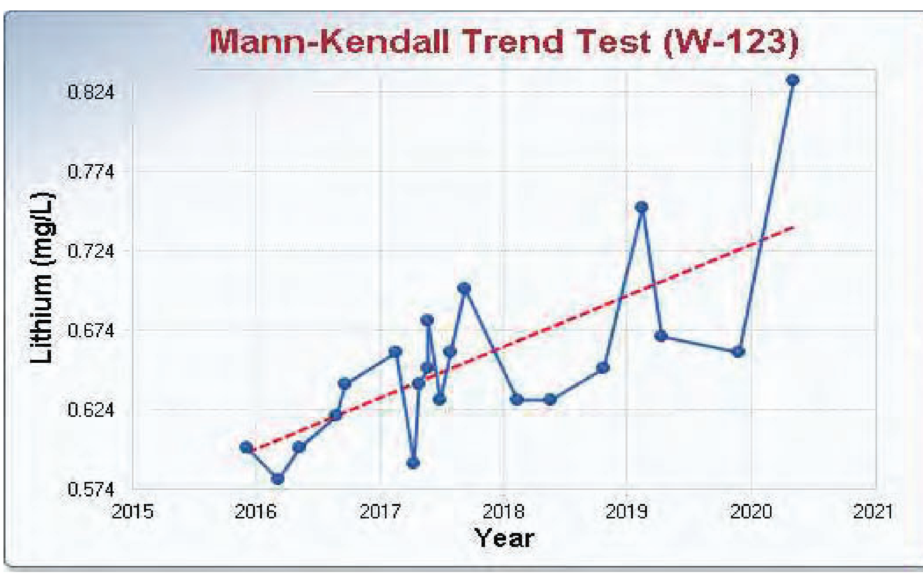
Mann-Kendall Trend Analysis

n	20
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	30.5723
Standardized Value of S	-2.9765
M-K Test Value (S)	-92
Tabulated p-value	0.0010
Approximate p-value	0.0015

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0361
Theil-Sen Intercept	73.4508

Statistically significant evidence of a decreasing trend at the specified level of significance.



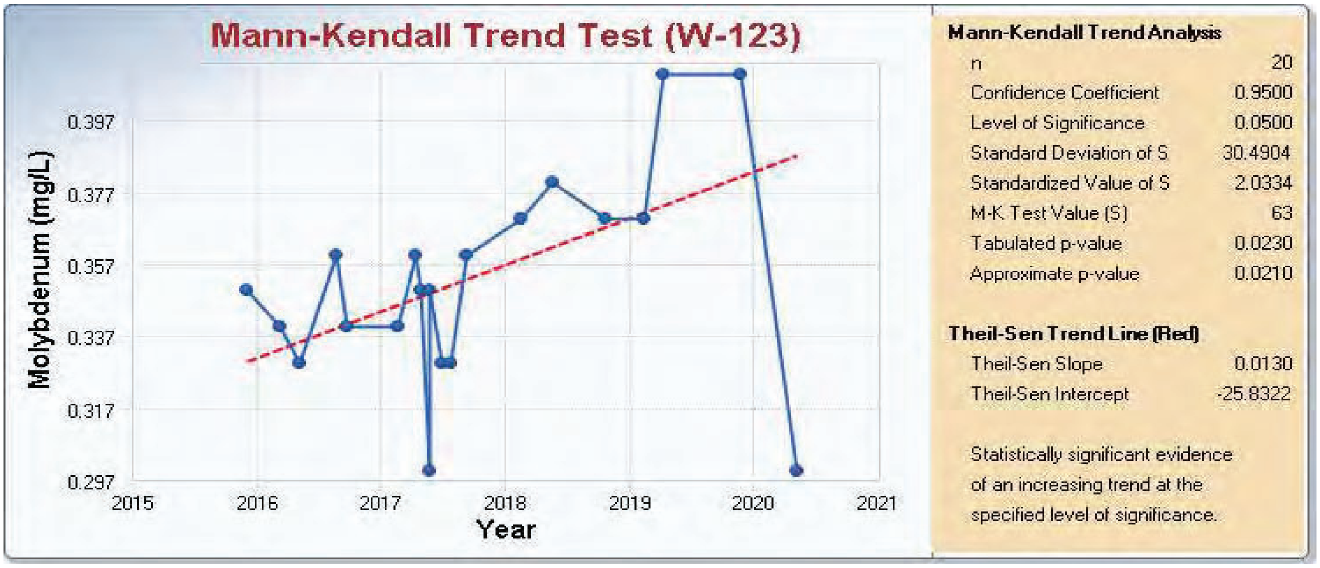
Mann-Kendall Trend Analysis

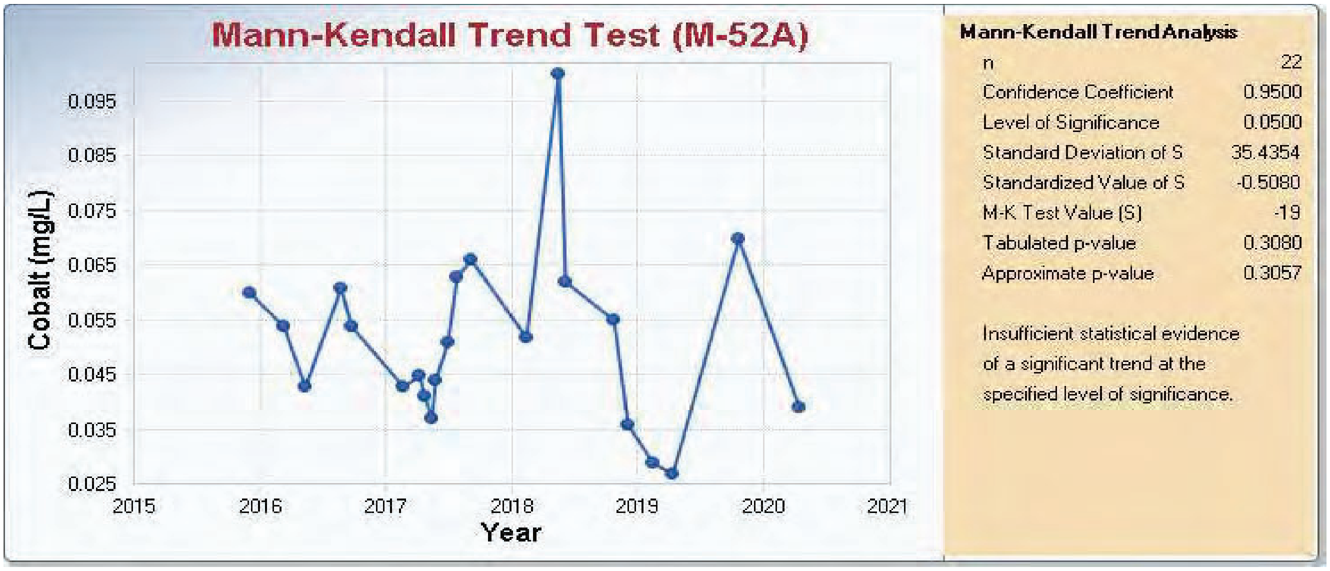
n	20
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	30.6540
Standardized Value of S	3.3275
M-K Test Value (S)	103
Tabulated p-value	0.0000
Approximate p-value	0.0004

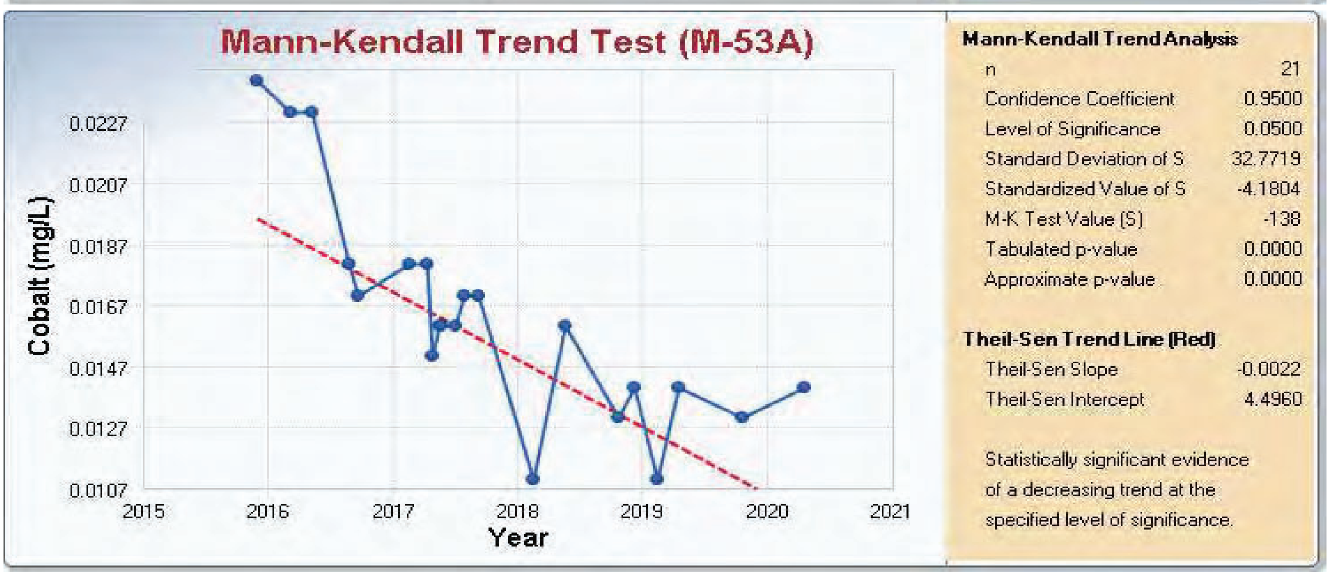
Theil-Sen Trend Line (Red)

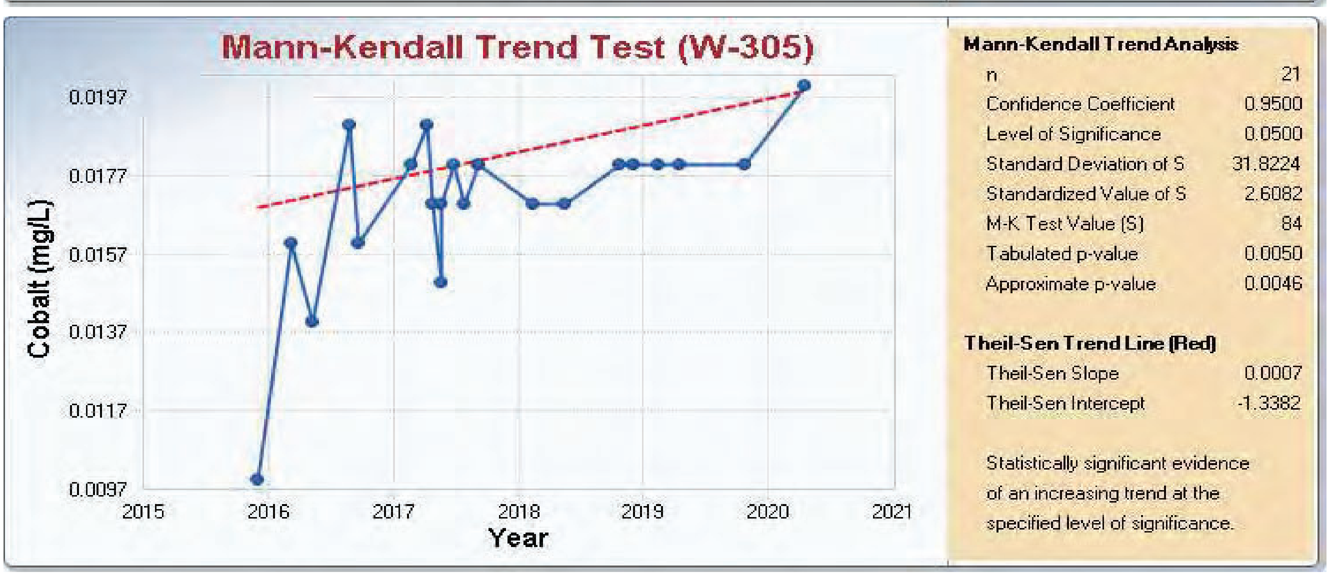
Theil-Sen Slope	0.0320
Theil-Sen Intercept	-63.9873

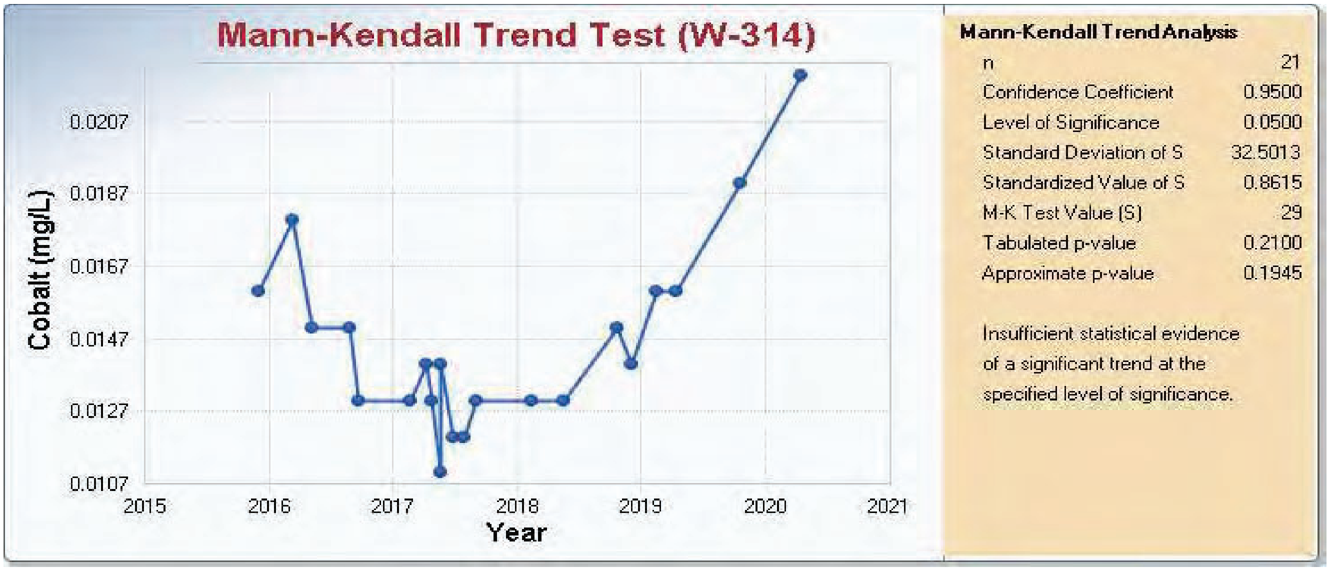
Statistically significant evidence of an increasing trend at the specified level of significance.

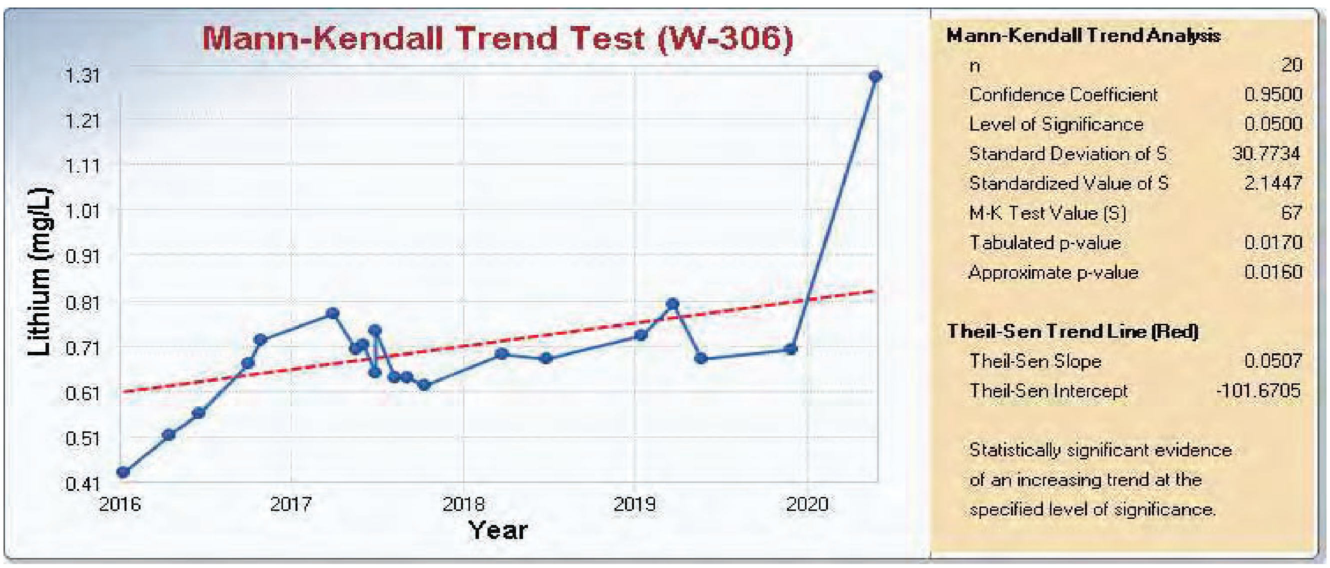

Mann-Kendall Trend Test (W-123)
Molybdenum (mg/L)
0.397
0.377
0.357
0.337
0.317
0.297
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 20
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 30.4904
Standardized Value of S 2.0334
M-K Test Value (S) 63
Tabulated p-value 0.0230
Approximate p-value 0.0210
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0130
Theil-Sen Intercept -25.8322
Statistically significant evidence of an increasing trend at the specified level of significance.

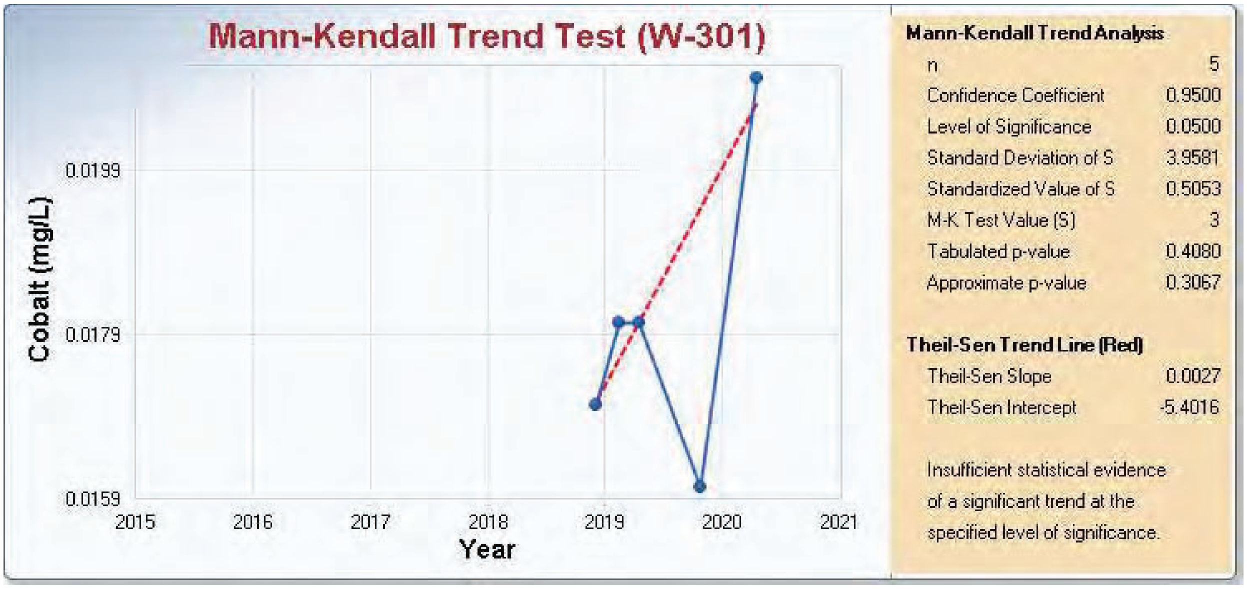

Mann-Kendall Trend Test (M-52A)
Cobalt (mg/L)
0.095
0.085
0.075
0.065
0.055
0.045
0.035
0.025
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 22
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 35.4354
Standardized Value of S -0.5080
M-K Test Value (S) -19
Tabulated p-value 0.3080
Approximate p-value 0.3057
Insufficient statistical evidence of a significant trend at the specified level of significance.

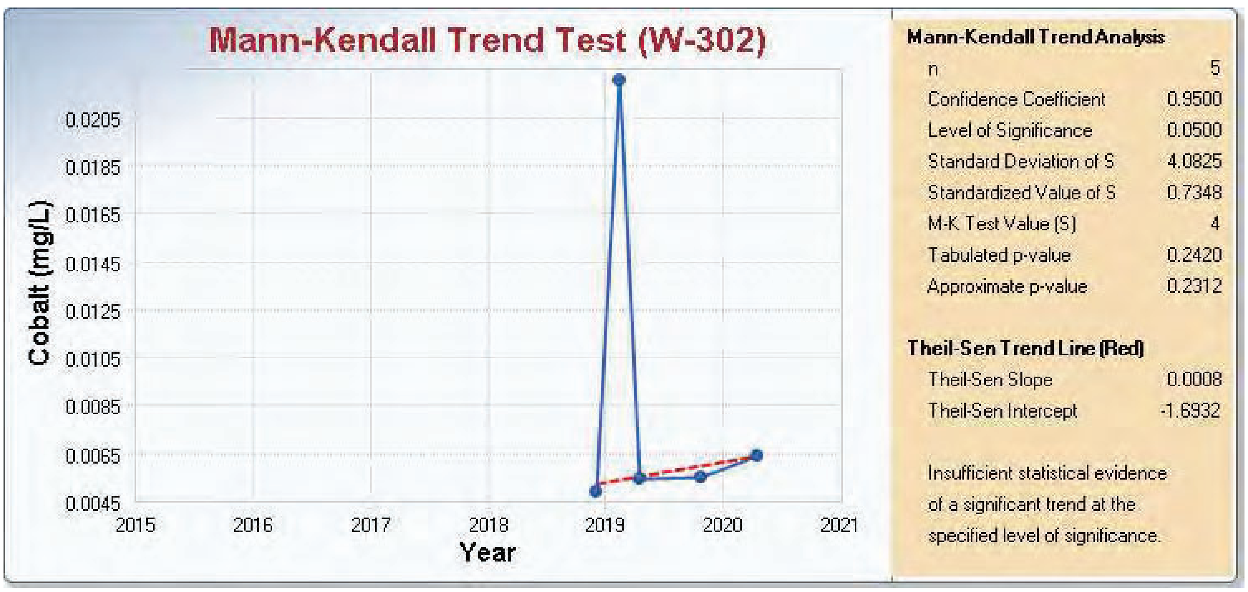

Mann-Kendall Trend Test (M-53A)
Cobalt (mg/L)
0.0227
0.0207
0.0187
0.0167
0.0147
0.0127
0.0107
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 21
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 32.7719
Standardized Value of S -4.1804
M-K Test Value (S) -138
Tabulated p-value 0.0000
Approximate p-value 0.0000
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0022
Theil-Sen Intercept 4.4960
Statistically significant evidence of a decreasing trend at the specified level of significance.

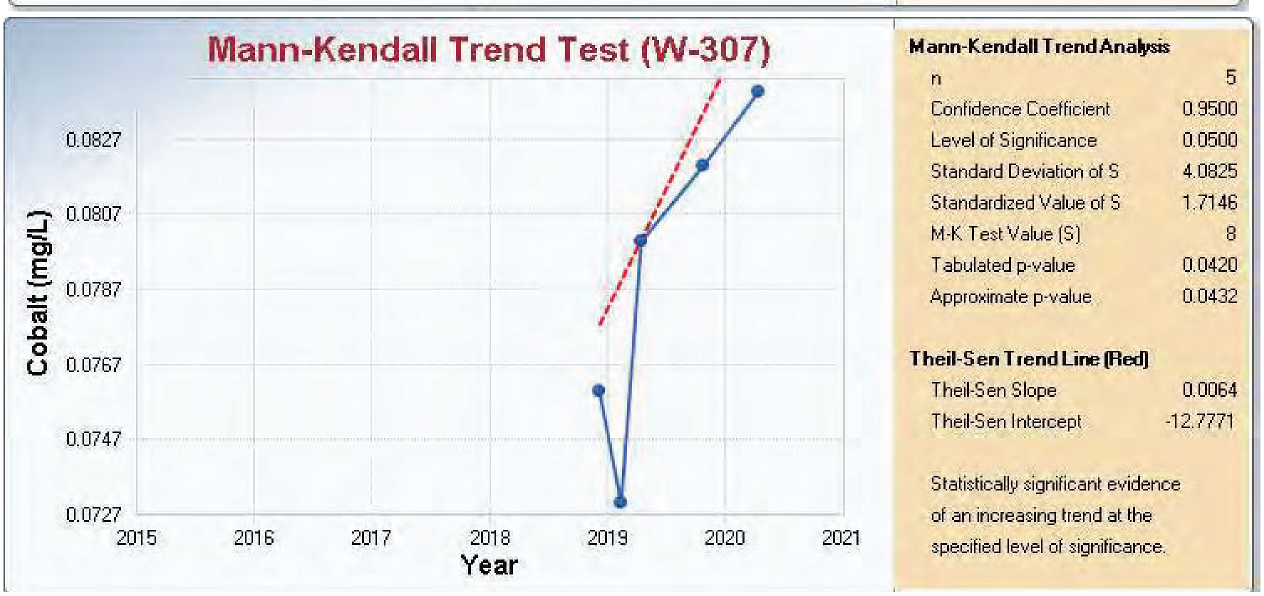

Mann-Kendall Trend Test (W-305)
Cobalt (mg/L)
0.0197
0.0177
0.0157
0.0137
0.0117
0.0097
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 21
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 31.8224
Standardized Value of S 2.6082
M-K Test Value (S) 84
Tabulated p-value 0.0050
Approximate p-value 0.0046
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0007
Theil-Sen Intercept -1.3382
Statistically significant evidence of an increasing trend at the specified level of significance.

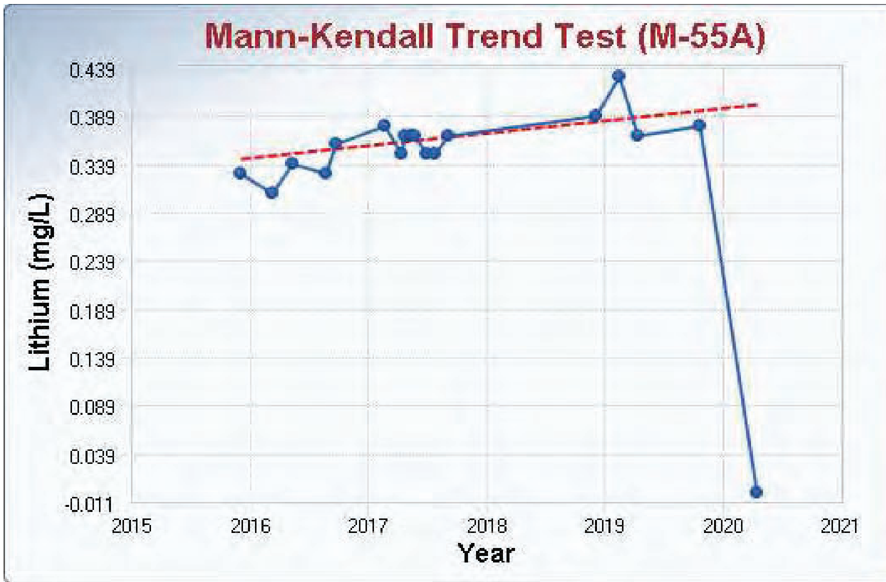

Mann-Kendall Trend Test (W-314)
Cobalt (mg/L)
0.0207
0.0187
0.0167
0.0147
0.0127
0.0107
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 21
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 32.5013
Standardized Value of S 0.8615
M-K Test Value (S) 29
Tabulated p-value 0.2100
Approximate p-value 0.1945
Insufficient statistical evidence of a significant trend at the specified level of significance.


Mann-Kendall Trend Test (W-306)
Lithium (mg/L)
1.31
1.21
1.11
1.01
0.91
0.81
0.71
0.61
0.51
0.41
2016
2017
2018
2019
2020
Year
Mann-Kendall Trend Analysis
n 20
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 30.7734
Standardized Value of S 2.1447
M-K Test Value (S) 67
Tabulated p-value 0.0170
Approximate p-value 0.0160
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0507
Theil-Sen Intercept -101.6705
Statistically significant evidence of an increasing trend at the specified level of significance.


Mann-Kendall Trend Test (W-301)
Cobalt (mg/L)
0.0199
0.0179
0.0159
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 5
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 3.9581
Standardized Value of S 0.5053
M-K Test Value (S) 3
Tabulated p-value 0.4080
Approximate p-value 0.3067
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0027
Theil-Sen Intercept -5.4016
Insufficient statistical evidence of a significant trend at the specified level of significance.


Mann-Kendall Trend Test (W-302)
Cobalt (mg/L)
0.0205
0.0185
0.0165
0.0145
0.0125
0.0105
0.0085
0.0065
0.0045
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 5
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 4.0825
Standardized Value of S 0.7348
M-K Test Value (S) 4
Tabulated p-value 0.2420
Approximate p-value 0.2312
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0008
Theil-Sen Intercept -1.6932
Insufficient statistical evidence of a significant trend at the specified level of significance.

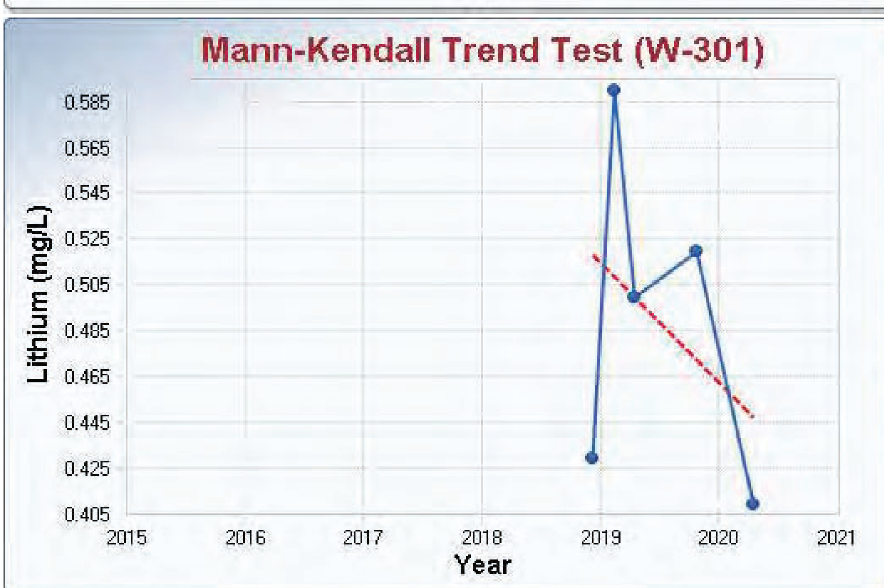

Mann-Kendall Trend Test (W-307)
Cobalt (mg/L)
0.0827
0.0807
0.0787
0.0767
0.0747
0.0727
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 5
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 4.0825
Standardized Value of S 1.7146
M-K Test Value (S) 8
Tabulated p-value 0.0420
Approximate p-value 0.0432
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0064
Theil-Sen Intercept -12.7771
Statistically significant evidence of an increasing trend at the specified level of significance.



Mann-Kendall Trend Analysis	
n	18
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	25.9743
Standardized Value of S	2.1945
M-K Test Value (S)	58
Tabulated p-value	0.0130
Approximate p-value	0.0141

Theil-Sen Trend Line (Red)	
Theil-Sen Slope	0.0128
Theil-Sen Intercept	-25.5171

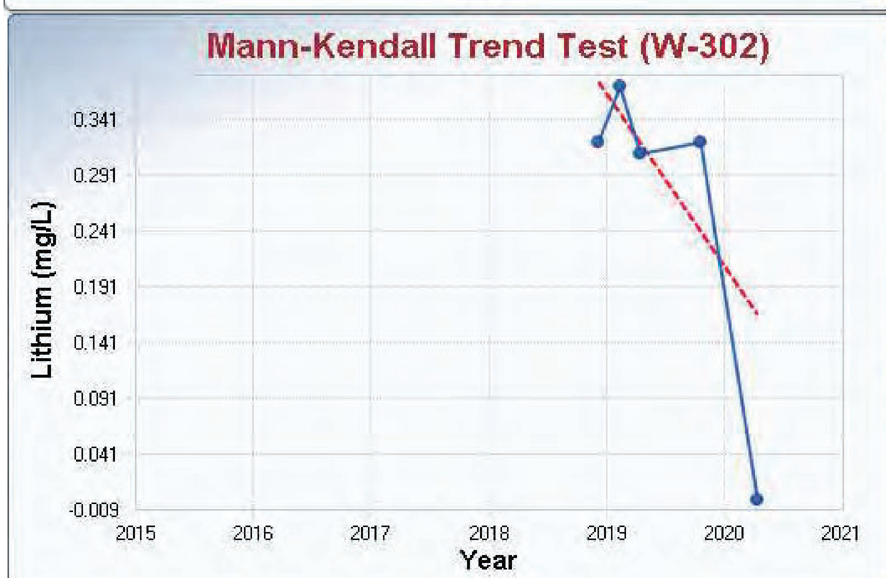
Statistically significant evidence of an increasing trend at the specified level of significance.



Mann-Kendall Trend Analysis	
n	5
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	4.0825
Standardized Value of S	-0.2449
M-K Test Value (S)	-2
Tabulated p-value	0.4080
Approximate p-value	0.4032

Theil-Sen Trend Line (Red)	
Theil-Sen Slope	-0.0520
Theil-Sen Intercept	105.5083

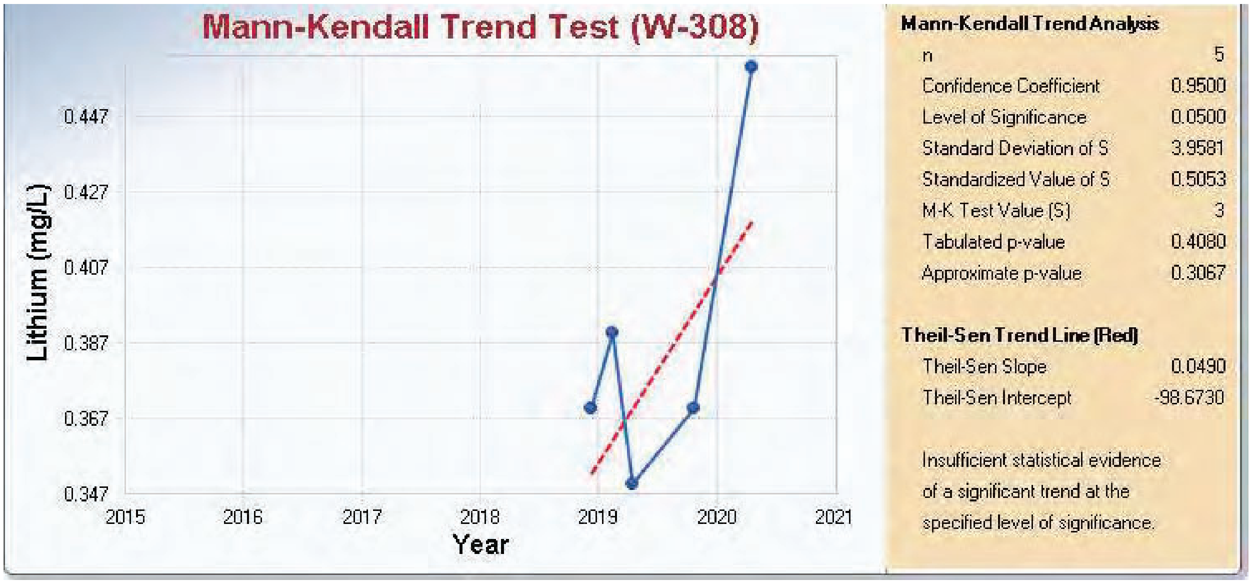
Insufficient statistical evidence of a significant trend at the specified level of significance.

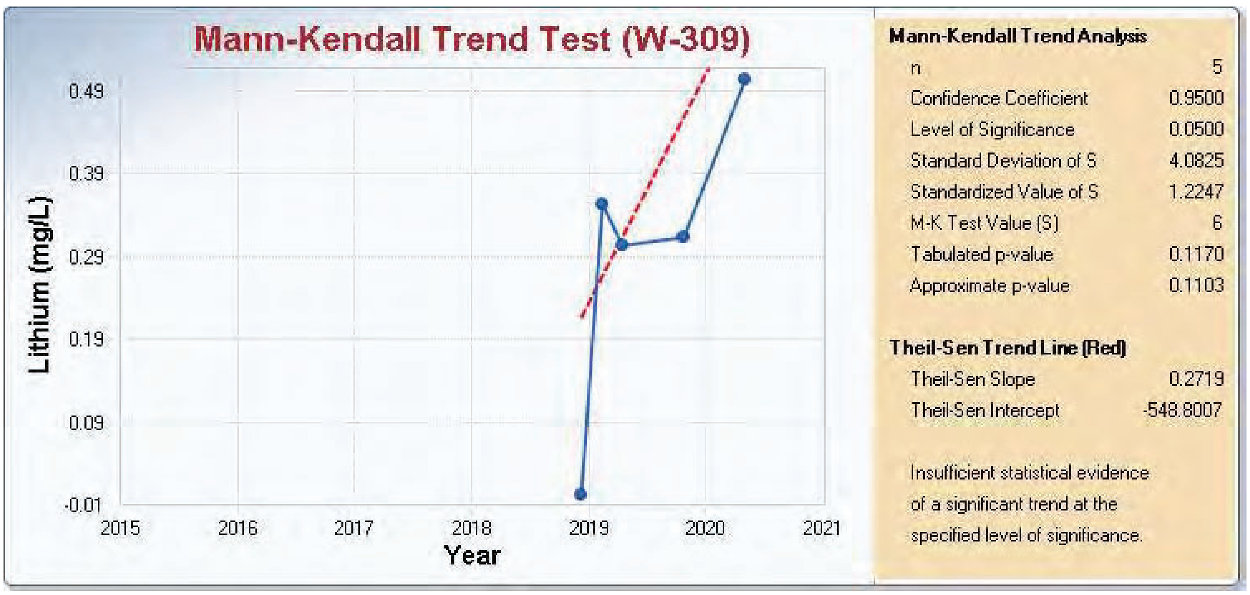


Mann-Kendall Trend Analysis	
n	5
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	3.9581
Standardized Value of S	-1.0106
M-K Test Value (S)	-5
Tabulated p-value	0.2420
Approximate p-value	0.1561

Theil-Sen Trend Line (Red)	
Theil-Sen Slope	-0.1541
Theil-Sen Intercept	311.4405

Insufficient statistical evidence of a significant trend at the specified level of significance.


Mann-Kendall Trend Test (W-308)
Lithium (mg/L)
0.447
0.427
0.407
0.387
0.367
0.347
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 5
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 3.9581
Standardized Value of S 0.5053
M-K Test Value (S) 3
Tabulated p-value 0.4080
Approximate p-value 0.3067
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0490
Theil-Sen Intercept -98.6730
Insufficient statistical evidence of a significant trend at the specified level of significance.


Mann-Kendall Trend Test (W-309)
Lithium (mg/L)
0.49
0.39
0.29
0.19
0.09
-0.01
2015
2016
2017
2018
2019
2020
2021
Year
Mann-Kendall Trend Analysis
n 5
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 4.0825
Standardized Value of S 1.2247
M-K Test Value (S) 6
Tabulated p-value 0.1170
Approximate p-value 0.1103
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.2719
Theil-Sen Intercept -548.8007
Insufficient statistical evidence of a significant trend at the specified level of significance.

Attachment C

aps

Richard Nicosia
Plant Manager
Cholla Power Plant

Tel. 928-288-1176
Fax 928-288-1399
e-mail: Richard.Nicosia@aps.com

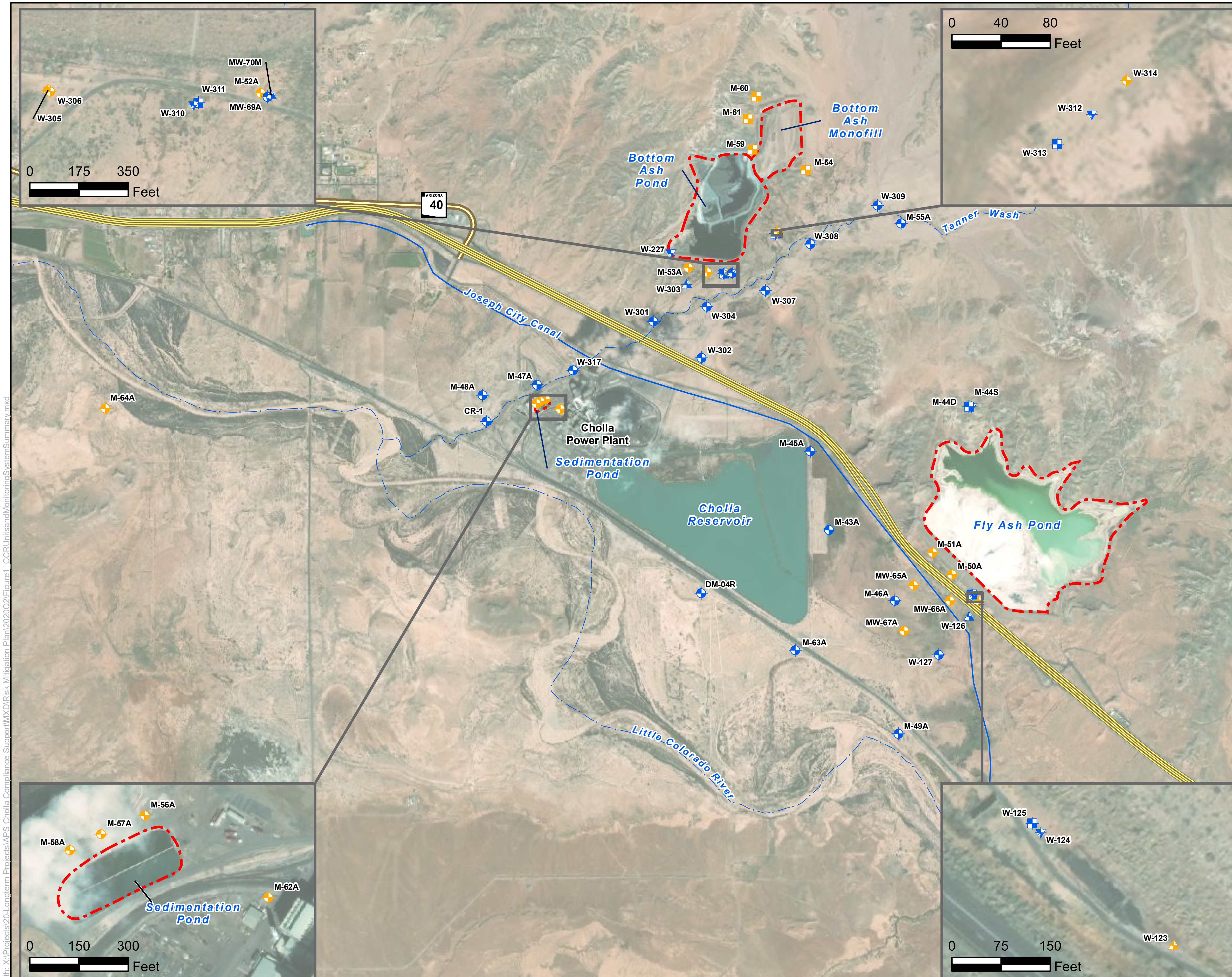
4801 Cholla Lake Road
Mail Station 4451
Joseph City, Arizona 86032

November 25, 2020

To Whom it May Concern,

Pursuant to the requirement identified in 40 Code of Federal Regulation (CFR) Section 257.103(f)(2)(v)(C)(1) for documentation supporting an Alternative Closure Demonstration that qualifies for continued use of the Bottom Ash Pond and the Fly Ash Pond through cessation of coal fired operations no later than April 2025, APS hereby certifies that Cholla Power Plant's operations currently are, and will remain in, compliance with all applicable requirements contained in 40 CFR Part 257, Subpart D, including the requirements to conduct any necessary corrective action. This certification is substantiated by the documentation and supporting materials identified and referenced within Attachment C to this Alternative Closure Demonstration package.

Richard Nicosia
Plant Manager
Cholla Power Plant



State Overview

Legend

CCR Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- C-Aquifer Monitoring Well

Supplementary Site Monitoring Well Location

- Alluvial Monitoring Well
- Moenkopi Formation (Moqui Member) Monitoring Well
- Moenkopi Formation (Wupatki Member) Monitoring Well
- C-Aquifer Monitoring Well
- Ephemeral Surface Water Feature
- Canal
- Approximate Extent of CCR Unit

Notes:

CCR Coal Combustion Residuals

0 1,250 2,500 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 1

CCR Units and Monitoring System Summary

Job No. 1420182040
PM: MBH
Date: 10/8/2020
Scale: 1"= 2500'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\Risk Mitigation Plan\2020Q2\Figure1_CCRUnitsandMonitoringSystemSummary.mxd

Table 1-2
CCR Groundwater Monitoring System Summary

Well	CCR Unit	Well Designation	Hydrogeologic Unit	Date Installed	Borehole Depth [ft bgs]	Top of Casing Elevation [ft AMSL]	Ground Surface Elevation [ft AMSL]	Top of Screen [ft bgs]	Bottom of Screen [ft bgs]	Screen Length [ft]	Top Screen Elevation [ft AMSL]	Bottom Screen Elevation [ft AMSL]	Bottom Borehole Elevation [ft AMSL]
M-54	BAM	Background	Coconino Sandstone	10/2/2015	370	5070.71	5068.21	315	365	50	4,753.21	4,703.21	4,698.21
M-59	BAM	Downgradient	Coconino Sandstone	10/21/2015	425	5136.00	5133.86	373	423	50	4,760.86	4,710.86	4,708.86
M-60	BAM	Downgradient	Coconino Sandstone	11/1/2015	450	5151.18	5148.69	395	445	50	4,753.69	4,703.69	4,698.69
M-61	BAM	Downgradient	Coconino Sandstone	11/13/2015	420	5127.58	5124.95	365	415	50	4,759.95	4,709.95	4,704.95
M-47A	BAP	Supplementary	LCR Alluvium	1/20/2012	184	5020.34	5021.45	30.5	60	29.5	4,990.95	4,961.45	4,837.45
M-52A	BAP	Downgradient	Tanner Wash Alluvium	9/22/2015	83	5049.36	5047.08	20	70	50	5,027.08	4,977.08	4,964.08
M-53A	BAP	Downgradient	Tanner Wash Alluvium	9/22/2015	38	5044.68	5042.09	10	35	25	5,032.09	5,007.09	5,004.09
M-55A	BAP	Supplementary	Tanner Wash Alluvium	10/30/2015	60	5062.82	5060.06	20	55	35	5,040.06	5,005.06	5,000.06
MW-69A	BAP	Supplementary	Tanner Wash Alluvium	11/20/2019	27	5050.741	5049.25	16.6	26.6	10	5,032.65	5,022.65	5,022.25
MW-70M	BAP	Supplementary	Moenkopi Formation - Moqui Member	11/22/2019	77.5	5051.119	5049.80	45.6	75.6	30	5,004.20	4,974.20	4,972.30
W-227	BAP	Supplementary	Moenkopi Formation - Wupatki Member	11/2/1983	58	5122.820	5120.32	38	55	17	5,082.32	5,065.32	5,062.32
W-301	BAP	Supplementary	Tanner Wash Alluvium	10/4/1983	62	5033.68	5031.18	40	60	20	4,991.18	4,971.18	4,969.18
W-302	BAP	Supplementary	Tanner Wash Alluvium	11/1/1983	44	5036.42	5033.90	27	42	15	5,006.90	4,991.90	4,989.90
W-303	BAP	Supplementary	Moenkopi Formation - Moqui Member	10/26/1983	32	5039.70	5037.20	20	30	10	5,017.20	5,007.20	5,005.20
W-304	BAP	Supplementary	Tanner Wash Alluvium	10/26/1983	56	5038.60	5036.10	35	54	19	5,001.10	4,982.10	4,980.10
W-305	BAP	Downgradient	Tanner Wash Alluvium	10/7/1983	102	5046.80	5044.65	80	100	20	4,964.65	4,944.65	4,942.65
W-306	BAP	Downgradient	Tanner Wash Alluvium	10/11/1983	52	5046.74	5044.78	30	50	20	5,014.78	4,994.78	4,992.78
W-307	BAP	Supplementary	Tanner Wash Alluvium	10/21/1983	62	5045.22	5042.70	40	60	20	5,002.70	4,982.70	4,980.70
W-308	BAP	Supplementary	Tanner Wash Alluvium	10/19/1983	72	5051.54	5049.00	50	70	20	4,999.00	4,979.00	4,977.00
W-309	BAP	Supplementary	Tanner Wash Alluvium	10/14/1983	81	5062.01	5059.50	64	79	15	4,995.50	4,980.50	4,978.50
W-310	BAP	Supplementary	Moenkopi Formation - Wupatki Member	12/19/1992	240	5050.61	5048.60	218	238	20	4,830.60	4,810.60	4,808.60
W-311	BAP	Supplementary	Coconino Sandstone	12/14/1991	281	5050.03	5047.7	259	279	20	4,788.70	4,768.70	4,766.70
W-312	BAP	Supplementary	Moenkopi Formation - Wupatki Member	1/22/1992	259	5052.01	5049.3	238	258	20	4,811.30	4,791.30	4,790.30
W-313	BAP	Supplementary	Coconino Sandstone	1/27/1992	293	5051.32	5049.1	272	292	20	4,777.10	4,757.10	4,756.10
W-314	BAP	Downgradient	Tanner Wash Alluvium	1/27/1992	63	5051.10	5051.32	41	61	20	5,010.32	4,990.32	4,988.32
W-317	BAP	Supplementary	LCR Alluvium	11/10/2011	122.5	5022.27	5023.09	28.8	58.8	30	4,994.29	4,964.29	4,900.59
DM-04R	FAP	Supplementary	LCR Alluvium	11/22/2008	90	5018.43	5015.77	35	65	30	4,980.77	4,950.77	4,925.77
M-43A	FAP	Supplementary	LCR Alluvium	11/21/2008	80	5022.56	5019.87	40	70	30	4,979.87	4,949.87	4,939.87
M-44D	FAP	Supplementary	Coconino Sandstone	11/13/2008	385	5143.52	5140.94	320	380	60	4,820.94	4,760.94	4,755.94
M-44S	FAP	Supplementary	Moenkopi Formation - Wupatki Member	11/13/2008	290	5145.63	5143.01	250	280	30	4,893.01	4,863.01	4,853.01
M-45A	FAP	Supplementary	LCR Alluvium	11/12/2011	68	5025.57	5023.57	31	60	29.7	4,993.07	4,963.37	4,955.57
M-46A	FAP	Supplementary	LCR Alluvium	11/14/2011	40	5025.36	5023.36	22	34	12	5,001.36	4,989.36	4,983.36
M-49A	FAP	Supplementary	LCR Alluvium	9/17/2015	35	5024.70	5022.70	10	20	10	5,012.70	5,002.70	4,987.70
M-50A	FAP	Downgradient	LCR Alluvium	9/18/2015	32	5038.18	5035.65	9	29	20	5,026.65	5,006.65	5,003.65
M-51A	FAP	Downgradient	LCR Alluvium	9/19/2015	14	5041.77	5039.10	7	12	5	5,032.10	5,027.10	5,025.10
M-63A	FAP	Supplementary	LCR Alluvium	9/25/2015	57	5021.82	5018.9	25	55	30	4,993.90	4,963.90	4,961.90
MW-65A	FAP	Downgradient	LCR Alluvium	11/15/2018	25	5027.86	5026.21	9	19	10	5,017.31	5,007.31	5,001.21
MW-66A	FAP	Downgradient	LCR Alluvium	11/14/2018	60	5033.35	5032.46	24	49	25.1	5,008.86	4,983.76	4,972.46

Table 1-2
CCR Groundwater Monitoring System Summary

Well	CCR Unit	Well Designation	Hydrogeologic Unit	Date Installed	Borehole Depth [ft bgs]	Top of Casing Elevation [ft AMSL]	Ground Surface Elevation [ft AMSL]	Top of Screen [ft bgs]	Bottom of Screen [ft bgs]	Screen Length [ft]	Top Screen Elevation [ft AMSL]	Bottom Screen Elevation [ft AMSL]	Bottom Borehole Elevation [ft AMSL]
MW-67A	FAP	Downgradient	LCR Alluvium	11/16/2018	50	5025.38	5024.05	15	45	30.1	5,009.45	4,979.35	4,974.05
MW-68M*	FAP	Supplementary	Moenkopi Formation - Moqui Member	9/16/2019	50	5026.95	5026.45	30	50	20.1	4,996.71	4,976.61	4,976.10
W-123	FAP	Downgradient	Moenkopi Formation - Moqui Member	11/4/1983	40	5039.84	5038.14	14	29	15	5,024.14	5,009.14	4,998.14
W-124	FAP	Supplementary	Moenkopi Formation - Wupatki Member	2/14/1992	96	5037.53	5036.00	76	96	20	4,960.00	4,940.00	4,940.00
W-125	FAP	Supplementary	Coconino Sandstone	2/13/1992	141	5038.37	5036.00	120	140	20	4,916.00	4,896.00	4,895.00
W-126	FAP	Supplementary	Moenkopi Formation - Moqui Member	12/1/1995	50	5034.75	5032.75	15	45	30	5,017.75	4,987.75	4,982.75
W-127	FAP	Supplementary	LCR Alluvium	2/11/1997	33.3	5030.04	5025.18	15	30	15	5,010.18	4,995.18	4,991.88
M-64A	FAP/BAP	Background	LCR Alluvium	2/9/2017	69	4991.90	4988.90	30	60	30	4,958.90	4,928.90	4,919.90
CR-1	SEDI	Supplementary	LCR Alluvium	9/24/1993	45	5010.20	5006.15	25	45	20	4,981.15	4,961.15	4,961.15
M-48A	SEDI	Supplementary	LCR Alluvium	1/22/2012	145	5020.37	5018.37**	30.5	59.5	29	4,987.87	4,958.87	4,873.37
M-56A	SEDI	Downgradient	LCR Alluvium	10/7/2015	100	5023.17	5020.63	40	85	45	4,980.63	4,935.63	4,920.63
M-57A	SEDI	Downgradient	LCR Alluvium	10/8/2015	100	5023.82	5021.16	40	85	45	4,981.16	4,936.16	4,921.16
M-58A	SEDI	Downgradient	LCR Alluvium	10/13/2015	100	5023.84	5021.24	39	84	45	4,982.24	4,937.24	4,921.24
M-62A	SEDI	Background	LCR Alluvium	11/17/2015	97	5020.87	5021.01	39	84	45	4,982.01	4,937.01	4,924.01

Notes:

Source of presented information presented is APS; AMEC, 2012; Montgomery & Associates, 2017; Wood Environment & Infrastructure Solutions, Inc. Surveying, 2018 and 2019.

Vertical datum is NAVD 88

AMSL - Above mean sea level
BAM - Bottom Ash Monofill
BAP - Bottom Ash Pond
bgs - below ground surface
CCR - Coal combustion residuals
FAP - Fly Ash Pond
ft - feet
LCR - Little Colorado River
NA - Not Available
SEDI - Sedimentation Pond
* Abandoned well
**Approximate - elevation based on measured stickups

TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 370.0 feet / 5068.208 feet msl	DATE DRILLED: 9/23 - 10/2/2015
CADASTRAL / NAD83 : (A-18-19)13cab / 1440088.611 N / 665508.134 E	

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 10	**Qal**	alluvium; moderate brown [5YR4/4]; non-lithified to weakly lithified; reddish-brown and green siltstone; reaction to acid: weak	weathered, clayey cuttings	ARCH, Air Rotary; chips to 1 in
10 - 19	**Qal**	alluvium; moderate brown [5YR4/4]; non-lithified to weakly lithified; reddish-brown and green siltstone; fine grained sandstone; reaction to acid: weak	weathered, clayey cuttings	chips to 0.9 in
TRIASSIC MOENKOPI FORMATION (TRm)				
19 - 30	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; fine grained green sandstone; reaction to acid: weak		chips to 0.7 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; fine grained green sandstone; reaction to acid: weak to moderate	trace clay in cuttings	chips to 1.4 in
40 - 50	**TRm**	sandy siltstone; reddish brown [5YR4/3]; weakly to moderately lithified; reddish-brown siltstone; trace green siltstone; reaction to acid: weak to moderate	clayey cuttings	platy subangular-rounded chips to 0.9 in
50 - 60	**TRm**	sandy siltstone; dark reddish gray [5YR4/2]; moderately to well lithified; dark gray fine-grained sandstone; trace red and green siltstone; reaction to acid: weak		platy subangular-rounded chips to 0.5 in
60 - 70	**TRm**	sandy siltstone; yellowish red [5YR4/6], dark reddish gray [5YR4/2]; moderately to well lithified; reddish-brown siltstone; green fine-grained sandstone; dark grey, fine-grained sandstone; reaction to acid: weak to moderate	trace clay in cuttings	platy subangular-rounded chips to 0.9 in
70 - 80	**TRm**	sandy siltstone; moderate brown [5YR4/4]; weakly to moderately lithified; reddish-brown siltstone; trace green siltstone; reaction to acid: moderate to strong	trace clay in cuttings	platy subangular chips to 0.9 in
80 - 90	**TRm**	sandy siltstone; yellowish red [5YR4/6]; weakly to moderately lithified; reddish-brown siltstone; brown silty sandstone; reaction to acid: strong	trace clay in cuttings	platy subangular chips to 0.7 in

TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
90 - 100	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate to strong		platy subangular chips to 0.6 in
100 - 110	**TRm**	sandy siltstone; moderate brown [5YR4/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate to strong		platy subangular chips to 0.6 in
110 - 120	**TRm**	sandy siltstone; yellowish red [5YR4/6]; moderately to moderately lithified; reddish-brown and green siltstone; reaction to acid: strong		platy subangular chips to 0.8 in
120 - 130	**TRm**	sandy siltstone; yellowish red [5YR4/6]; moderately to moderately lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate	trace clay in cuttings	platy subangular chips to 0.6 in
130 - 140	**TRm**	sandy siltstone; yellowish red [5YR4/6]; moderately to moderately lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate	trace clay in cuttings	platy subangular chips to 0.7 in
140 - 150	**TRm**	sandy siltstone; yellowish red [5YR4/6], dark reddish brown [5YR3/2]; moderately to well lithified; reddish-brown and green siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: weak to moderate	trace clay in cuttings	platy subangular-angular chips to 0.9 in
150 - 160	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to moderately lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate		platy subangular-angular chips to 0.7 in
170 - 180	**TRm**	sandy siltstone; very dark brown [5YR2.5/2]; moderately to well lithified; dark gray fine-grained sandstone; trace fine green sandstone; reaction to acid: moderate to strong		platy rounded chips to 0.6 in
180 - 190	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.6 in

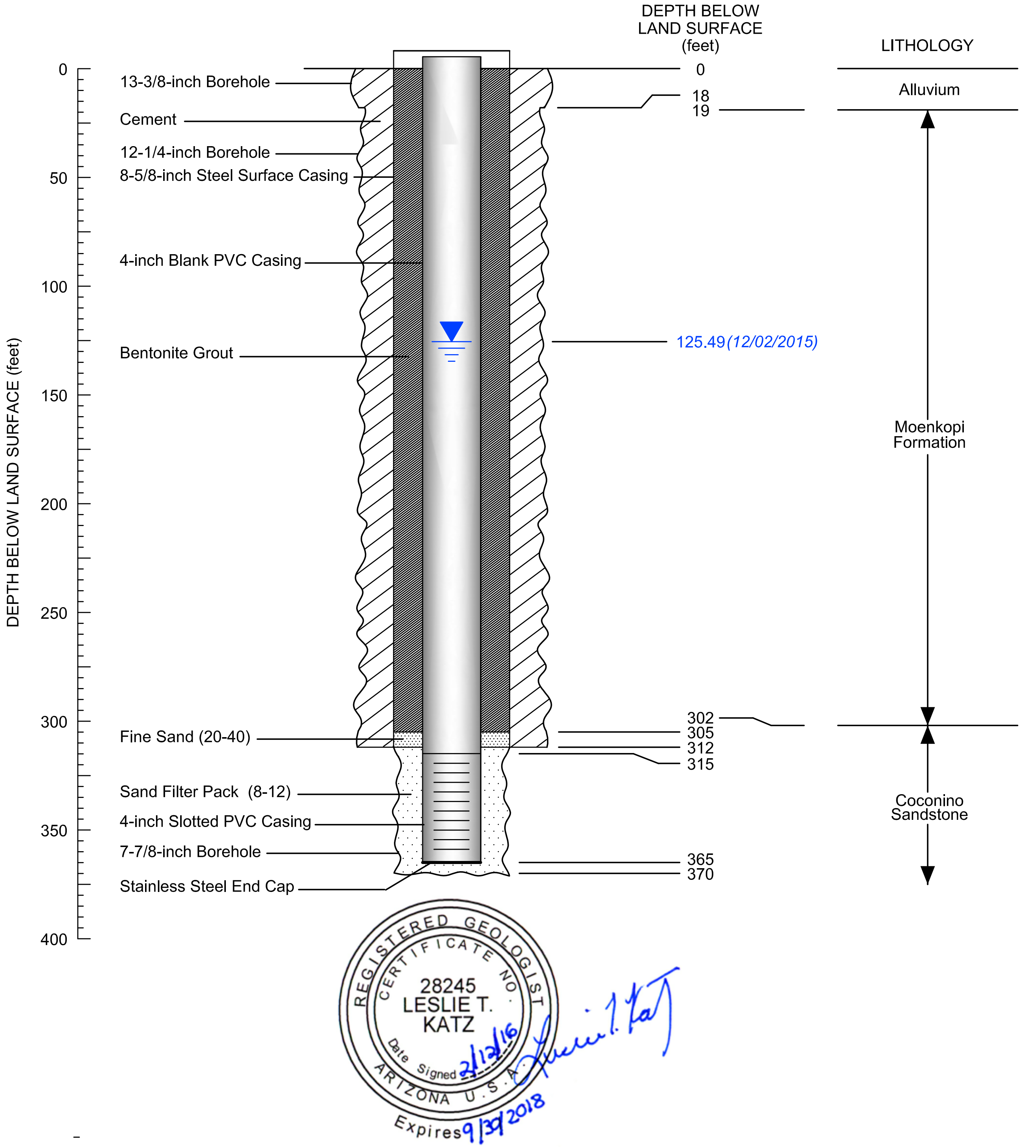
MONTGOMERY & ASSOCIATES

TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
190 - 200	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.9 in
200 - 210	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.8 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; gypsum; reaction to acid: moderate to strong		platy subangular-angular chips to 0.9 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; gypsum; reaction to acid: moderate to strong		platy subangular-angular chips to 0.9 in
230 - 240	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: moderate to strong		platy subangular-angular chips to 0.7 in
240 - 250	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; well to well lithified; reddish-brown siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: strong		platy subangular-angular chips to 0.8 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: strong		platy subangular-angular chips to 0.7 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; well to well lithified; fine dark reddish brown sandstone; reddish siltstone; trace tan sandstone; reaction to acid: moderate to strong		platy rounded chips to 0.7 in
270 - 280	**TRm**	sandy siltstone; moderate brown [5YR4/4]; well to well lithified; fine dark reddish brown sandstone; reaction to acid: moderate to strong		platy rounded chips to 0.5 in
280 - 290	**TRm**	sandy siltstone; moderate brown [5YR4/4]; well to well lithified; fine dark reddish brown sandstone; reaction to acid: weak to moderate		platy rounded chips to 0.6 in

TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
290 - 302	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], moderate brown [5YR4/4]; weakly to moderately lithified; fine dark reddish brown sandstone; reddish siltstone; trace green siltstone; reaction to acid: moderate to strong		platy subrounded-angular chips to 0.9 in
PERMIAN COCONINO SANDSTONE (Pc)				
302 - 310	**Pc**	fine sandstone; gray [5YR5/1], dark reddish brown [5YR3/3]; weakly to well lithified; fine reddish brown sandstone; fine gray sandstone; very fine buff sandstone; reaction to acid: weak to moderate		platy subrounded-subangular chips to 0.9 in
310 - 320	**Pc**	fine sandstone; light reddish brown [5YR6/3]; weakly to weakly lithified; very fine buff/tan sandstone; trace red clay; reaction to acid: weak to moderate		mostly pulverized; rounded chips to 0.4 in
320 - 330	**Pc**	fine sandstone; light yellowish brown [2.5Y6/3]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: weak to moderate		mostly pulverized; rounded chips to 0.4 in
330 - 340	**Pc**	fine sandstone; light gray [2.5Y7/2]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: moderate to strong		mostly pulverized; rounded chips to 0.2 in
340 - 350	**Pc**	fine sandstone; light gray [2.5Y7/2]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: moderate		mostly pulverized; rounded chips to 0.3 in
350 - 360	**Pc**	fine sandstone; light gray [2.5Y7/1]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: strong		mostly pulverized; rounded chips to 0.3 in
360 - 370	**Pc**	fine sandstone; light gray [2.5Y7/1]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: strong		mostly pulverized; rounded chips to 0.4 in



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-54 (BAM-1U)	NORTHING: 1440088.61
REGISTRATION: 55-918646	EASTING: 665508.13
COUNTY: Navajo, Arizona	MP Elevation: 5070.71 feet amsl
DATE COMPLETED: 10/02/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-54 APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

FIGURE

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TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps — LOGGED BY: J. Laney

DEPTH DRILLED / LAND SURFACE ELEVATION: 425.0 feet / 5133.863 feet msl — DATE DRILLED: 10/14 - 10/21/2015

CADASTRAL / NAD83 : (A-18-19)13cbb / 1440604.729 N / 664161.355 E

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 13	**Qal**	alluvium; brownish gray [5YR4/1]; 60% sand (subrounded, fine to coarse); 30% gravel (subangular to rounded, consisting of sandstone and chert); 10% silt; reaction to acid: weak		ARCH, Air Rotary; poorly sorted
TRIASSIC MOENKOPI FORMATION (TRm)				
13 - 20	**TRm**	sandy siltstone; moderate brown [5YR4/4]; non-lithified; 90% reddish brown siltstone; 10% fine-grained gray sandstone; reaction to acid: weak		subangular chips to 1.2 in
20 - 30	**TRm**	sandy siltstone; moderate brown [5YR4/4]; moderately to well lithified; 90% reddish brown siltstone; 10% fine-grained gray sandstone; reaction to acid: weak		subangular chips to 1.2 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; moderately to well lithified; 60% reddish brown siltstone; 40% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.8 in
40 - 50	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 50% reddish brown siltstone; 50% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.8 in
50 - 60	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 50% reddish brown siltstone; 50% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 1 in
60 - 70	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 80% reddish brown siltstone; 20% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 1 in
70 - 80	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; weakly lithified; 60% reddish brown siltstone; 40% blue gray sandstone; platy; reaction to acid: weak		subrounded to subangular chips to 1.2 in
80 - 90	**TRm**	sandy siltstone; gray [5YR5/1]; moderately to well lithified; reddish gray medium to fine-grained sandstone; reaction to acid: none		subrounded chips to 0.4 in

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
90 - 100	**TRm**	sandy siltstone; gray [5YR5/1], dark reddish brown [5YR3/4]; weakly to well lithified; reddish gray medium to fine-grained sandstone; reddish brown siltstone; trace blue green siltstone; platy; reaction to acid: none		subrounded to subangular chips to 0.8 in
100 - 110	**TRm**	sandy siltstone; gray [5YR5/1]; moderately to well lithified; reddish gray medium to fine-grained sandstone; reaction to acid: none		subrounded chips to 0.4 in
110 - 120	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 50% reddish brown siltstone; 50% blue gray siltstone; platy; reaction to acid: none		subangular chips to 0.8 in
120 - 130	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 70% reddish brown siltstone; 30% blue gray siltsone; platy; reaction to acid: weak		subangular chips to 0.8 in
130 - 140	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 90% reddish brown siltstone; 10% blue gray siltsone; trace gypsum; platy; reaction to acid: moderate	clayey cuttings	subangular chips to 0.8 in
140 - 150	**TRm**	sandy siltstone; light greenish gray [5BG7/1], gray [5YR5/1]; weakly to moderately lithified; 60% reddish brown siltstone; 40% blue gray siltsone; trace gypsum; reaction to acid: weak		subangular chips to 0.4 in
150 - 160	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 90% reddish brown siltstone; 5% blue gray siltsone; 5% gypsum; platy; reaction to acid: none		subangular to subrounded chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; light greenish gray [5BG7/1], dark reddish brown [5YR3/3]; weakly to moderately lithified; 40% reddish brown siltstone; 60% blue gray sandstone; platy; reaction to acid: weak		subangular chips to 0.4 in
170 - 180	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly lithified; 80% reddish brown siltstone; 20% blue gray siltstone; platy; reaction to acid: none	clayey cuttings	subangular chips to 0.6 in

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
180 - 190	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; platy; reaction to acid: none		subangular chips to 0.4 in
190 - 200	**TRm**	sandy siltstone; light greenish gray [5BG7/1], dark reddish brown [5YR3/4]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.4 in
200 - 210	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.8 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: weak		subangular chips to 0.4 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.4 in
230 - 240	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 80% reddish brown siltstone; 15% blue gray sandstone (very fine to fine-grained); 5% gypsum needle crystals; reaction to acid: weak		subangular to subrounded chips to 0.4 in
240 - 250	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 70% reddish brown sandstone (very fine to fine-grained); 30% blue gray sandstone (very fine to fine-grained); trace gypsum needle crystals; reaction to acid: weak		subangular chips to 0.4 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 80% reddish brown sandstone (very fine to fine-grained); 15% blue gray sandstone (very fine to fine-grained); 5% gypsum needle crystals; reaction to acid: moderate		subangular chips to 0.4 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 45% reddish brown sandstone (very fine to fine-grained); 45% reddish brown siltstone; 10% blue gray sandstone (very fine to fine-grained); trace gypsum; reaction to acid: strong		subangular chips to 0.4 in

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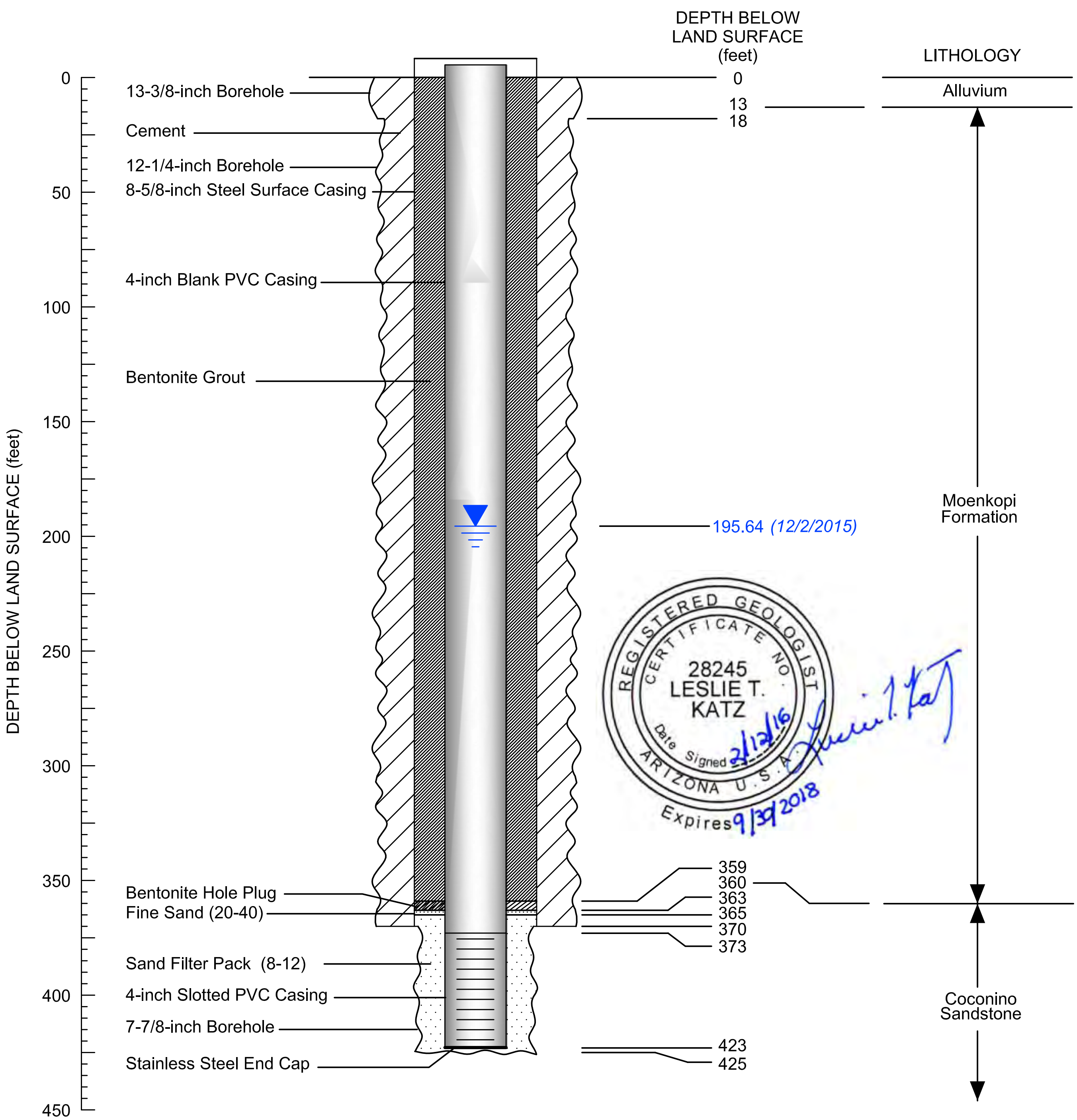
TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
270 - 280	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light gray [2.5Y7/2]; well lithified; reddish brown siltstone and sandstone; greenish-tan fine-grained sandstone; reaction to acid: moderate		subangular to subrounded chips to 0.4 in
280 - 290	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light gray [2.5Y7/2]; moderately to well lithified; 80% reddish brown siltstone; 20% red to green very fine-grained sandstone; reaction to acid: strong		subangular chips to 0.4 in
290 - 300	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light gray [2.5Y7/2]; moderately to well lithified; 80% reddish brown siltstone; 20% green-tan grained sandstone (very fine to fine-grained); reaction to acid: strong		subangular chips to 0.4 in
300 - 310	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; 50% reddish brown siltstone; 50% reddish brown sandstone (very fine to fine-grained); reaction to acid: weak		subangular chips to 0.4 in
310 - 320	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1], light brown [5YR6/4]; moderately to well lithified; 80% reddish brown sandstone (very fine to fine-grained); 15% blue gray sandstone (very fine to fine-grained); 5% tan sandstone (fine-grained); reaction to acid: moderate		subrounded chips to 0.4 in
320 - 330	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; dark reddish brown sandstone (fine-grained); reaction to acid: none		subrounded chips to 0.4 in
330 - 340	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; dark reddish brown sandstone (fine-grained); reaction to acid: none		subrounded chips to 0.4 in
340 - 350	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; dark reddish brown sandstone (fine-grained); trace light brown sandstone; reaction to acid: none		subrounded chips to 0.4 in
350 - 360	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], gray [5YR5/1]; moderately to well lithified; dark reddish brown sandstone (very fine to fine-grained); reaction to acid: none		subangular to angular chips to 0.4 in

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PERMIAN COCONINO SANDSTONE (Pc)				
360 - 370	**Pc**	fine sandstone; pale red [2.5YR6/2]; well lithified; greyish tan sandstone (very fine to fine-grained); reaction to acid: weak		subangular chips to 0.6 in
370 - 380	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: strong		mostly pulverized to fine sand; trace rounded chips to 0.2 in
380 - 390	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: strong		pulverized; very fine to fine sand
390 - 400	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: moderate		mostly pulverized to fine sand; trace rounded chips to 0.2 in
400 - 410	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: weak		mostly pulverized to fine sand; trace rounded chips to 0.2 in
410 - 420	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: weak		mostly pulverized to fine sand; trace rounded chips to 0.2 in
420 - 425	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: weak		mostly pulverized to fine sand; trace rounded chips to 0.2 in



EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-59 (BAM-1D)	NORTHING: 1440604.73
REGISTRATION: 55-918647	EASTING: 664161.36
COUNTY: Navajo, Arizona	MP Elevation: 5136.002 feet amsl
DATE COMPLETED: 10/21/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-59 APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 450.0 feet / 5148.694 feet msl	DATE DRILLED: 10/21 - 11/1/2015
CADASTRAL / NAD83 : (A-18-19)13bac / 1441947.886 N / 664249.994 E	

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 14	**Qal**	alluvium; grayish orange [10YR7/4]; non-lithified to non lithified; 60% medium to high plasticity clay; 20% very fine to coarse subrounded sand; 20% gravel consisting of sandstone and chert; CL sandy loam clay with gravel; reaction to acid: moderate		ARCH, Air Rotary; subrounded-subangular chips to 0.8 in
TRIASSIC MOENKOPI FORMATION (TRm)				
14 - 20	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; 50% red brown siltstone; 40% blue gray siltstone; 10% gray fine-grained sandstone; reaction to acid: strong		subangular chips to 0.8 in
20 - 30	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; 50% red brown siltstone; 40% blue gray siltstone; 10% gray fine-grained sandstone; reaction to acid: strong		subangular chips to 0.8 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; moderately to well lithified; 90% red brown siltstone; 10% blue gray siltstone; platy clayey cuttings; reaction to acid: strong		subangular chips to 0.4 in
40 - 50	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; weakly to moderately lithified; 70% red brown siltstone; 30% blue gray siltstone; platy; reaction to acid: strong		subangular chips to 0.4 in
50 - 60	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; weakly to moderately lithified; 70% red brown siltstone; 30% blue gray siltstone; platy; reaction to acid: moderate		subangular chips to 0.6 in
60 - 70	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; weakly to moderately lithified; 80% red brown siltstone; 20% blue gray siltstone; platy; reaction to acid: moderate		subangular chips to 0.4 in
70 - 80	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: moderate		rounded-subrounded chips to 0.8 in
80 - 90	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; Reddish gray fine- to medium-grained sandstone; reaction to acid: moderate		subrounded-subangular chips to 0.4 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
90 - 100	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; 90% red gray to blue gray fine- to medium-grained sandstone; 10% red brown siltstone; reaction to acid: moderate		subrounded-subangular chips to 0.8 in
100 - 110	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: moderate		rounded-subrounded chips to 0.4 in
110 - 120	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: moderate		rounded-subrounded chips to 0.4 in
120 - 130	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], dark reddish gray [2.5YR4/1]; moderately to well lithified; 80% red brown siltstone; 20% dark gray fine- to medium-grained sandstone; reaction to acid: moderate		subangular-subrounded chips to 0.8 in
130 - 140	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: strong		rounded-subrounded chips to 0.6 in
140 - 150	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown / blue gray siltstone; 40% red brown fine-grained sandstone; platy siltstone; reaction to acid: weak		subangular chips to 0.8 in
150 - 160	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 50% red brown siltstone; 50% red brown / blue gray fine- to medium-grained sandstone; platy siltstone; reaction to acid: weak		subangular chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; weak red [2.5YR5/2], light blue green [5BG6/6]; moderately to well lithified; 60% red gray / blue gray fine-grained sandstone; 40% red brown siltstone; reaction to acid: weak		subangular chips to 0.6 in
170 - 180	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red siltstone; 10% blue gray fine-grained sandstone; trace gypsum; reaction to acid: moderate		subangular chips to 0.6 in
180 - 190	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], dark reddish gray [2.5YR4/1]; moderately to well lithified; 70% red brown siltstone; 30% dark gray fine- to medium-grained sandstone; reaction to acid: weak		subangular-subrounded chips to 0.4 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
190 - 200	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; moderately to well lithified; Dark gray / red gray fine to medium-grained sandstone; trace gypsum; reaction to acid: weak		subrounded chips to 0.4 in
200 - 210	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown siltstone; 40% red brown / blue gray fine-grained sandstone; platy siltstone; reaction to acid: none		subangular chips to 0.6 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown siltstone; 40% red brown / blue gray fine-grained sandstone; and trace gypsum; reaction to acid: none		subangular chips to 0.6 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown siltstone; 40% red brown / blue gray fine-grained sandstone; trace gypsum; reaction to acid: none		subangular chips to 0.6 in
230 - 240	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown / blue gray fine-grained sandstone; 40% red brown siltstone; reaction to acid: none		subangular chips to 0.6 in
240 - 250	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 70% red brown siltstone; 30% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.6 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 60% blue gray siltstone; 35% red brown siltstone; 5% gypsum needle crystals; platy; reaction to acid: weak		subangular chips to 0.6 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 15% blue gray siltstone; 5% gypsum needle crystals; platy; reaction to acid: moderate		subangular chips to 0.8 in
270 - 280	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; moderately lithified; 95% red brown siltstone; 5% gypsum needle crystals; platy; reaction to acid: weak		subangular chips to 0.8 in

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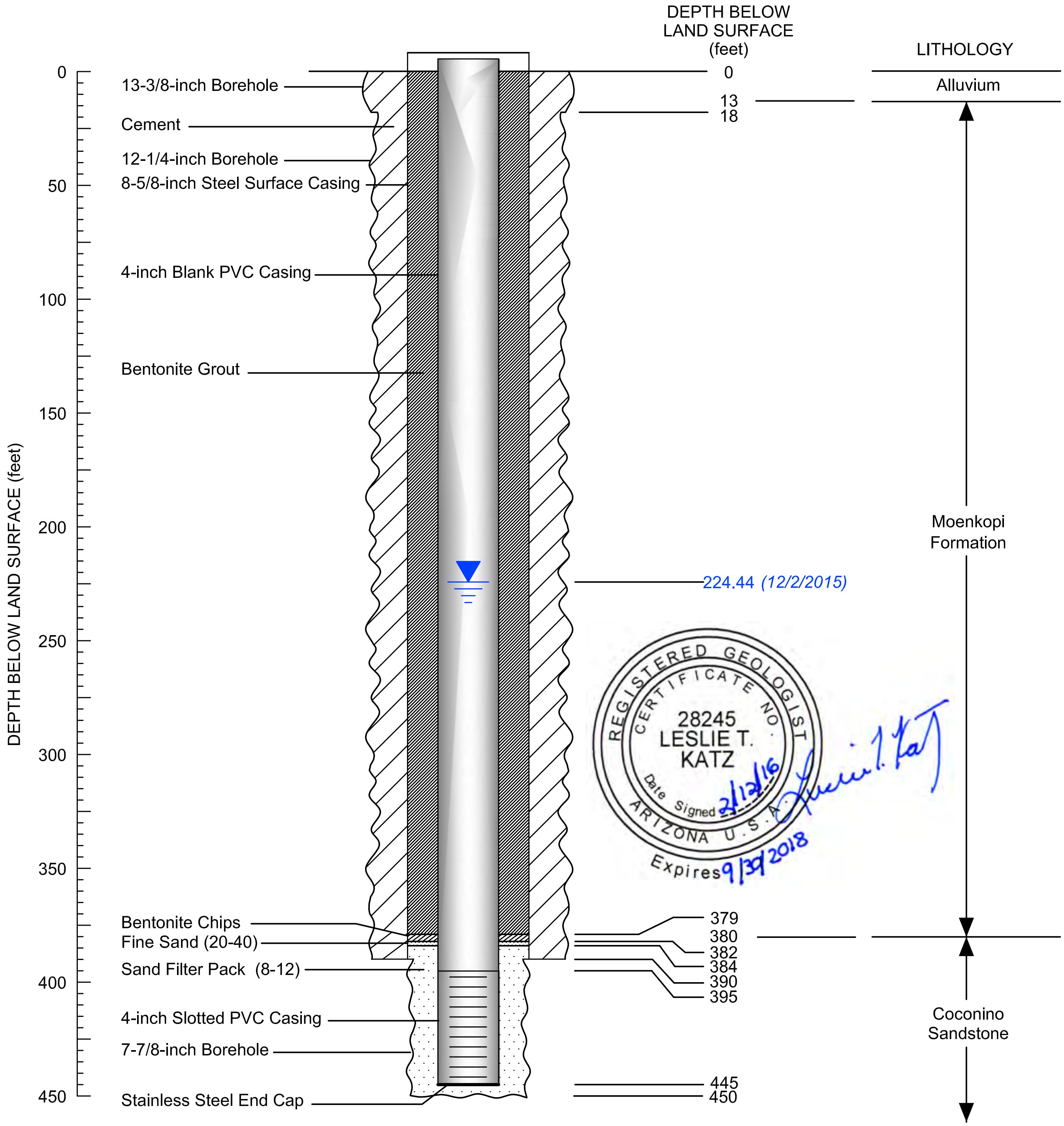
TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
280 - 290	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; trace gypsum; platy; reaction to acid: weak		subangular chips to 0.4 in
290 - 300	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 80% red brown siltstone; 20% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.4 in
300 - 310	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; platy; reaction to acid: moderate		subangular chips to 0.8 in
310 - 320	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.8 in
320 - 330	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], reddish gray [2.5YR6/1]; moderately to well lithified; 90% red brown siltstone; 10% gray fine-grained sandstone; reaction to acid: weak		subangular chips to 0.4 in
330 - 340	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], reddish gray [2.5YR6/1]; moderately to well lithified; 80% red brown siltstone; 20% gray to blue gray fine-grained sandstone; reaction to acid: weak		subangular chips to 0.4 in
340 - 350	**TRm**	sandy siltstone; reddish brown [2.5YR4/4]; well lithified; Red brown fine- to medium-grained sandstone; reaction to acid: weak		subrounded chips to 0.2 in
350 - 360	**TRm**	sandy siltstone; reddish brown [2.5YR4/4]; well lithified; Red brown fine- to medium-grained sandstone; reaction to acid: weak		subrounded chips to 0.6 in
360 - 370	**TRm**	sandy siltstone; light brown [5YR5/6], dark reddish brown [2.5YR3/4]; moderately to well lithified; 60% brown fine-grained sandstone; 40% dark red brown siltstone; reaction to acid: none		subrounded-subangular chips to 0.6 in
370 - 378	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; moderately to well lithified; Dark red brown very fine- to fine-grained sandstone; reaction to acid: none		subangular chips to 0.4 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
378 - 380	**TRm**	sandy siltstone; gray [5YR6/1]; moderately to well lithified; Grayish tan very fine- to fine-grained sandstone; reaction to acid: none		subangular chips to 0.6 in
PERMIAN COCONINO SANDSTONE (Pc)				
380 - 390	**Pc**	fine sandstone; pale yellow [2.5Y7/3]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		pulverized very fine-fine sand size chips
390 - 400	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		mostly pulverized very fine-fine sand size
400 - 410	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		rounded chips to 0.1 in
410 - 420	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		mostly pulverized very fine-fine sand size chips
420 - 430	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		rounded chips to 0.1 in
430 - 440	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		mostly pulverized very fine-fine sand size
440 - 450	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		rounded chips to 0.1 in



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-60 (BAM-3D)	NORTHING: 1441947.89
REGISTRATION: 55-918649	EASTING: 664249.99
COUNTY: Navajo, Arizona	MP Elevation: 5151.175 feet amsl
DATE COMPLETED: 11/1/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-60 APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 420.0 feet / 5124.949 feet msl	DATE DRILLED: 11/2 - 11/17/2015
CADASTRAL / NAD83 : (A-18-19)13bca / 1441383.546 N / 664047 E	

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 5	**Qal**	alluvium; pink [7.5YR7/3]; non-lithified; 60% fine to coarse-grained sand; 20% rounded to subrounded gravel, up to 2.4 in., consisting of sandstone and chert; 20% low plasticity silt; reaction to acid: moderate		ARCH, Air Rotary
TRIASSIC MOENKOPI FORMATION (TRm)				
5 - 10	**TRm**	sandy siltstone; reddish brown [2.5YR4/3], light blue green [5BG6/6]; weakly to moderately lithified; 70% red brown sandy siltstone; 30% blue gray sandy siltstone; clayey cuttings; reaction to acid: moderate	weathered Moenkopi Fm.	subangular chips to 1.6 in
10 - 20	**TRm**	sandy siltstone; light blue green [5BG6/6], reddish brown [2.5YR4/3]; moderately lithified; 80% blue gray sandy siltstone; 20% red brown siltstone; reaction to acid: strong		subangular to subrounded chips to 0.8 in
20 - 30	**TRm**	sandy siltstone; light blue green [5BG6/6], reddish brown [2.5YR4/3]; moderately lithified; 80% blue gray sandy siltstone; 20% red brown siltstone; reaction to acid: strong		subangular to subrounded chips to 0.8 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; weakly lithified; red brown siltstone; reaction to acid: strong		subangular chips to 0.4 in
40 - 50	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; 60% red brown fine- to medium-grained sandstone; 40% red brown siltstone; reaction to acid: weak		subrounded to subangular chips to 0.4 in
50 - 60	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; reddish gray fine- to medium-grained sandstone; reaction to acid: weak		subrounded to subangular chips to 0.4 in
60 - 70	**TRm**	sandy siltstone; olive gray [5Y4/2]; moderately to well lithified; olive gray fine- to medium-grained sandstone; reaction to acid: moderate		subrounded to subangular chips to 0.4 in
70 - 80	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; dark red gray fine- to medium-grained sandstone; reaction to acid: weak		subrounded to subangular chips to 0.4 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
80 - 90	**TRm**	sandy siltstone; reddish brown [2.5YR4/3], light blue green [5BG6/6]; moderately to well lithified; 80% dark red gray / blue gray fine- to medium-grained sandstone; 20% blue gray siltstone; reaction to acid: weak		round to subangular chips to 0.8 in
90 - 100	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; weakly to moderately lithified; red brown sandy siltstone; reaction to acid: weak		subangular chips to 0.4 in
100 - 110	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], weak red [2.5YR4/2]; moderately to well lithified; 50% red brown siltstone; 50% dark red gray fine- to medium-grained sandstone; reaction to acid: weak		subangular to angular chips to 0.8 in
110 - 120	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately to well lithified; 50% dark red brown fine- to medium-grained sandstone; 40% red brown sandy siltstone; 10% blue gray siltstone; reaction to acid: strong		subangular to subrounded chips to 0.4 in
120 - 130	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; reaction to acid: strong		subangular chips to 0.4 in
130 - 140	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 60% red brown to red gray siltstone; 40% blue gray siltstone; reaction to acid: strong		subangular chips to 0.4 in
140 - 150	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 15% blue gray siltstone; 5% gypsum; reaction to acid: moderate		subrounded to subangular chips to 0.4 in
150 - 160	**TRm**	sandy siltstone; weak red [2.5YR4/2]; well lithified; dark gray fine- to medium-grained sandstone; reaction to acid: moderate		subrounded chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; trace gypsum; platy siltstone; reaction to acid: moderate		subangular chips to 0.6 in
170 - 180	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; moderately lithified; 90% red brown siltstone; 10% blue gray sandy siltstone; platy; reaction to acid: moderate		subangular chips to 0.6 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

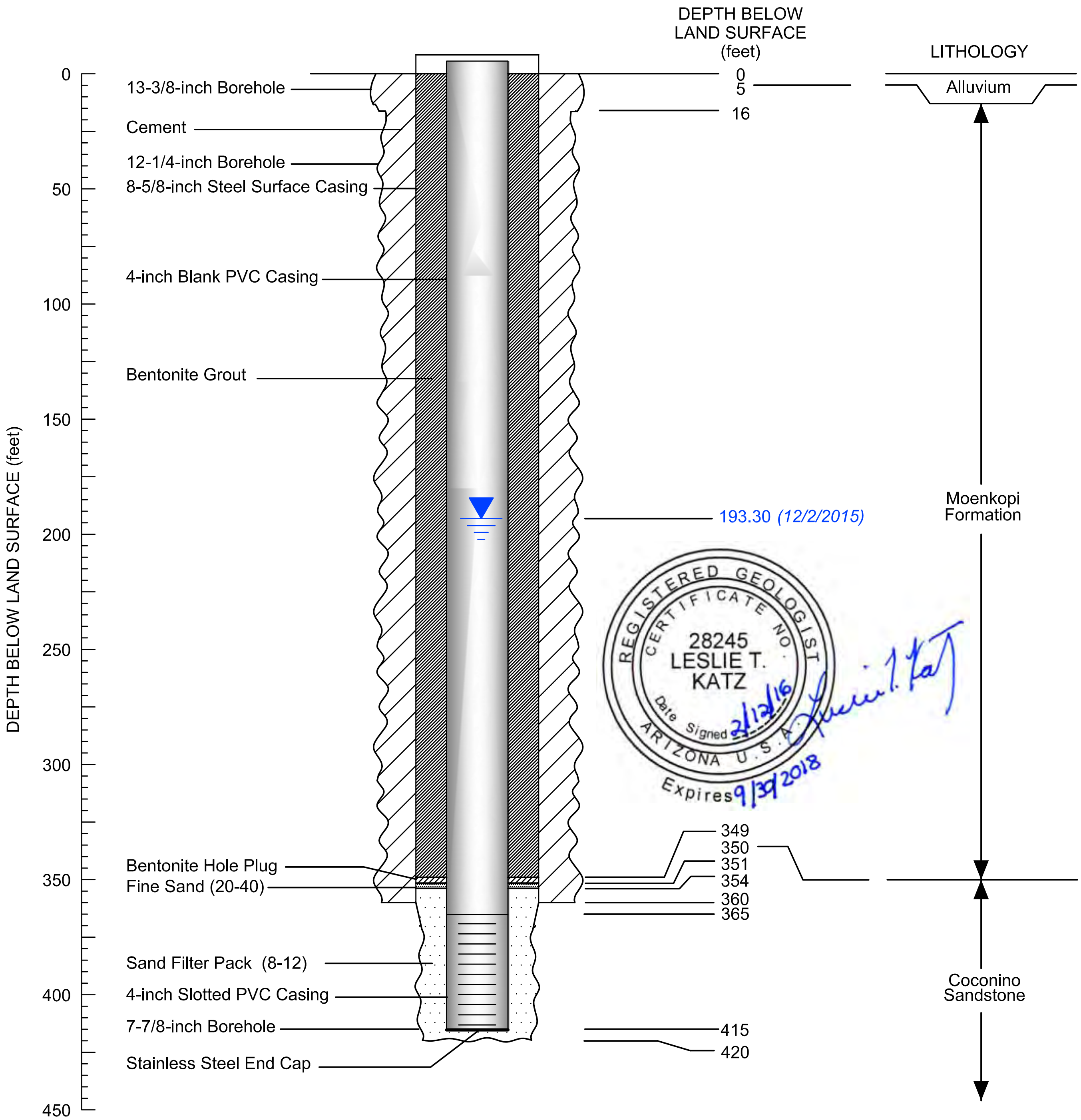
DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
180 - 190	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 60% red brown siltstone; 40% blue gray siltstone; trace gypsum; reaction to acid: moderate		subangular chips to 0.4 in
190 - 200	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 50% red brown siltstone; 50% blue gray siltstone; trace gypsum; platy; reaction to acid: moderate		subangular chips to 0.4 in
200 - 210	**TRm**	sandy siltstone; weak red [2.5YR4/2]; well lithified; dark red brown fine-grained sandstone; trace gypsum; reaction to acid: moderate		subrounded to subangular chips to 0.6 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: moderate		subangular chips to 0.6 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 20% blue gray siltstone; trace gypsum; reaction to acid: moderate		
230 - 240	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 75% red brown siltstone; 20% blue gray siltstone; 5% gypsum needle crystals; platy; reaction to acid: strong		subangular chips to 0.4 in
240 - 250	**TRm**	sandy siltstone; light blue green [5BG6/6], dark reddish brown [2.5YR3/4]; moderately lithified; 60% blue gray siltstone; 40% red brown siltstone; trace gypsum; reaction to acid: strong		subangular chips to 0.4 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 50% red brown siltstone; 25% blue gray siltstone; 20% blue gray fine-grained sandstone; 5% gypsum; reaction to acid: strong		subangular chips to 0.4 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray fine-grained sandstone; trace gypsum; reaction to acid: strong		subangular chips to 0.4 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
270 - 280	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], reddish gray [2.5YR6/1]; moderately to well lithified; 80% red brown siltstone; 20% gray fine-grained sandstone; reaction to acid: strong		subangular chips to 0.4 in
280 - 290	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], reddish gray [2.5YR6/1]; moderately to well lithified; 90% red brown siltstone; 10% gray fine-grained sandstone; reaction to acid: moderate		subangular chips to 0.6 in
290 - 300	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], reddish gray [2.5YR6/1]; moderately to well lithified; 90% red brown siltstone; 10% gray fine-grained sandstone; reaction to acid: moderate		subangular chips to 0.6 in
300 - 310	**TRm**	sandy siltstone; reddish brown [2.5YR4/3], light gray [2.5Y7/2], light blue green [5BG6/6]; moderately to well lithified; 50% red brown sandy siltstone; 40% light brown fine-grained sandstone; 10% blue gray fine-grained sandstone; reaction to acid: moderate		subangular to subrounded chips to 0.4 in
310 - 320	**TRm**	sandy siltstone; reddish brown [2.5YR4/3]; well lithified; red brown fine-grained sandstone; reaction to acid: none		subrounded chips to 0.3 in
320 - 330	**TRm**	sandy siltstone; reddish brown [2.5YR4/3]; well lithified; red brown fine-grained sandstone; reaction to acid: none		subrounded chips to 0.3 in
330 - 340	**TRm**	sandy siltstone; reddish brown [2.5YR4/3]; well lithified; red brown fine-grained sandstone; reaction to acid: none		subrounded chips to 0.4 in
340 - 348	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; well lithified; dark red brown fine- to very fine-grained sandstone; reaction to acid: none		subangular to subrounded chips to 0.4 in
348 - 350	**TRm**	sandy siltstone; gray [5YR6/1]; well lithified; grayish tan very fine- to fine-grained sandstone; reaction to acid: none		subangular chips to 0.6 in
PERMIAN COCONINO SANDSTONE (Pc)				
350 - 360	**Pc**	fine sandstone; pale yellow [2.5Y7/3]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		mostly pulverized, very fine to fine sand size; round chips to 0.3 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
360 - 370	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
370 - 380	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
380 - 390	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		mostly pulverized, very fine to fine sand size; round chips to 0.1 in
390 - 400	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
400 - 410	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
410 - 420	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-61 (BAM-2D)	NORTHING: 1441383.55
REGISTRATION: 55-918648	EASTING: 664047.00
COUNTY: Navajo, Arizona	MP Elevation: 5127.577 feet amsl
DATE COMPLETED: 11/13/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-61 APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 **DATE** 1-18-12 to 1-20-12

LOCATION N1434626.0 W658682.2
RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 6" & 8" Casing
SURFACE ELEV. 5020.34'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL	slightly moist	**Little Colorado River Alluvium** **CLAY,** medium to high plasticity, dark brown
								SP	slightly moist	**SAND,** fine grained, subangular to subrounded, uncemented, nonplastic, light brown
5				A						
				A						
								CL with SP zones	slightly moist	**CLAY WITH SAND ZONES,** fine grained sand zones up to 2' thick, medium to high plasticity, dark brown with light brown zones note: ring sample pushed with rig
10				A						
				A						
15				A						
				A						
20				A						
				A						
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1500	1-18-12
▼	38.0	0740	1-19-12
▼	38.1	0750	1-21-12
▼			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 **DATE** 1-18-12 to 1-20-12

LOCATION	N1434626.0 W658682.2
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	6" & 8" Casing
SURFACE ELEV.	5020.34'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				U A				CL	slightly moist	**CLAY WITH SAND ZONES,** continued
				A						
30				A						
				A						
35				U A						
				A						
40				A				SP with GP zones	very moist to wet	**SAND WITH GRAVEL ZONES,** some zone with considerable silt, predominantly fine grained sand with coarse grained, subrounded gravel zones, uncemented, weakly to moderately well stratified, nonplastic, light brown note: fine to medium grained sand with occasional coarse grained zones below 42'
				A						
45				A						
				A						
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1500	1-18-12
▼	38.0	0740	1-19-12
▼	38.1	0750	1-21-12
▼			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 1-18-12 to 1-20-12

LOCATION N1434626.0 W658682.2
RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 6" & 8" Casing
SURFACE ELEV. 5020.34'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				U				SP	wet	**SAND WITH GRAVEL ZONES,** continued, predominantly fine to medium grained sand with rare coarse grained zones; predominantly coarse grained, subrounded gravel, uncemented, nonplastic, light brown to brown
				A						
				A						
55				U	NR					
				A						
				A						
60				U						
				A						
				A						
65				A						
				A						
70				A						
				A						
75										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1500	1-18-12
▼	38.0	0740	1-19-12
▼	38.1	0750	1-21-12
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 1-18-12 to 1-20-12

LOCATION	N1434626.0 W658682.2
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	6" & 8" Casing
SURFACE ELEV.	5020.34'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				A				SP	wet	**SAND WITH GRAVEL ZONES,** continued
				A						note: rare small cobble below 77'6"
80				A						
				A						
85				A						
				A						
90				A						
				A						
95				A						
				A						
100										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
40.0	1500	1-18-12
38.0	0740	1-19-12
38.1	0750	1-21-12

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 1-18-12 to 1-20-12

LOCATION N1434626.0 W658682.2

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 6" & 8" Casing
SURFACE ELEV. 5020.34'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
100				A				SP	wet	**SAND WITH GRAVEL ZONES,** continued
										note: well stratified in zones below 100'
										note: rare thin clay zone
				A						note: high plasticity clay zone from 100' to 101'
105				A						note: predominantly medium to coarse grained sand with some predominantly coarse grained, subangular to subrounded gravel from 105' to 112'6"
				A						
110				A						
				A						note: predominantly fine grained sand from 112'6" to 125'
115				A						
				A						
120				A						
				A						
125										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1500	1-18-12
▼	38.0	0740	1-19-12
▽	38.1	0750	1-21-12
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 1-18-12 to 1-20-12

LOCATION	N1434626.0 W658682.2
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	6" & 8" Casing
SURFACE ELEV.	5020.34'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
125				A				SP	wet	**SAND WITH GRAVEL ZONES,** continued note: considerable medium to coarse grained sand with some predominantly coarse grained subrounded gravel from 125' to 145'
				A						
130				A						note: advancing 6" casing with 4" core due to heaving sand
				A						
135				A						
				A						
140				A						
				A						
145				A						
				A						
150										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
40.0	1500	1-18-12
38.0	0740	1-19-12
38.1	0750	1-21-12

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

JOB NO. 17-2011-4054 **DATE** 1-18-12 to 1-20-12

LOCATION N1434626.0 W658682.2
RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 6" & 8" Casing
SURFACE ELEV. 5020.34'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
150				A				SP	wet	**SAND WITH GRAVEL ZONES,** continued, predominantly medium to coarse grained, subangular to subrounded sand & well graded, predominantly subrounded gravel, uncemented, nonplastic, brown
				A						
155				A						
				A						
160				A						
		+ +		A						**Moenkopi Formation - Moqui Member** **CALCAREOUS MUDSTONE,** fine grained, moderately to highly weathered, thinly bedded, soft to very soft (161'6" to 180') with some moderately soft zones below 180', dark to light reddish-brown with some grayish-green zones below 180' note: gypsum in zones
165		+ +		A						
		+ +		A						
170		+ +		A						
		+ +		A						
175										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1500	1-18-12
▼	38.0	0740	1-19-12
▼	38.1	0750	1-21-12
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 1-18-12 to 1-20-12

LOCATION	N1434626.0 W658682.2
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	6" & 8" Casing
SURFACE ELEV.	5020.34'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
175		+ +		A					wet	**Moenkopi Formation - Moqui Member** **CALCAREOUS MUDSTONE,** continued
				A						
180				A						
				A						
										Stopped Drilling at 184' Installed 4-inch diameter Schedule 40 PVC monitor well
185										
190										
195										
200										

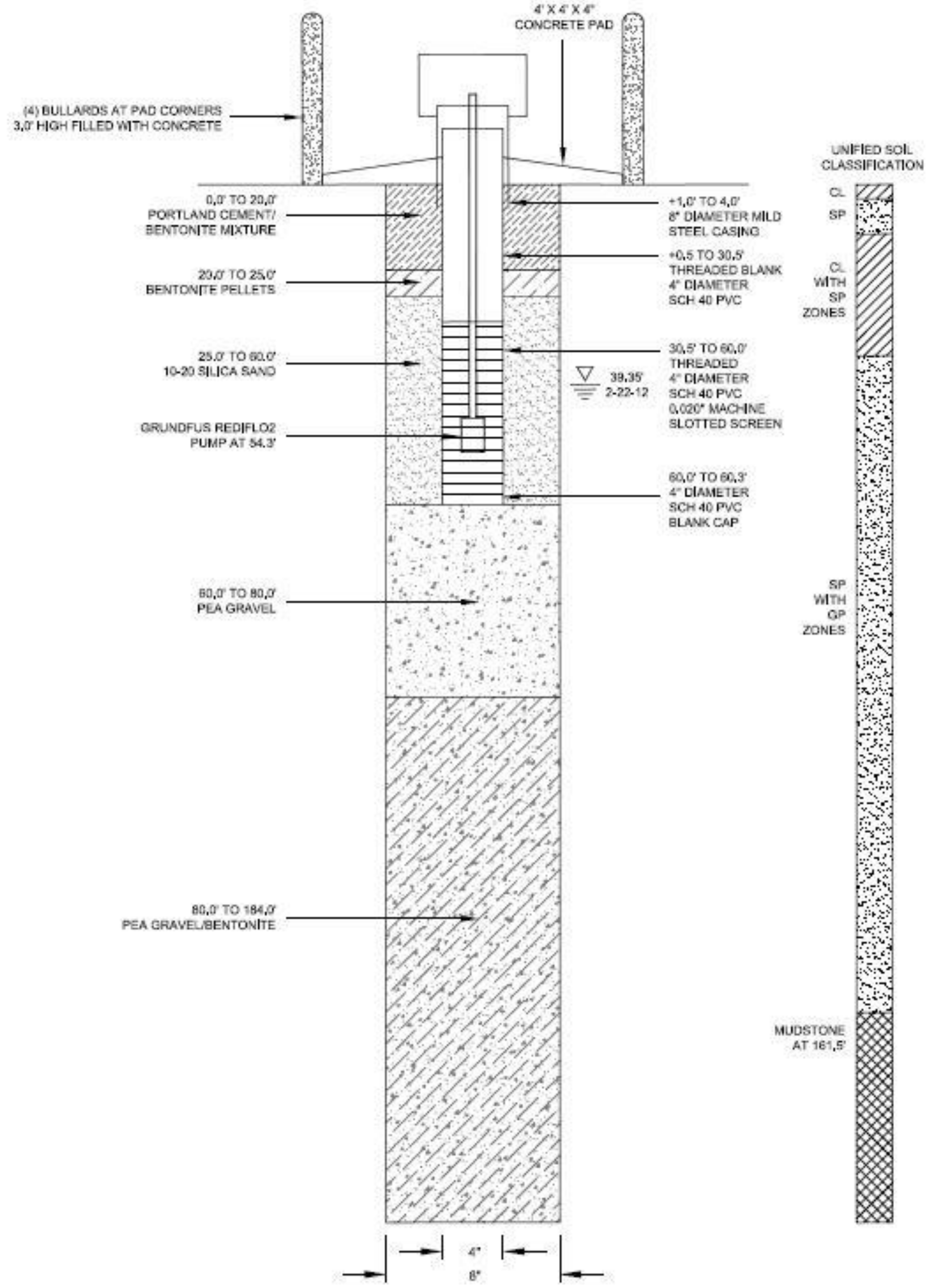
GROUNDWATER

DEPTH(ft)	HOUR	DATE
40.0	1500	1-18-12
38.0	0740	1-19-12
38.1	0750	1-21-12

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-47A



JOB NO.	17-2011-4054
DESIGN:	MAK
DRAWN:	GWH
DATE:	3/2012
SCALE:	NOT TO SCALE

MONITOR WELL M-47A
ADWR REGISTRATION NO. 55-913984

ARIZONA PUBLIC SERVICE - CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

amec
Environment & Infrastructure
4600 East Washington Street, Suite 600
Phoenix, Arizona

TABLE A-3. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-52A [*55-918657*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 38.0 feet / 5047.080 feet msl	DATE DRILLED: 9/21 - 9/22/2015
CADASTRAL / NAD83 : (A-18-19)24bbc / 1437475.711 N / 663614.281 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded, fine to medium sand 65%, silt and clay 30%, gravel 5%. Gravel fraction: gravel to 0.6 in. consisting of multicolored chert. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded, fine to medium sand 65%, silt and clay 30%, gravel 5%. Gravel fraction: gravel to 0.4 in. consisting of multicolored chert. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: strong.
10.0 - 15.0	**Qal**	**SILTY GRAVEL WITH SAND (GM)**: Reddish brown [5YR4/3]; gravel 50%, subangular to rounded, fine to coarse sand 30%, silt and clay 20%. Gravel fraction: gravel to 0.9 in. consisting of multicolored chert. Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 55%, gravel 30%, silt and clay 15%. Gravel fraction: gravel to 0.8 in. consisting of multicolored chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 65%, gravel 25%, silt and clay 10%. Gravel fraction: gravel to 0.7 in. consisting of multicolored chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Dark reddish gray [5YR4/2]; subangular to rounded fine sand 65%, gravel 25%, silt and clay 10%. Gravel fraction: gravel to 0.9 in. consisting of multicolored chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.4 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 80%, gravel 10%, silt and clay 10%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.4 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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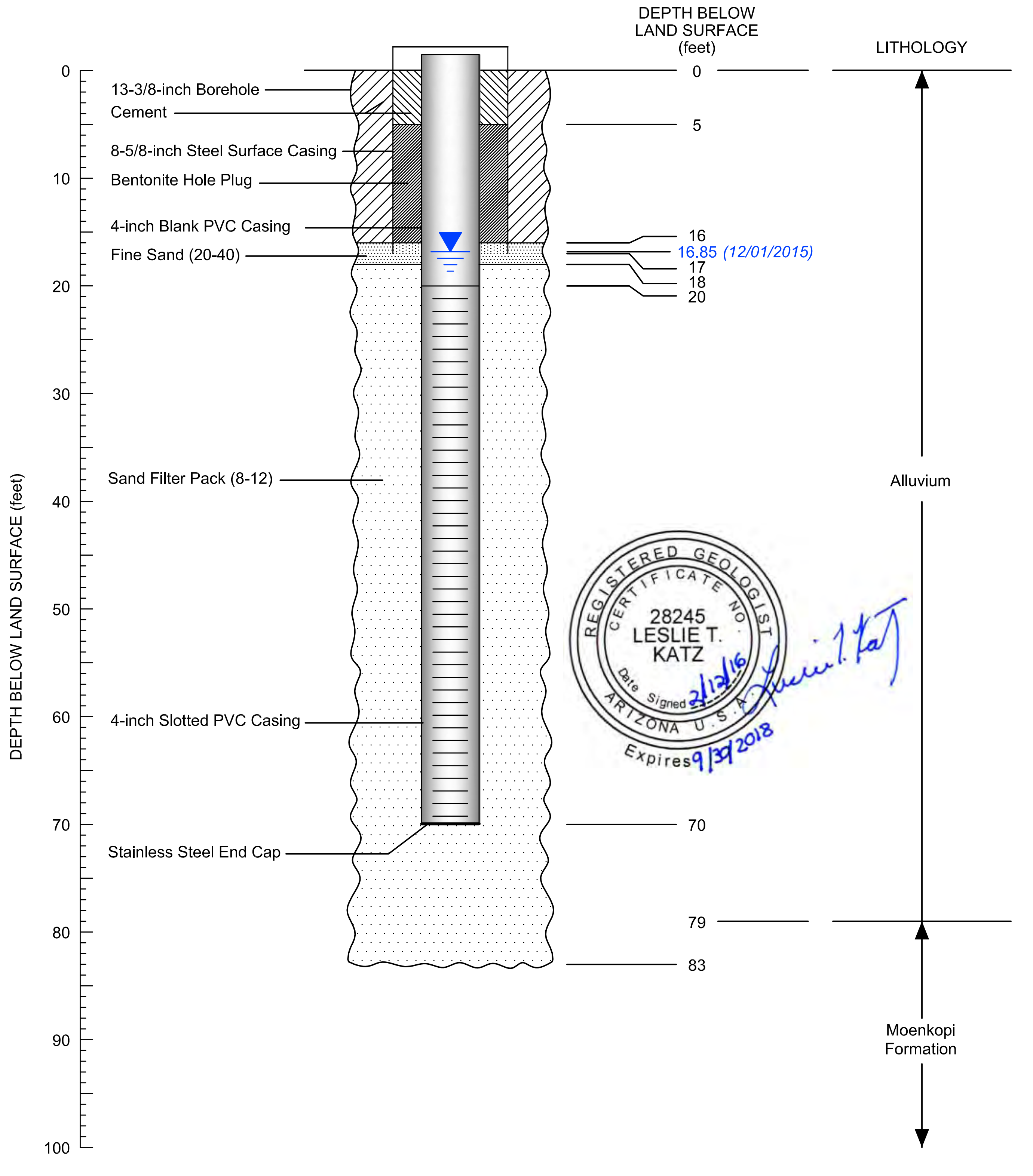
TABLE A-3. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-52A [*55-918657*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.6 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.3 in. consisting of chert, fine grained brown sandstone, and trace siltstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Moderate brown [5YR4/4]; angular to rounded fine sand 65%, gravel 25%, silt and clay 10%. Gravel fraction: gravel to 2.3 in. consisting of fine grained brown sandstone, green sandy siltstone, and trace chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
65.0 - 70.0	**Qal**	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**: Moderate brown [5YR4/4]; gravel 60%, angular to rounded fine sand 30%, silt and clay 10%. Gravel fraction: gravel to 2.6 in. consisting of chert, fine grained brown sandstone, and green sandy siltstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
70.0 - 75.0	**Qal**	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**: Moderate brown [5YR4/4]; gravel 70%, angular to rounded fine sand 20%, silt and clay 10%. Gravel fraction: gravel to 0.6 in. consisting of fine grained brown sandstone, red and green sandy siltstone, and trace chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
75.0 - 79.0	**Qal**	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**: Moderate brown [5YR4/4]; gravel 70%, angular to rounded fine sand 20%, silt and clay 10%. Gravel fraction: gravel to 1.4 in. consisting of fine grained brown sandstone, red and green sandy siltstone, and trace chert. Non-lithified to moderately lithified. Low to medium plasticity. Well graded. Reaction to acid: weak to moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
79.0 - 83.0	**TRm**	**SANDSTONE AND SILTSTONE**: Moderate brown [5YR4/4]; Weakly to moderately lithified. Reaction to acid: weak to moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.



EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-52A (BAP-2D)	NORTHING: 1437475.71
REGISTRATION: 55-918657	EASTING: 663614.28
COUNTY: Navajo, Arizona	MP Elevation: 5049.363 feet amsl
DATE COMPLETED: 09/21/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-52A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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TABLE A-4. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-53A [*55-918651*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 83.0 feet / 5042.094 feet msl	DATE DRILLED: 9/21 - 9/22/2015
CADASTRAL / NAD83 : (A-18-19)23aab / 1437605.112 N / 662529.371 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 60%, silt and clay 25%, gravel 15%. Gravel fraction: gravel to 1.2 in. consisting of chert and black rock (fill). Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
5.0 - 10.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 60%, silt and clay 25%, gravel 15%. Gravel fraction: gravel to 0.7 in. consisting of chert and black rock (fill). Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
10.0 - 15.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 80%, gravel 10%, silt and clay 10%. Gravel fraction: gravel to 1.2 in. consisting of chert and black rock (fill). Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR4/3]; gravel 80%, subangular to rounded fine sand 15%, silt and clay 5%. Gravel fraction: gravel to 0.8 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 75%, gravel 15%, silt and clay 10%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 70%, gravel 20%, silt and clay 10%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
30.0 - 34.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR4/3]; gravel 70%, subangular to rounded fine sand 25%, silt and clay 5%. Gravel fraction: gravel to 0.9 in. consisting of chert, fine grained brown sandstone, and reddish-brown and green siltstone. Non-lithified to moderately lithified. Low plasticity. Well graded. Reaction to acid: moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
34.0 - 38.0	**TRm**	**FINE GRAINED SANDSTONE AND SILTSTONE**: Moderate brown [5YR4/4]; Moderately to well lithified. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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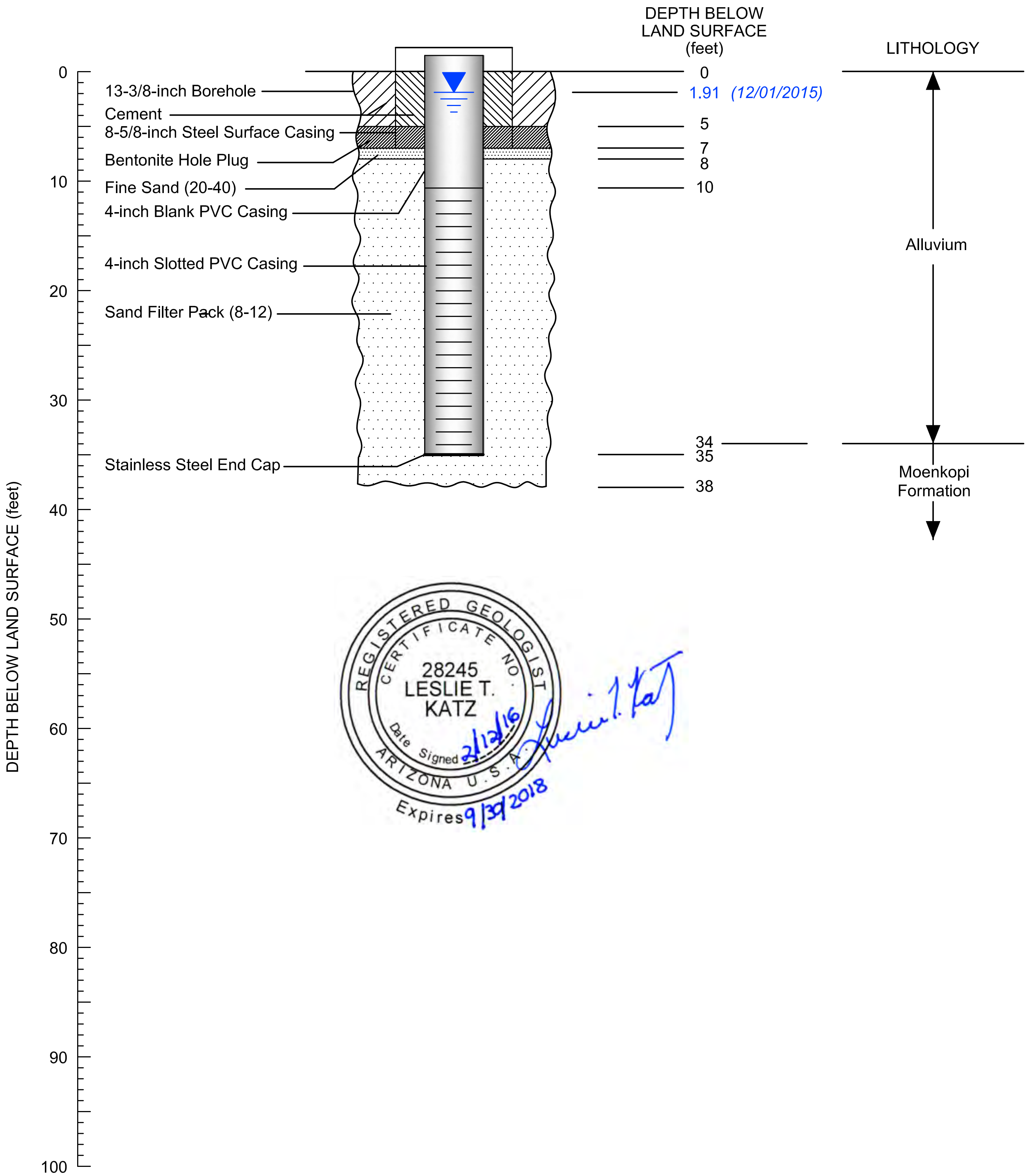

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-53A (BAP-1D)	NORTHING: 1437605.11
REGISTRATION: 55-918651	EASTING: 662529.37
COUNTY: Navajo, Arizona	MP Elevation: 5044.677 feet amsl
DATE COMPLETED: 09/22/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-53A APS CHOLLA POWER PLANT

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2016

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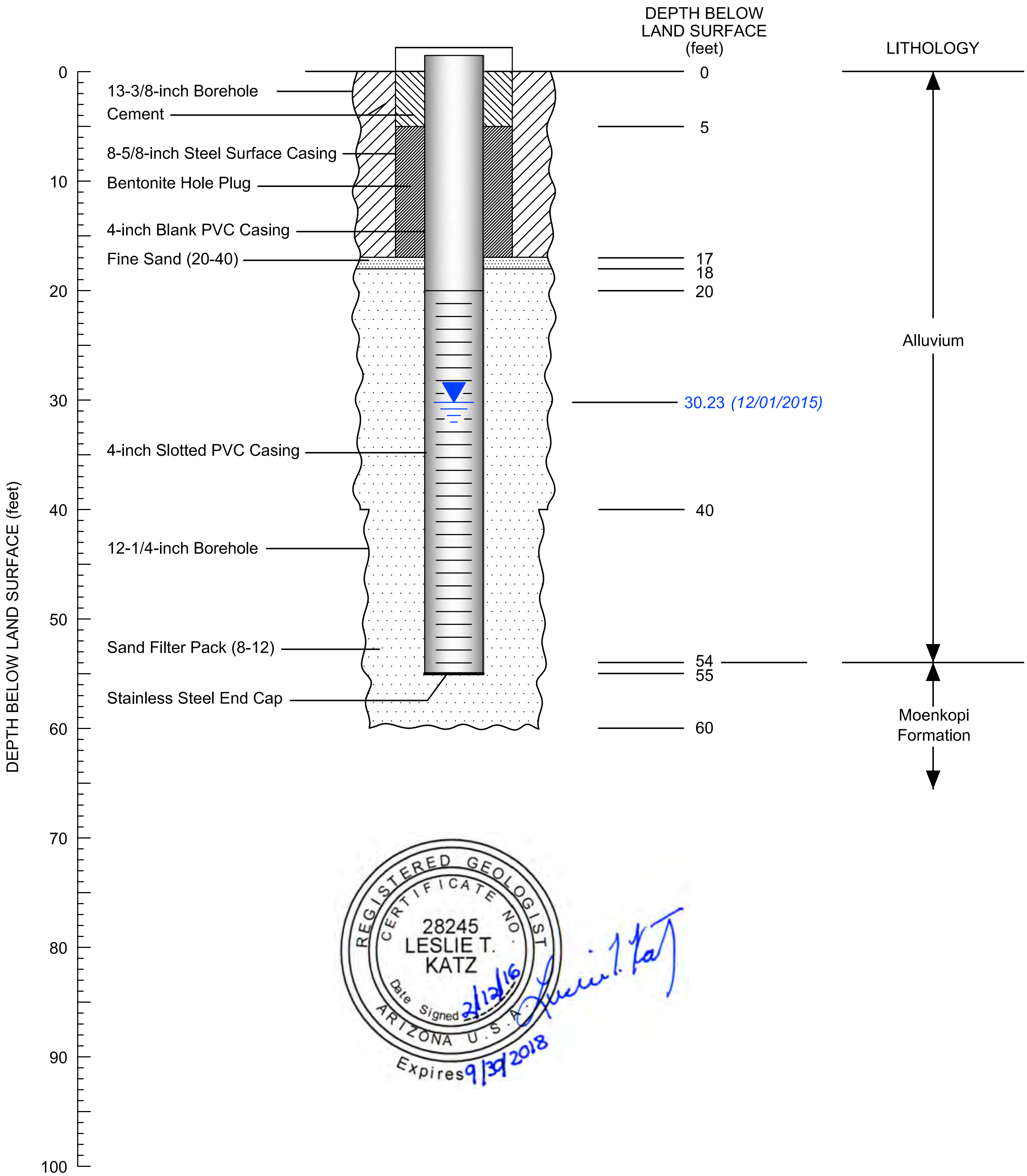

EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-55A (TW-1U)	NORTHING: 1438730.73
REGISTRATION: 55-918701	EASTING: 667934.10
COUNTY: Navajo, Arizona	MP Elevation: 5062.824 feet amsl
DATE COMPLETED: 10/03/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-55A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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TABLE A-07. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-55A [*55-918701*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING METHOD / COMPANY: ARCH / National Exploration Wells Pumps	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 60.0 feet / 5060.058 feet msl	DATE DRILLED: 10/3/2015
CADASTRAL / NAD83 : (A-18-19)13ddb / 1438730.732 N / 667934.101 E	BOREHOLE DIAMETER: 13 3/8 inches

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 60%, silt and clay 40%, trace gravel. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
5.0 - 10.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Brown [7.5YR5/2]; subangular fine sand 70%, gravel 15%, silt and clay 15%. Gravel fraction: angular to rounded gravel to 1.2 in. consisting of chert. Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
10.0 - 15.0	**Qal**	**WELL GRADED GRAVEL (GW)**: Brown [7.5YR4/2]; gravel 80%, subangular fine sand 15%, silt and clay 5%. Gravel fraction: angular to rounded gravel to 1.3 in. consisting of chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: weak to moderate.
15.0 - 20.0	**Qal**	**WELL GRADED GRAVEL (GW)**: Dark reddish gray [5YR4/2]; gravel 80%, subangular fine sand 15%, silt and clay 5%. Gravel fraction: angular to rounded gravel to 1 in. consisting of chert. Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate to strong.
20.0 - 25.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 55%, silt and clay 45%, trace gravel. Gravel fraction: angular to rounded gravel to 0.7 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
25.0 - 30.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 50%, silt and clay 50%, trace gravel. Gravel fraction: angular to rounded gravel to 0.2 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
30.0 - 35.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 50%, silt and clay 40%, gravel 10%. Gravel fraction: angular to rounded gravel to 0.3 in. consisting of fine dark gray sandstone and chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
35.0 - 40.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 50%, silt and clay 40%, gravel 10%. Gravel fraction: angular to rounded gravel to 0.4 in. consisting of fine dark gray sandstone and chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
40.0 - 45.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 40%, silt and clay 40%, gravel 20%. Gravel fraction: subrounded to rounded gravel to 0.6 in. consisting of fine dark gray sandstone and chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

MONTGOMERY & ASSOCIATES

TABLE A-07. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-55A [*55-918701*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**POORLY GRADED GRAVEL WITH SAND (GP)**: Dark reddish gray [5YR4/2]; gravel 75%, subangular fine sand 20%, silt and clay 5%. Gravel fraction: subrounded to rounded gravel to 0.6 in. consisting of fine dark gray sandstone and trace chert. Moderately lithified. Low plasticity. Well graded. Reaction to acid: moderate to strong.
50.0 - 54.0	**Qal**	**POORLY GRADED GRAVEL WITH SAND (GP)**: Dark reddish gray [5YR4/2]; silt 90%, subangular fine sand 10%, trace gravel. Gravel fraction: subrounded to rounded gravel to 0.8 in. consisting of fine dark gray sandstone and trace chert. Moderately to well lithified. Non-plastic. Reaction to acid: moderate to strong.
TRIASSIC MOENKOPI FORMATION (TRm)		
54.0 - 60.0	**TRm**	**FINE SANDSTONE**: Dark reddish gray [5YR4/2]; 100%, trace sand. Well lithified. Reaction to acid: moderate to strong.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

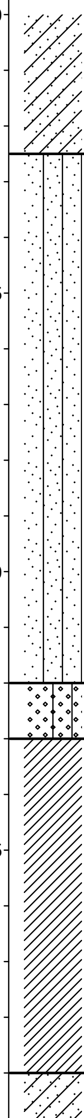
MONTGOMERY & ASSOCIATES

wood.

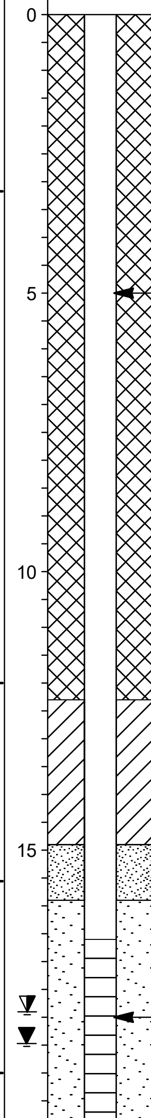
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-69A

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	D. Andersen	**PROJECT FEATURE:**	Bottom Ash Pond
DRILLER:	C. Patterson	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-923618
RIG I.D.:	SR-112	**STATION/OFFSET:**	N/A
RIG TYPE:	Sonic	**REFERENCE:**	N/A
BORING TYPE:	N/A; **BORING DIA.:** 9"	**COORDINATES:**	N1437462.107, E663637.500
ORIENTATION:	90°	**COORDINATE SYS:**	NAD83
HAMMER TYPE:	N/A	**SURFACE ELEV. (FT):**	5049.25
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**VERTICAL DATUM:**	NAVD88
START DATE:	11/18/2019; **START TIME:** 10:58	**COMPLETION DATE:**	11/18/2019; **COMPLETION TIME:** 12:17



Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
5049.3	0			SC	**SILTY SAND WITH GRAVEL,** 60% fine to medium grained, subrounded to subangular sand, 25% medium to coarse grained, rounded to subrounded chert gravel, 15% low plasticity fines, uncemented, moderate reaction with HCl, 7.5 YR 6/3 (light brown), dry
				SM	**SILTY SAND,** 65% fine to medium grained, subrounded to subangular sand, 30% low plasticity fines, 5% fine to medium grained, rounded to subrounded gravel, uncemented, moderate reaction to HCl, 7.5 YR 6/3 (light brown), dry
5044.3	5				
5039.3	10				
				SW-SM	**WELL GRADED SAND WITH SILT AND GRAVEL,** 60% fine to medium grained, subrounded to subangular sand, 30% fine to medium grained, subrounded to rounded chert gravel, 10% low plasticity fines, uncemented, moderate reaction with HCl, 7.5YR 6/3 (light brown), moist
				CL	**LEAN CLAY WITH SAND,** 80% medium plasticity fines, 20% fine to medium grained, subrounded to subangular sand, uncemented, moderate reaction with HCl, 5YR 4/3 (reddish-brown), wet at 16'
5034.3	15				
				SC	**CLAYEY SAND WITH GRAVEL**
5029.3	20				



WELL INFORMATION (Construction Details and/or Drilling Remarks)

- 6" Concrete pad at surface
- Neat Cement Grout From 0.0 to 12.3'
- 3" Nominal Diameter Flush Threaded Schedule 80 PVC Blank Casing From +2.0' to 16.6'
- Bentonite Hole Plug From 12.3' to 14.9'
- Transition Sand 20/40 Silica Sand From 14.9' to 15.9'
- Filter Pack 12/20 Silica Sand From 15.9' to 27.0'
- 3" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 16.6' to 26.6'

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	21.5	- - -	11/20/19
▼	18.5	- - -	11/21/19
▼	17.9	- - -	11/23/19
▼			

METHOD N/A

(Continued Next Page)

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923618	**PROJECT FEATURE:**	Bottom Ash Pond

Elevation in Feet	Depth in Feet	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5029.3	20	SC	**CLAYEY SAND WITH GRAVEL,** 45% fine and medium grained, subrounded to subangular sand, 35% fine and medium grained, subrounded to rounded chert gravel, 20% medium plasticity fines, uncemented, moderate reaction with HCl, 5YR 4/3 (reddish-brown), wet, fining up sequence with chert gravel layer at 25'	(Continued) Filter Pack 12/20 Silica Sand From 15.9' to 27.0' 3" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 16.6' to 26.6'
5024.3	25	CL	**LEAN CLAY WITH SAND,** 70% medium plasticity fines, 25% fine and medium grained, subrounded to subangular sand, 5% fine grained, rounded chert gravel, uncemented, no HCL reaction, 5 YR 4/3 (reddish-brown), wet	End Cap
		SC	**CLAYEY SAND WITH GRAVEL,** 50% fine and medium grained, subrounded to subangular sand, 35% fine and coarse grained, rounded chert gravel, 15% medium plasticity fines, uncemented, moderate reaction with HCl, 5YR 4/3 (reddish-brown), wet, fining up sequence	
5019.3	30	CL	**LEAN CLAY WITH SAND,** 60% medium plasticity fines, 35% fine and medium grained, subrounded to subangular sand, 5% fine grained, rounded chert gravel, uncemented, no HCL reaction, 5 YR 4/3 (reddish-brown), wet	
5014.3	35		**MOQUI MEMBER OF THE MOENKOPI FORMATION,** highly weathered, brownish-red colored mudstone and claystone with sand-sized fragments of subangular and fine grained grayish-green colored siltstone, mudstone and claystone weathered to clay consistency, siltstone fragments present in clayey matrix, angular fragments of gypsum, weak reaction to HCl, wet	Bentonite Hole Plug From 27.0' to 52.0'
5009.3	40			
5004.3	45			

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	21.5	- - -	11/20/19
▼	18.5	- - -	11/21/19
▼	17.9	- - -	11/23/19
▼			

METHOD N/A

(Continued Next Page)

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-69A

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	PROJECT LOCATION:	APS Cholla Power Plant
ADWR REG. #:	55-923618	PROJECT FEATURE:	Bottom Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5004.3	45					**MOQUI MEMBER OF THE MOENKOPI FORMATION,** continued	45	(Continued)
								Bentonite Hole Plug From 27.0' to 52.0'
4999.3	50						50	
								Slough From 52.0' to 53.0'
						Total Depth = 53'		Total Depth = 53.0'
4994.3	55						55	
4989.3	60						60	
4984.3	65						65	
4979.3	70						70	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	21.5	- - -	11/20/19
▼	18.5	- - -	11/21/19
▽	17.9	- - -	11/23/19
▼			

METHOD N/A

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-70M

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	D. Andersen	**PROJECT FEATURE:**	Bottom Ash Pond
DRILLER:	C. Patterson	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-923582
RIG I.D.:	SR-112	**STATION/OFFSET:**	N/A
RIG TYPE:	Sonic	**REFERENCE:**	N/A
BORING TYPE:	N/A **BORING DIA.:** 9" to 7"	**COORDINATES:**	N1437468.038, E663648.643
ORIENTATION:	90°	**COORDINATE SYS:**	NAD83
HAMMER TYPE:	N/A	**SURFACE ELEV. (FT):**	5049.80
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**VERTICAL DATUM:**	NAVD88
START DATE:	11/20/2019 **START TIME:** 12:10	**COMPLETION DATE:**	11/21/2019 **COMPLETION TIME:** 10:42

Elevation in Feet	Depth in Feet	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
5049.8	0	SC	**SILTY SAND WITH GRAVEL,** 60% fine to medium grained, subrounded to subangular sand, 25% medium to coarse grained, rounded to subrounded chert gravel, 15% low plasticity fines, uncemented, moderate reaction with HCl, 7.5 YR 6/3 (light brown), dry
		SM	**SILTY SAND,** 65% fine to medium grained, subrounded to subangular sand, 30% low plasticity fines, 5% fine to medium grained, rounded to subrounded gravel, uncemented, moderate reaction to HCl, 7.5 YR 6/3 (light brown), dry
5044.8	5		
5039.8	10		
		SW-SM	**WELL GRADED SAND WITH SILT AND GRAVEL,** 60% fine to medium grained, subrounded to subangular sand, 30% fine to medium grained, subrounded to rounded chert gravel, 10% low plasticity fines, uncemented, moderate reaction with HCl, 7.5YR 6/3 (light brown), moist
		CL	**LEAN CLAY WITH SAND,** 80% medium plasticity fines, 20% fine to medium grained, subrounded to subangular sand, uncemented, moderate reaction w/ith HCl. 5YR 4/3 (reddish-brown), wet at 16'
5034.8	15		
		SC	**CLAYEY SAND WITH GRAVEL**
5029.8	20		

Graphical Log, Sample ID. or Date (Time), PID Meter Reading (ppm): no entries.

WELL INFORMATION (Construction Details and/or Drilling Remarks)

- 6" Concrete pad at surface
- Neat Cement Grout From 0.0 to 20.5'
- 3" Nominal Diameter Flush Threaded Schedule 80 PVC Blank Casing From +2.0' to 45.6'
- 9" Diameter Borehole From 0.0 to 26.5'

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	19.7	- - -	11/21/19
▼	19.1	- - -	11/22/19
▼			
▼			

METHOD N/A

(Continued Next Page)

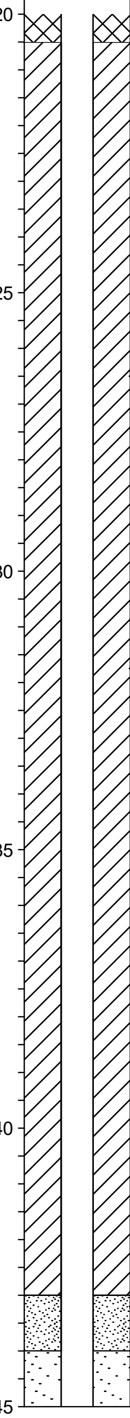
wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-70M

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923582	**PROJECT FEATURE:**	Bottom Ash Pond

Elevation in Feet	Depth in Feet	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
5029.8	20	SC	**CLAYEY SAND WITH GRAVEL,** 45% fine and medium grained, subrounded to subangular sand, 35% fine and medium grained, subrounded to rounded chert gravel, 20% medium plasticity fines, uncemented, moderate reaction with HCl, 5YR 4/3 (reddish-brown), wet, fining up sequence with chert gravel layer at 25'
5024.8	25	CL	**LEAN CLAY WITH SAND,** 70% medium plasticity fines, 25% fine and medium grained, subrounded to subangular sand, 5% fine grained, rounded chert gravel, uncemented, no HCL reaction, 5 YR 4/3 (reddish-brown), wet
		SC	**CLAYEY SAND WITH GRAVEL,** 50% fine and medium grained, subrounded to subangular sand, 35% fine and coarse grained, rounded chert gravel, 15% medium plasticity fines, uncemented, moderate reaction with HCl, 5YR 4/3 (reddish-brown), wet, fining up sequence
5019.8	30	CL	**LEAN CLAY WITH SAND,** 60% medium plasticity fines, 35% fine and medium grained, subrounded to subangular sand, 5% finegrained, rounded chert gravel, uncemented, no HCL reaction, 5 YR 4/3 (reddish-brown), wet
5014.8	35		**MOQUI MEMBER OF THE MOENKOPI FORMATION,** highly weathered, brownish-red colored mudstone and claystone with sand-sized fragments of subangular and fine grained, grayish-green colored siltstone, mudstone and claystone weathered to clay consistency, siltstone fragments present in clayey matrix, angular fragments of gypsum, weak reaction to HCl, wet with high water production at approximately 67', coarse grained, rounded gravels present at 67', □□ps□□ str□n□er at □7□'
5009.8	40		
5004.8	45		



WELL INFORMATION (Construction Details and/or Drilling Remarks)

(Continued)

7" Diameter Borehole From 26.5' to 77.5'

Bentonite Hole Plug From 20.5' to 43.0'

Transition Sand 20/40 Silica Sand From 43.0' to 44.0'

Filter Pack 12/20 Silica Sand From 44.0' to 76.0'

(Continued Next Page)

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
∇	19.7	- - -	11/21/19
▼	19.1	- - -	11/22/19

METHOD N/A

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-70M

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923582	**PROJECT FEATURE:**	Bottom Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5004.8	45					**MOQUI MEMBER OF THE MOENKOPI FORMATION,** continued	45	(Continued)
								3" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 45.6' to 75.6'
4999.8	50						50	
4994.8	55						55	Filter Pack 12/20 Silica Sand From 44.0' to 76.0'
4989.8	60						60	
4984.8	65						65	
4979.8	70						70	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	19.7	- - -	11/21/19
▼	19.1	- - -	11/22/19
▼			
▼			

METHOD N/A

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-70M

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923582	**PROJECT FEATURE:**	Bottom Ash Pond

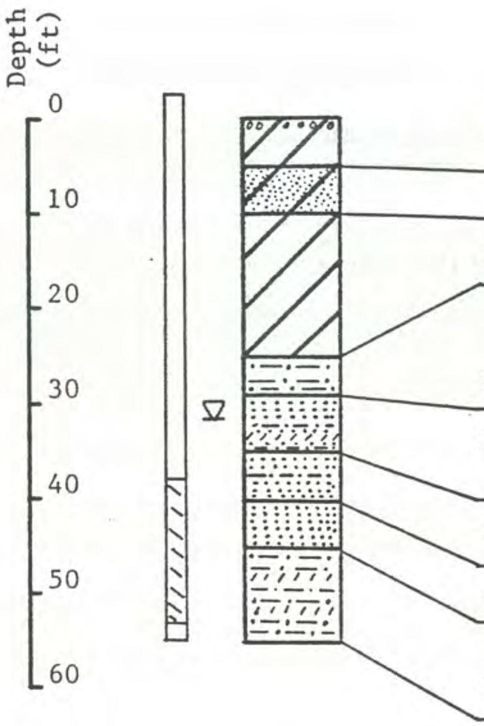
Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
4979.8	70					**MOQUI MEMBER OF THE MOENKOPI FORMATION,** continued	70	(Continued)
								3" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 45.6' to 75.6'
						MOQUI MEMBER OF THE MOENKOPI FORMATION, competent, unweathered, brownish-red colored mudstone and claystone interbedded with grayish-green colored siltstone, weak reaction to HCl, dry		Filter Pack 12/20 Silica Sand From 44.0' to 76.0'
4974.8	75						75	End Cap
								Slough From 76.0' to 77.5'
						Total Depth = 77.5'		Total Depth = 77.5'
4969.8	80						80	
4964.8	85						85	
4959.8	90						90	
4954.8	95						95	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
∇	19.7	- - -	11/21/19
▼	19.1	- - -	11/22/19

METHOD N/A

Log of Well: W-227



Description 1/

Dam Core Material

0-5 Red clay, gravel from road bed near top of interval

5-10 Sandy clay, BRN

10-25 Clay, BRN

Holbrook Member of the Moenkopi Formation

25-29 BRN and GRN siltstone

29-35 Dark BRN sandstone, some GRN siltstone, some re clay at 33-34

35-40 Dark BRN sandstone, some GRN siltstone

40-45 GRN and BRN sandstone, mostly GRN

Moqui Member of the Moenkopi Formation

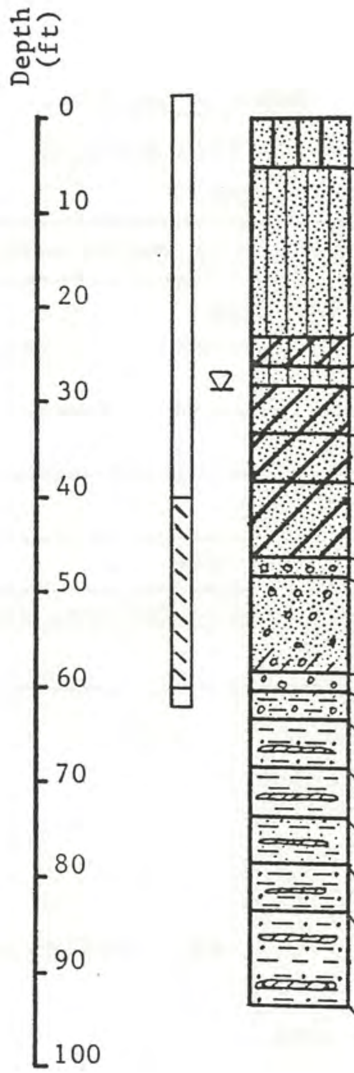
45-55 GRN and BRN siltstone and red clay

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

62-9057/10-1

Log of Well: W-301



Description 1/

Tanner Wash Alluvium

0-5	Very fine sandy silt, BRN
5-23	Silty sand, BRN
23-26	Silty clay, BRN
26-28	Silty sand, BRN
28-33	Clay, BRN
33-38	Clay, some fine sand, BRN
38-46	Clay, BRN
46-48	Sand and gravel, up to 1/2 inch
48-58	Sand and gravel becomes clayey near 58 ft.
58-60	Sand and gravel

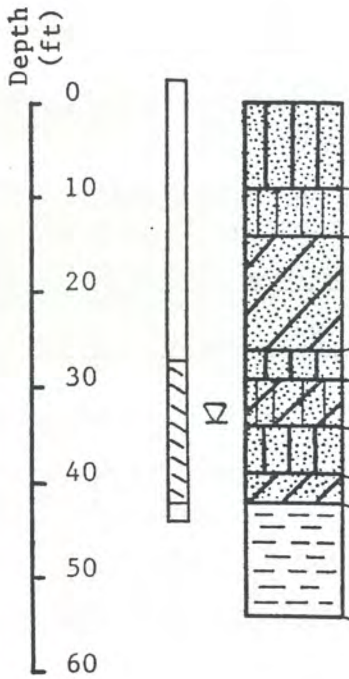
Moqui Member of the Moenkopi Formation

60-63	Red claystone, some sand and gravel
63-68	Red and GRN siltstone and claystone, some gypsu
68-73	Red claystone, some gypsum
73-78	Red claystone, some sand and gypsum
78-83	Red and GRN siltstone and claystone, some gypsu
83-93	Red and GRN siltstone and claystone, some gypsu

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-302



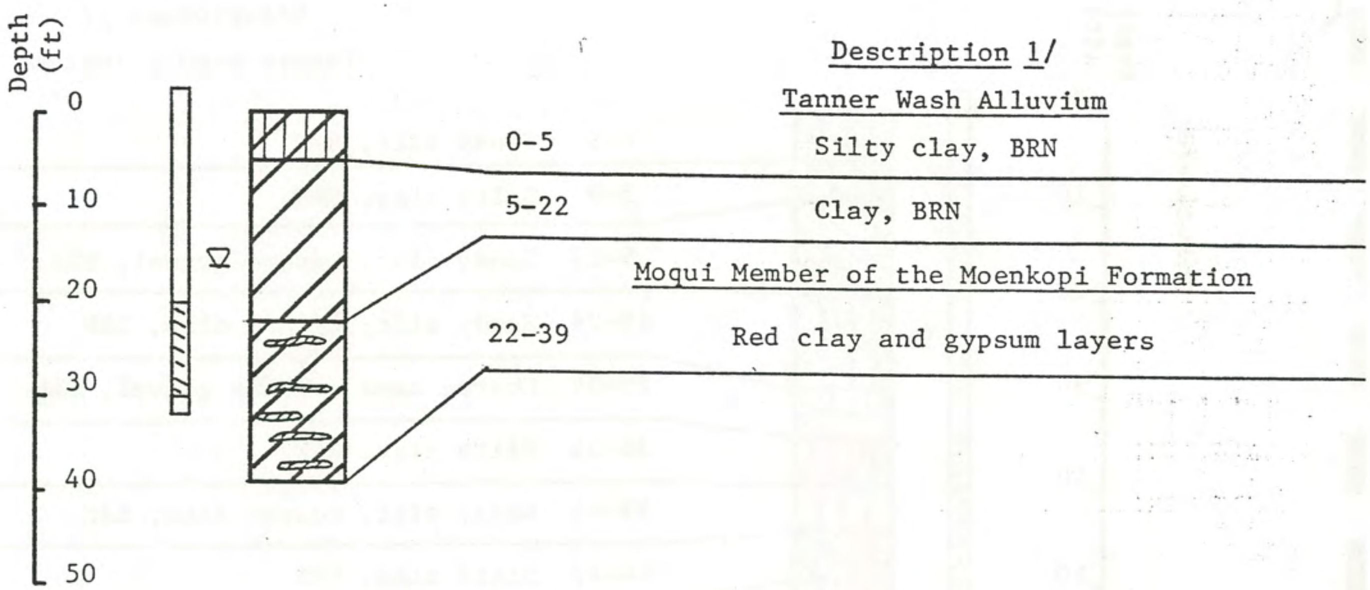
Description 1/

Depth (ft)	Description
	Tanner Wash Alluvium
0-9	Fine sandy silt, BRN
9-14	Silty sand, medium to coarse w/some gravel
14-26	Fine sandy clay, BRN
26-29	Sandy silt, BRN
29-34	Silty clay, BRN
34-39	Sandy silt, BRN
39-42	Coarse sandy clay, BRN
	Moqui Member of the Moenkopi Formation
42-54	Red claystone

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

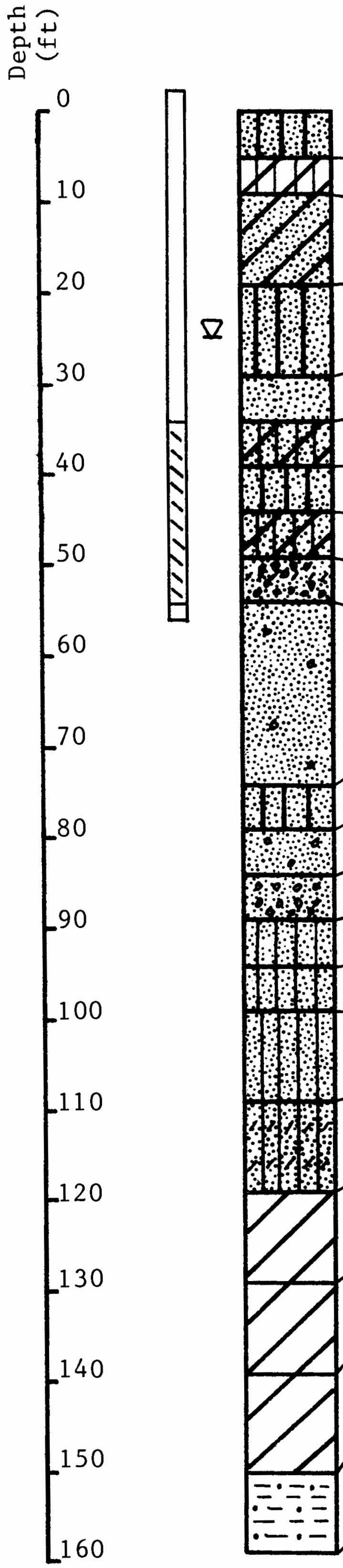
Log of Well: W-303



1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-304



Description 1/

Tanner Wash Alluvium

0-5	Sandy silt, BRN
5-9	Silty clay, BRN
9-19	Sandy clay, w/some gravel, BRN
19-29	Sandy silt, w/some clay, BRN
29-34	Coarse sand, w/some gravel, BRN
34-39	Silty clay, BRN
39-44	Sandy silt, coarse sand, BRN
44-49	Silty clay, BRN
49-54	Sand and gravel, interbedded silt and clay
54-74	Silty sand, w/some gravel and clay
74-79	Sandy silt, BRN
79-84	Coarse sand, w/some gravel and silt
84-89	Coarse sand and gravel
89-94	Silty sand, BRN
94-99	Silty sand, w/some red clay and GRN claystone
99-109	Silty sand, w/some coarse sand and some red clay
109-119	Silty fine sand, BRN, some gypsum
119-129	Silty clay, BRN, some red clay
129-139	Silty clay, BRN
139-150	Silty clay, BRN, some red clay

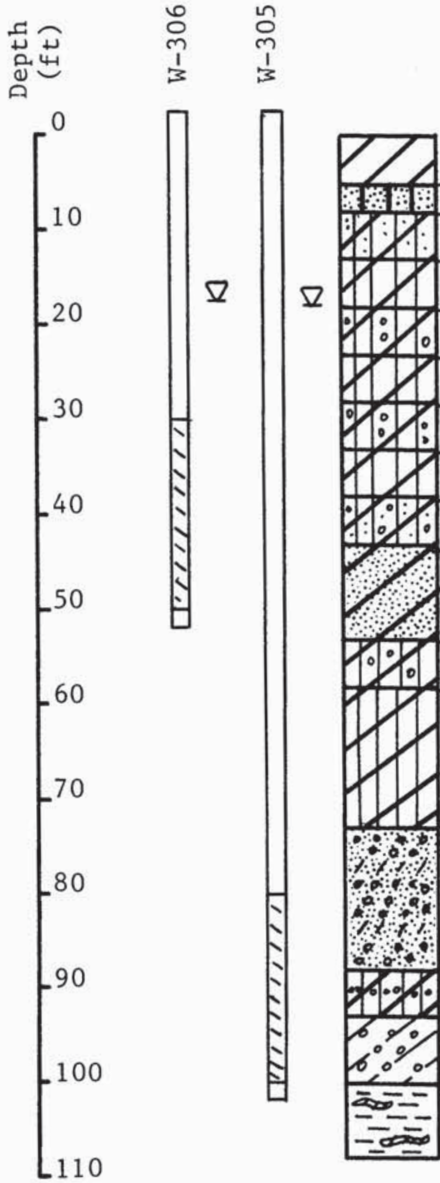
Moqui Member of the Moenkopi Formation

150-159	Red clay, w/GRN siltstone and gypsum

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-305 2/



Description 1/

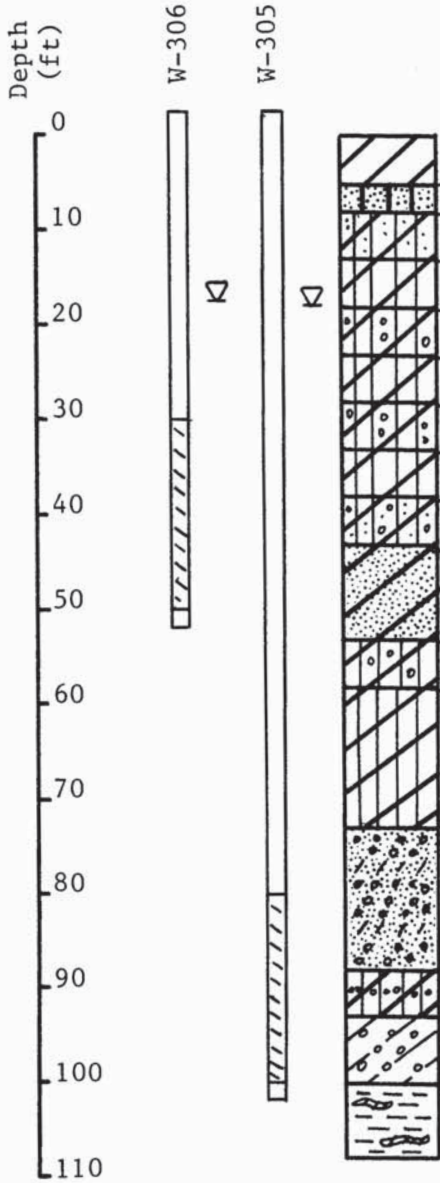
Depth	Description
	Tanner Wash Alluvium
0-5	Silty clay, BRN
5-8	Sandy silt, BRN
8-13	Silty clay, BRN , some sand
13-18	Silty clay, BRN
18-23	Silty clay, BRN, some 1/8" gravel
23-28	Silty clay, BRN
28-33	Silty clay, BRN, some 1/8" gravel
33-38	Silty clay, BRN
38-43	Silty clay, BRN, some coarse sand and ¼" gravel
43-53	Sandy clay, BRN
53-58	Silty clay, BRN, some gravel
58-73	Silty clay, BRN
73-88	Sandy gravel, w/layers of clay, BRN
88-93	Silty clay,BRN, thin layers gravel,some GRN sandstone chips
93-100	Clayey sandy gravel
	Moqui Member of the Moenkopi Formation
100-108	Red claystone, some gypsum

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

2/ This log also applies for Well W-306 which was drilled approximately 10 feet east of W-305.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-305 2/



Description 1/

Tanner Wash Alluvium

0-5	Silty clay, BRN
5-8	Sandy silt, BRN
8-13	Silty clay, BRN, some sand
13-18	Silty clay, BRN
18-23	Silty clay, BRN, some 1/8" gravel
23-28	Silty clay, BRN
28-33	Silty clay, BRN, some 1/8" gravel
33-38	Silty clay, BRN
38-43	Silty clay, BRN, some coarse sand and ¼" gravel
43-53	Sandy clay, BRN
53-58	Silty clay, BRN, some gravel
58-73	Silty clay, BRN
73-88	Sandy gravel, w/layers of clay, BRN
88-93	Silty clay, BRN, thin layers gravel, some GRN sandstone chips
93-100	Clayey sandy gravel

Moqui Member of the Moenkopi Formation

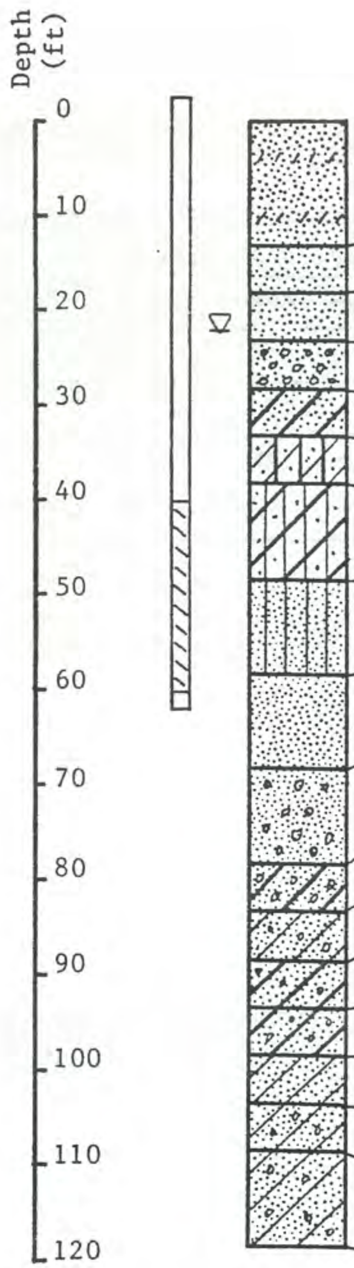
100-108	Red claystone, some gypsum

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

2/ This log also applies for Well W-306 which was drilled approximately 10 feet east of W-305.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-307



Description 1/

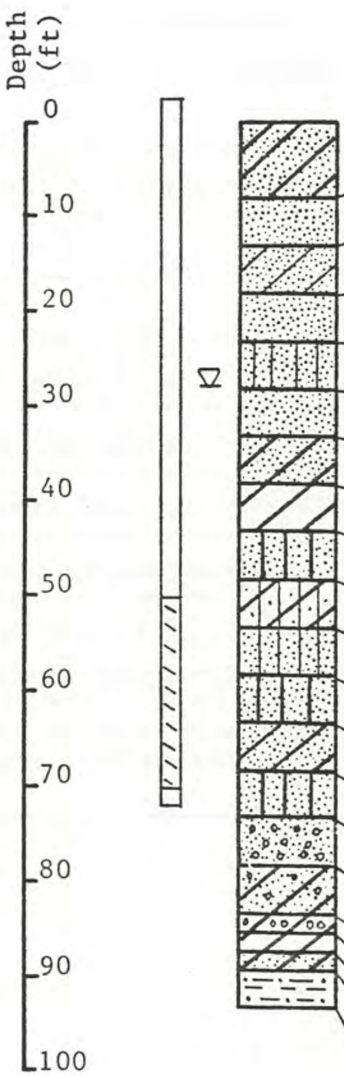
Tanner Wash Alluvium

0-13	Fine sand, BRN, w/thin layers of silty clay
13-18	Fine sand, BRN
18-23	Fine to coarse sand, BRN
23-28	Sandy gravel, up to 1" gravel
28-33	Sandy clay, BRN
33-38	Clayey silt, BRN, some sand
38-48	Silty clay, BRN, some sand
48-58	Silty sand, BRN, fine to coarse sand, some gravel
58-68	Fine to coarse sand, BRN
68-78	Sand and gravel, BRN
78-83	Gravelly clay - light pinkish BRN
83-88	Clayey sand, light pinkish BRN some gravel
88-93	Sandy clay,light pinkish BRN,some gravel and red clay
93-98	Sandy clay, light pinkish BRN, ¼" gravel
98-103	Clayey sand, light pinkish BRN
103-108	Clayey sand, light pinkish BRN, some red clay and 1/8" - 1/4" gravel
108-118	Clayey sand, light pinkish BRN, some gravel

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-308



Description 1/

Tanner Wash Alluvium

0-8 Sandy clay, BRN

8-13 Fine to medium sand, BRN

13-18 Clayey sand, some gravel, BRN

18-23 Gravelly sand, BRN, 1/4" - 1/2" gravel

23-28 Silty sand, BRN, w/some 1/4" - 1/2" gravel

28-33 Sandy gravel - BRN, 1/4" - 1/2" gravel

33-38 Sandy clay, BRN, some gravel

38-43 Gravelly clay, BRN, fine to 3/4" gravel

43-48 Sandy silt, BRN, w/1/4" - 1/2" gravel

48-53 Silty clay, BRN, some sand

53-58 Silty sand, BRN, w/1/8" - 1/4" gravel

58-63 Sandy silt, BRN, w/some gravel

63-68 Sandy clay, BRN, w/some gravel

68-73 Sandy silt, BRN, w/some gravel

73-78 Sandy gravel, BRN w/some clay

78-83 Sandy clay, BRN, w/some gravel and blue clay

83-85 Gravelly clay, BRN, to greenish BRN

85-87 Red clay

87-89 Sandy clay, BRN

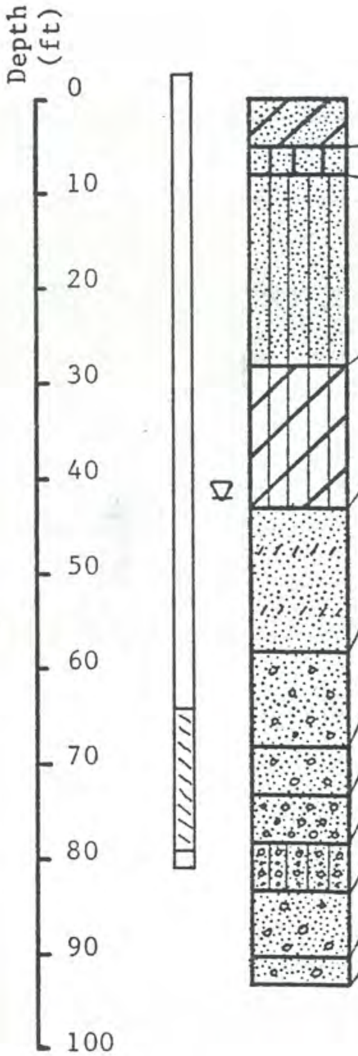
Moqui Member of the Moenkopi Formation

89-93 Red and blue siltstone and claystone

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

Log of Well: W-309



Description 1/

Tanner Wash Alluvium

0-5	Sandy clay, BRN
5-8	Sandy silt, BRN, w/pieces of claystone
8-28	Silty sand, BRN
28-43	Silty clay, BRN
43-58	Sandy gravel, w/layers of clay, BRN
58-68	Gravelly sand, some sandstone pieces, BRN
68-73	Gravelly sand , 1/4" to 1/2" gravel , BRN
73-78	Sandy gravel , some sandstone pieces , BRN
78-83	Silty sandy gravel , up to 1/2" gravel , BRN to pink
83-90	Gravelly sand, up to 1/2" gravel, pinkish BRN
90-93	Gravelly sand, greenish BRN changing to pinkis[illegible] BRN

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

LOG OF TEST HOLE No.: W310

DATE: **12/19/92** SURFACE ELEVATION: **5048.6' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)-API-GR 0–200; DENSITY-G-CC 0–5; RESISTIVITY(16N)-OHM-M 0–100
0–10		ALLUVIUM CLAY, very stiff, dry silty, sandy, moderate reddish brown (10 YR 4/6) to moderate brown (5 YR 3/4), (CL)	5038.6		
10–15		SAND, dense, dry, clayey, moderate reddish brown (10YR 4/6) to moderate brown (5 YR 3/4), with chert gravels	10.0 5033.6		
15–20		CLAY, very stiff, very moist, sandy, moderate reddish brown (10 YR 4/6) to moderate brown (5 YR 3/4), occasional gravels	15.0 5028.6		
20–27		SAND, dense, very moist, clayey, moderate reddish brown (10 YR 4/6) to moderate brown (5 YR 3/4) with chert gravels	20.0 5021.6		
27–		BEDROCK Formation: Moenkopi, Member: Mouqi SILTSTONE, soft to moderately hard, very clayey, very fine sandy, with alternating moderate to thick beds of moderate reddish orange (10 R 6/6) to moderate reddish brown (10 YR 4/6) and generally thinner beds of pale green (10 G 6/2) to greyish green (10 GY 5/2), abundant lenses of	27.0		

Casing Material: 4" SCHEDULE 80 PVC
Casing Inner Dia: 3.72 INCHES
Slot Size: 0.01 INCH
Screened Interval: 218' TO 238'
Filter Pack Material: 20-40 SILICA SAND
Casing Connection: FLUSH THREAD W/ O-RING GASKET
Temporary Steel Casing (TSC) Dia: 10 INCH
TSC Depth Of Penetration: 203'
Drilling Method: DUAL AIR ROTARY

Completed Well Head Elev: 5050.61' MSL
Geologist: STEVEN C KAMINSKI
Bit Diameter: 7.87"
Drill Rig: BARBER
Drill Contractor: MAHER ENVIRONMENTAL
Geophysic Contractor: NOT CONDUCTED
Initial Water: 25' BELOW GRADE

Completion Depth: **240.0 Ft.**
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.
Project No.: **914X236B**
Project Name: **APS - CHOLLA POWER PLANT**
Drawn By: STEVEN C KAMINSKI
Reviewed By: LEO LEONHART

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W310

DATE: 12/19/92 SURFACE ELEVATION: 5048.6' MSL LOCATION: BOTTOM ASH POND

GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100

DESCRIPTION	STRATUM EL / DEPTH
deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet,	4999.6
SANDSTONE, moderately hard to hard, silty, clayey, very fine grained, well graded, light olive brown (5 Y 5/6), fast reaction to HCl, abundant water,	49.0 / 4994.6
SILTSTONE, moderately soft, clayey, very fine sandy, moderate reddish orange (10 R 6/6) to moderate reddish brown (10 R 4/6), fast reaction to HCl	54.0 / 4990.6
SANDSTONE, hard, very fine grained, well sorted, silty, light olive brown (5 Y 5/6), with abundant gypsum, micaceous, fast reaction to HCl	58.0 / 4986.6
SILTSTONE, moderately hard, clayey, very fine sandy, moderate reddish orange (10 R 6/6) to moderate reddish brown (10 R 4/6), fast reaction to HCl	62.0 / 4985.6 / 63.0 / 4984.6
SANDSTONE, hard, fine grained, well sorted, moderate olive brown, (5 YR 4/4), gypsum, micaceous, fast reaction to HCl	64.0 / 4982.6 / 66.0 / 4981.6 / 67.0
SILTSTONE, moderately soft to moderately hard, sandy, moderate reddish orange (10 R 6/6), moderate reddish brown (10 R 4/6) to moderately olive brown (5 YR 4/4), well bioturbated, fast reaction to HCl	
SANDSTONE, moderately hard, silty, very fine to fine grained, well sorted,with gypsum, micaceos, fast reaction to HCl	
SILTSTONE, moderately soft to moderately hard, clayey, sandy, moderate reddish orange (10 R 6/6) to moderate reddish brown (10 R 4/6) and generally thinner beds of pale green (10 G 6/2) to	

Depth scale, ft.: 40, 45, 50, 55, 60, 65, 70, 75, 80

Completion Depth: 240.0 Ft. Water Depth: ______ ft., After ______ hrs. ______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W310

DATE: 12/19/92 SURFACE ELEVATION: 5048.6' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100
85		greyish green (10 GY 5/2), abundant lenses of deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet, abundant evidence of bioturbation			
		- @ 74' hole becomes dry			
90					
95		- @ 94' sandy lense with much gypsum, wet			
100					
105		- @ 104' cuttings become finer grained, cuttings dry out			
		- @ 106' cuttings become sandy, much gypsum, wet			
110		- @ 106' cuttings become finer grained, hole becomes dry			
115		- @ 113' cutting become sandy, much gypsum, wet			
120		- @ 119' cuttings become finer grained, hole becomes dry			
125		- @ 125' muddy cuttings, poor cuttings return, wet			
130		- @ 129' abundant water			

Completion Depth: 240.0 Ft.

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W310

DATE: 12/19/92 SURFACE ELEVATION: 5048.6' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
		- @ 132' cuttings become dry			
		- @ 134' moist			
135		- @ 135' dry			
		- @ 136' abundant water			
		- @ 138' dry			
140		- @ 139' rock becomes harder, much less weathered, abundant water			
145					
150					
155					
160					
165			4878.6		
170		SANDSTONE, hard, fine grained, well sorted, silty, dark yellowish brown (10 YR 4/2) to light olive brown (5 Y 5/6), micaceous, abundant gypsum	170.0 4875.6		
175		SILTSTONE, moderately soft to moderately hard, clayey, sandy, moderate reddish orange (10 R 6/6) to moderate reddish brown (10 R 4/6) and generally thinner beds of pale green (10 G 6/2) to greyish green (10 GY 5/2), abundant lenses of	173.0		

Completion Depth: 240.0 Ft.

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W310

DATE: **12/19/92** SURFACE ELEVATION: **5048.6' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100
180–210		deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet, abundant evidence of bioturbation, abundant gypsum - @ 176' abundant gypsum - @ 177' abundant gypsum - @ 179' abundant gypsum - @ 203' stopped casing advancement, open hole drilling for remainder hole.	4835.6		
215–225		Formation: Moenkopi; Member: Wupatki SANDSTONE, hard, very fine grained, moderately well sorted, silty, micaceous, color is greyish red (5 R 4/2) to greyish brown (5 YR 3/2), very reactive to HCl when crushed - @ 218' becomes moderately hard, very fine grained, well sorted, clean, very finely micaceous, slightly friable, color is greyish red (5R 4/2) to moderate brown (5 YR 3/4), moderate reaction to HCl when crushed	213.0		

Completion Depth: **240.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W310

DATE: **12/19/92** SURFACE ELEVATION: **5048.6' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100
230					
235		- @ 232' becomes very hard to hard, very fine grained, well sorted, clean, very finely micaceous, non-friable, color is dark reddish brown (10 R 3/4) to dusky red (5 R 3/4), moderate reaction to HCl when crushed	4808.6		
240		TOTAL DEPTH OF HOLE AT 240 FEET BELOW GRADE. Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet below grade.	240.0		

Completion Depth: **240.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

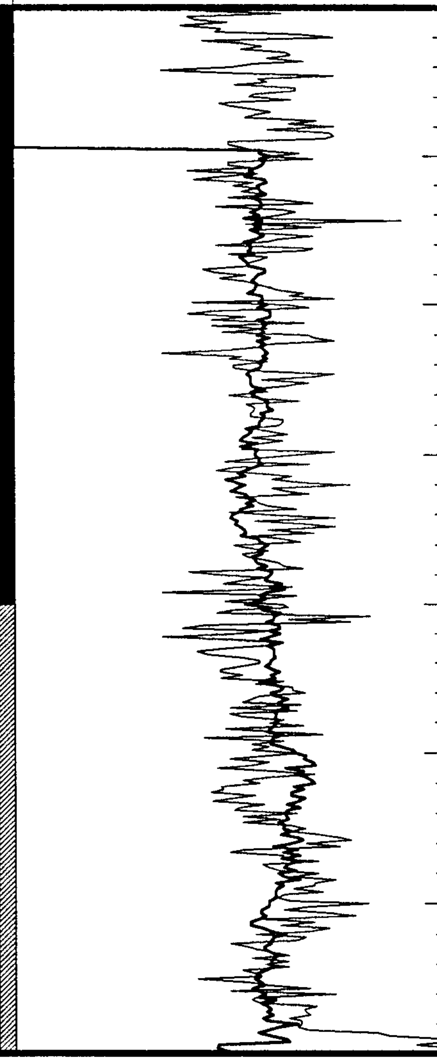
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W311

DATE: **12/14/91** SURFACE ELEVATION: **5047.7' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
		ALLUVIUM CLAY , very stiff, dry, silty, with trace sand and fine chert gravels, light reddish brown (CL)			
5					
10					
15					
20					
25		- wet from 25 to 27 feet	5020.7		
		BEDROCK Formation: Moenkopi, Member: Mouqi SILTSTONE , soft to moderately hard, very clayey, very fine sandy, with alternating medium to thick beds of moderate reddish orange (10 R 6/6) to moderate reddish brown (10 YR 4/6) and generally thinner beds of pale green (10 G 6/2) to	27.0		
30					



Casing Material:	4" SCHEDULE 80 PVC	Completed Well Head Elev:	5050.03' MSL
Casing Inner Dia:	3.72 INCHES	Geologist:	STEVEN C KAMINSKI
Slot Size:	0.02 INCH	Bit Diameter:	7.87"
Screened Interval:	259' TO 279'	Drill Rig:	BARBER
Filter Pack Material:	10-20 SILICA SAND	Drill Contractor:	MAHER ENVIRONMENTAL
Casing Connection:	FLUSH THREAD W/ O-RING GASKET	Geophysic Contractor:	CENTURY GEOPHYSICS
Temporary Steel Casing (TSC) Dia:	10 INCH	Initial Water:	25' BELOW GRADE
TSC Depth Of Penetration:	35'		
Drilling Method:	DUAL AIR ROTARY		

Completion Depth: **281.8 Ft.** Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drawn By: STEVEN C KAMINSKI Reviewed By: LEO LEONHART

3/28/92 WCGEOP 1236A

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W311

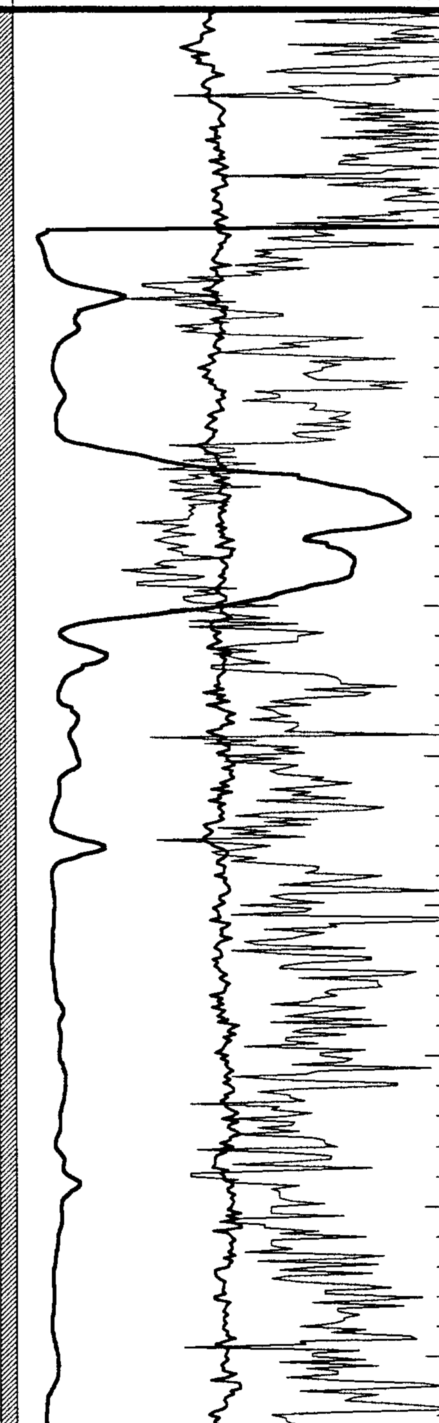
DATE: **12/14/91** SURFACE ELEVATION: **5047.7' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
40, 45		greyish green (10 GY 5/2), abundant lenses of deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet, - wet	4997.7	
50, 55		SANDSTONE (Mouqi), moderately hard very fine to fine grained, moderately to well sorted, with coarse silt and abundant gypsum crystals, dusky yellowish green (5 GY 5/2) to greyish green (10 GY 5/2)	50.0 4987.7	
60, 65, 70, 75, 80		SILTSTONE (Mouqi), soft to moderately hard, very clayey, very fine sandy, with alternating medium to thick beds of moderate reddish orange (10 R 6/6) to moderate reddish brown (10 YR 4/6) and generally thinner beds of pale green (10 G 6/2) to greyish green (10 GY 5/2), abundant lenses of deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet, bioturbated	60.0	

GAMMA (NATURAL)–API-GR 0 — 200

DENSITY–G-CC 0 — 5

RESISTIVITY(16N)–OHM-M 0 — 100



Completion Depth: **281.8 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

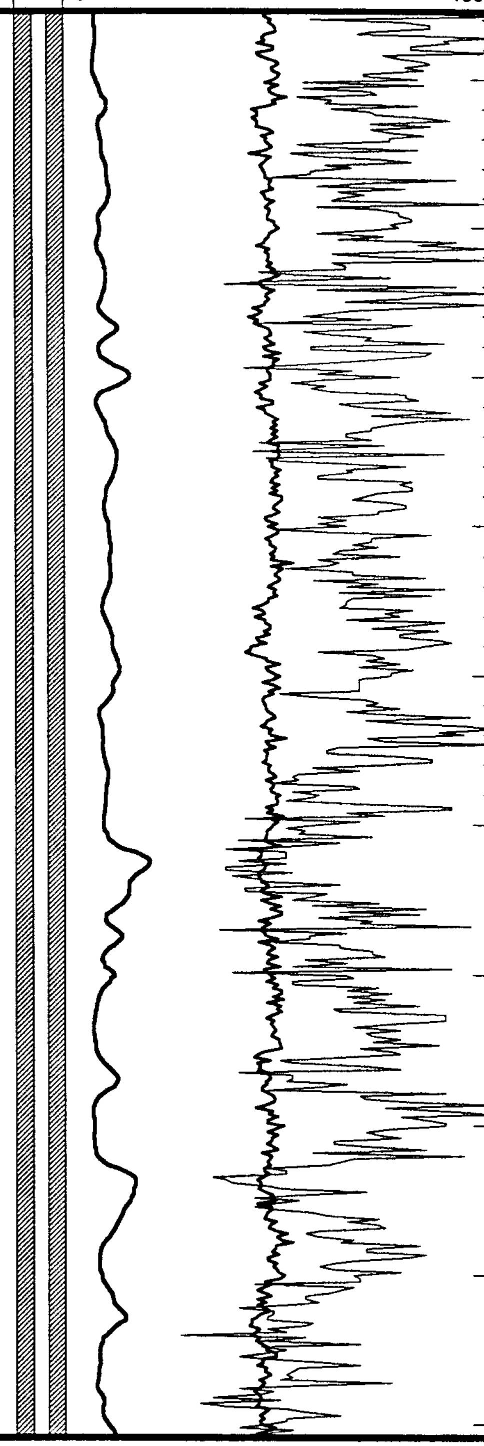
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W311

DATE: **12/14/91** SURFACE ELEVATION: **5047.7' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
105		- @~105' abundant gypsum to ~115', sandy			



Completion Depth: **281.8 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

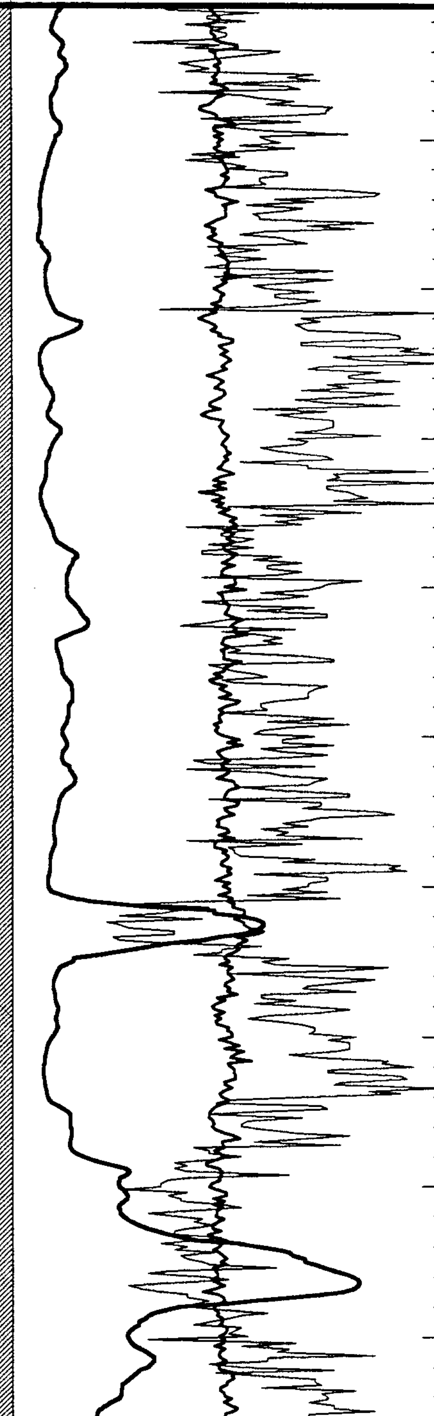
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W311

DATE: **12/14/91** SURFACE ELEVATION: **5047.7' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
		- @~130' sandy			
135					
140					
145					
150					
155					
160		- @~160' abundant crystalline gypsum to ~165'			
165					
170		- @~170' becomes sandy, increased crystalline gypsum to ~177'			
175					



Completion Depth: **281.8 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

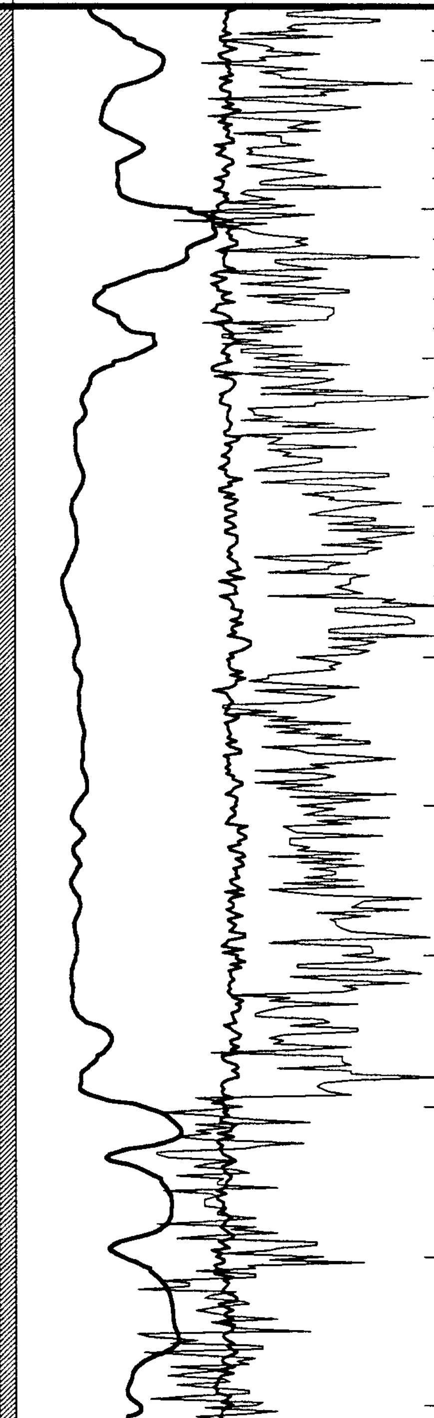
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W311

DATE: **12/14/91** SURFACE ELEVATION: **5047.7' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
180–215			4832.7		
215–225		Formation: Moenkopi, Member: Wupatki SANDSTONE, hard, very fine grained, moderately well sorted, silty, micaceous, color is greyish red (5 R 4/2) to greyish brown (5 YR 3/2), very reactive to HCl when crushed - @ 218' becomes moderately hard, very fine grained, well sorted, clean, very finely micaceous, slightly friable, color is greyish red (5R 4/2) to moderate brown (5 YR 3/4), moderate reaction	215.0		



Completion Depth: **281.8 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W311

DATE: 12/14/91 SURFACE ELEVATION: 5047.7' MSL LOCATION: BOTTOM ASH POND

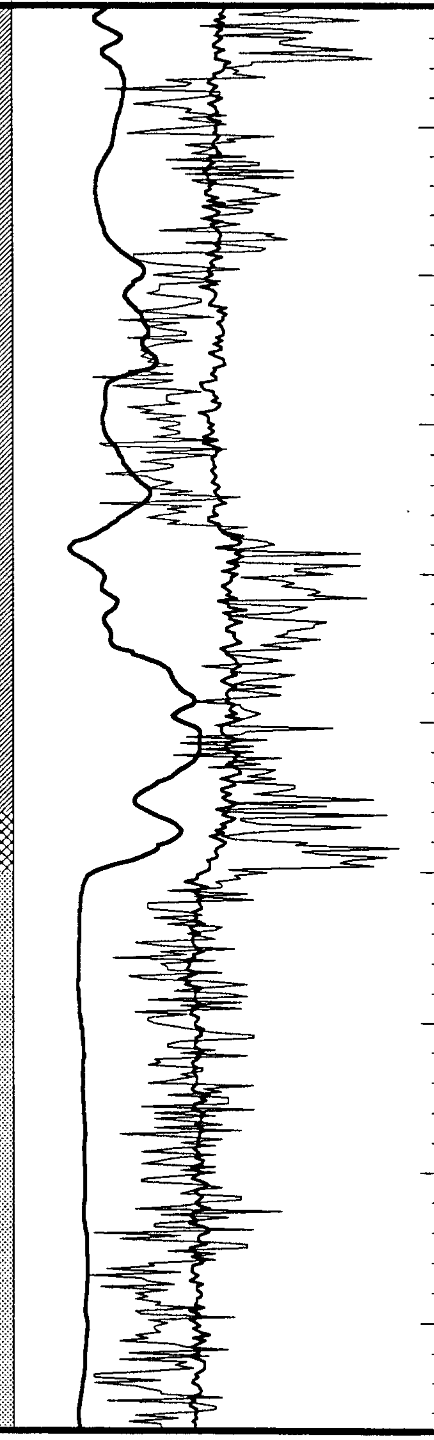
DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
		to HCl when crushed	4807.7	
240		SILTSTONE (Wupatki), moderately hard, clayey, very fine sandy, with alternating medium to thick beds of moderate brown (5 YR 3/4) to blackish red (5 R 2/2) and thinner beds of yellowish grey (5 Y 8/1) silty sandstone, moderate to slow reaction to HCl when crushed	240.0 4797.7	
250		Formation: uncertain (possibly Kaibab limestone) SHALE, hard, dolomitic, sandy, very finely micaceous, olive grey (5 Y 4/1), moderate reaction to HCl when crushed	250.0 4792.7	
255		Formation: Coconino SANDSTONE, hard, slightly friable, very fine to fine grained, well sorted, color is yellowish grey (5 Y 8/1) to light olive grey (5 YG 6/1), no reaction to HCl.	255.0	

Depth scale: 230, 235, 240, 245, 250, 255, 260, 265, 270

GAMMA (NATURAL)–API-GR 0 — 200

DENSITY–G-CC 0 — 5

RESISTIVITY(16N)–OHM-M 0 — 100



Completion Depth: 281.8 Ft.

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

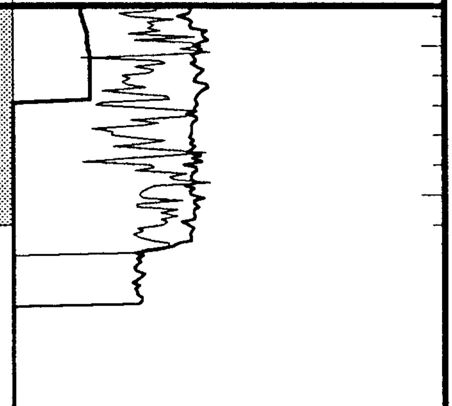
Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W311

DATE: **12/14/91** SURFACE ELEVATION: **5047.7' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
275				
280			4766.7	
		Total depth of hole @ 281 feet. Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 6' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet below grade.	281.0	

GAMMA (NATURAL)--API-GR 0 — 200
DENSITY--G-CC 0 — 5
RESISTIVITY(16N)--OHM-M 0 — 100



Completion Depth: **281.8 Ft.**
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W312

DATE: 1/22/92 SURFACE ELEVATION: 5049.3' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	DESCRIPTION	STRATUM EL / DEPTH
	ALLUVIUM CLAY, very hard to hard, dry, fat, with occasional silty lenses throughout, moderate brown (5 YR 3/4) to greyish brown (5 YR 3/2), laminated	
5	- @~5' standard penetration split spoon sample recovered approximately 2" of clay with 100 blows for 6 inches @~8' cuttings become slightly moist to moist	
10		
15	@~15' standard penetration split-spoon sample recovered ~1 foot of silty clay after 8 blows advanced sampler 2'.	
20		
25	@~26' cuttings are wet @~28' cuttings become dry	5019.3
30	CLAY, very hard, wet, gravels are rounded and fragmented chert, silty, gypsum and petrified wood.	30.0

Geophysical log scales: GAMMA (NATURAL)--API-GR 0 – 200; DENSITY--G-CC 0 – 5; RESISTIVITY(16N)--OHM-M 0 – 100

Casing Material:	4" SCHEDULE 80 PVC	Completed Well Head Elev:	5052.01' MSL
Casing Inner Dia:	3.72 INCHES	Geologist:	STEVEN C KAMINSKI
Slot Size:	0.01 INCH	Bit Diameter:	7.87"
Screened Interval:	238' TO 258'	Drill Rig:	BARBER
Filter Pack Material:	20-40 SILICA SAND	Drill Contractor:	MAHER ENVIRONMENTAL
Casing Connection:	FLUSH THREAD W/ O-RING GASKET	Geophysic Contractor:	NOT CONDUCTED
Temporary Steel Casing (TSC) Dia:	10 INCH	Initial Water:	15' BELOW GRADE
TSC Depth Of Penetration:	83'		
Drilling Method:	DUAL AIR ROTARY		

Completion Depth: **259.0 Ft.**
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drawn By: STEVEN C KAMINSKI
Reviewed By: LEO LEONHART

LOG OF TEST HOLE No.: W312

DATE: 1/22/92 SURFACE ELEVATION: 5049.3' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
		@~35' standard penetration split-spoon sample recovered ~2" of clay after 100 blows			
40		@~40' no cuttings return			
45					
50		@~50' cuttings return resumes			
55					
60		BEDROCK Formation: Moenkopi, Member:Mouqi SILTSTONE, very soft, deeply weathered, clayey, with interbeds of sandstone, and shale, moderate brown (5 YR 3/4) to greyish brown (5 YR 3/2) and moderate brown (5 YR 4/4), occasional chips of sandstone are greyish green (10 GY 5/2) to greyish green (10 G 5/2)	4989.3 60.0		
65					
70					
75					
80		@~80' abundant gypsum to 83' @~81' soft to moderately hard, moderate			

Completion Depth: 259.0 Ft. Water Depth: ____ ft., After ____ hrs. ____ ft., After ____ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W312

DATE: 1/22/92 SURFACE ELEVATION: 5049.3' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
85		reddish brown (10 R 4/6) to dark reddish brown (10 R 3/4) with some lenses of greyish green (10 R 4/6) to pale green (5 G 7/2), soft lenses of greyish yellow green (5 GY 7/2), slow to fast reaction to HCl			
90					
95		@~94' abundant gypsum @~96' abundant gypsum			
100		@~100' abundant gypsum			
105					
110					
115		@~117' abundant gypsum			
120			4926.3		
125		SANDSTONE (Mouqi), silty, moderately hard, color is dark yellowish brown (10 YR4/2) to moderate brown (5 YR 3/4), gypsum mineralization noted on parting surfaces, moderate reaction to HCl when crushed	123.0		
130					

Completion Depth: 259.0 Ft. Water Depth: ______ ft., After ______ hrs. ______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W312

DATE: 1/22/92 SURFACE ELEVATION: 5049.3' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)-API-GR 0–200 / DENSITY-G-CC 0–5 / RESISTIVITY(16N)-OHM-M 0–100
135					
140			4907.3		
		SILTSTONE (Mouqi), soft to moderately hard, sandy, clayey, greyish red (5 R 4/2) to grayish brown (5 YR 3/2) to dark reddish brown (10 R 3/4) to moderate brown (5 YR 3/4), with some greyish green (10 GY 5/2) to greyish green (5 G 5/2), frequent gypsum lenses, slow reaction to HCl.	142.0		
145					
150					
155					
160					
165					
170					
175					

Completion Depth: 259.0 Ft.

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W312

DATE: 1/22/92 SURFACE ELEVATION: 5049.3' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
180					
185					
190					
195					
200					
205					
210					
215					
220					
225					

Completion Depth: 259.0 Ft. Water Depth: ______ ft., After ______ hrs. ______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W312

DATE: **1/22/92** SURFACE ELEVATION: **5049.3' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
230			4817.3		
235		SANDSTONE (Wupatki), Hard, very fine grained, moderately well sorted, silty, micaceous, color is greyish red (5 R 4/2) to greyish brown (5 YR 3/2), very slow reaction to HCl when crushed	232.0		
240					
245					
250					
255		@~253' slow reaction to HCl when crushed	4790.3		
		TOTAL DEPTH AT 259 FEET BELOW GRADE Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet below grade.	259.0		

Completion Depth: **259.0 Ft.** Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

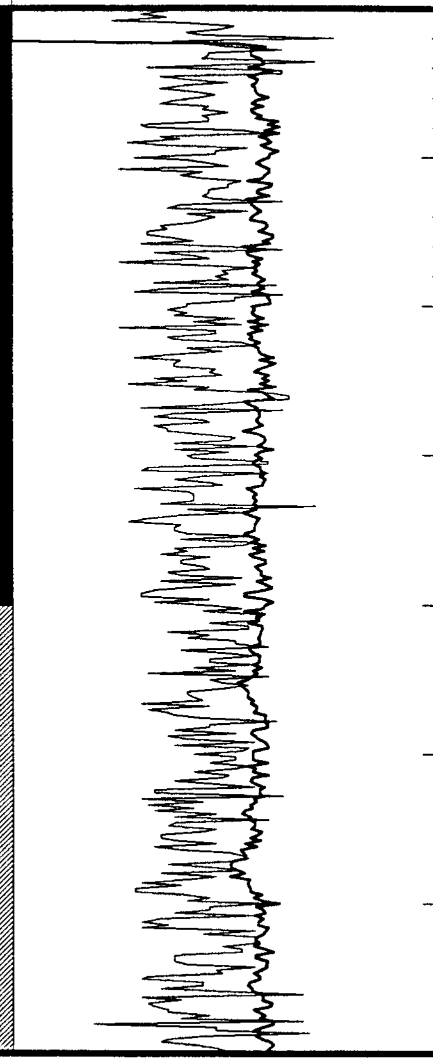
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W313

DATE: **1/12/92** SURFACE ELEVATION: **5049.1' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100
		ALLUVIUM CLAY, very hard to hard, fat with occasional silty lenses, dry, color is moderate brown (5 YR 3/4) to greyish brown (5 YR 3/2), silt laminations appear saturated (CH)			
5		- @~5' standard penetration split spoon soil sample collected >100 blows for 6" - @~8' laminations become less distinct, silt content increases, becomes slightly moist			
10					
15		- @~14' soil cuttings becomes moist - @~15'standard penetration split spoon soil samples collected, 8 blows for 2', recovery contained a distinct 2" thick saturated silt lamination,			
20					
25		- @~26' soil cuttings becomes wet - @~28' soil cuttings becomes dry to damp	5019.1		
30		CLAY, stiff, sandy, moist to wet, fine rounded chert gravels, moderate brown (5 YR 4/4) to light brown (5 YR 5/6)	30.0		



Casing Material:	4" SCHEDULE 80 PVC	Completed Well Head Elev:	5051.32' MSL
Casing Inner Dia:	3.72 INCHES	Geologist:	STEVEN C KAMINSKI
Slot Size:	0.02 INCH	Bit Diameter:	7.87"
Screened Interval:	272' TO 292'	Drill Rig:	BARBER
Filter Pack Material:	10-20 SILICA SAND	Drill Contractor:	MAHER ENVIRONMENTAL
Casing Connection:	FLUSH THREAD W/ O-RING GASKET	Geophysic Contractor:	CENTURY GEOPHYSICS
Temporary Steel Casing (TSC) Dia:	10 INCH	Initial Water:	28' BG, POSSIBLY 15'
TSC Depth Of Penetration:	81'		
Drilling Method:	DUAL AIR ROTARY		

Completion Depth: **293.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drawn By: STEVEN C KAMINSKI

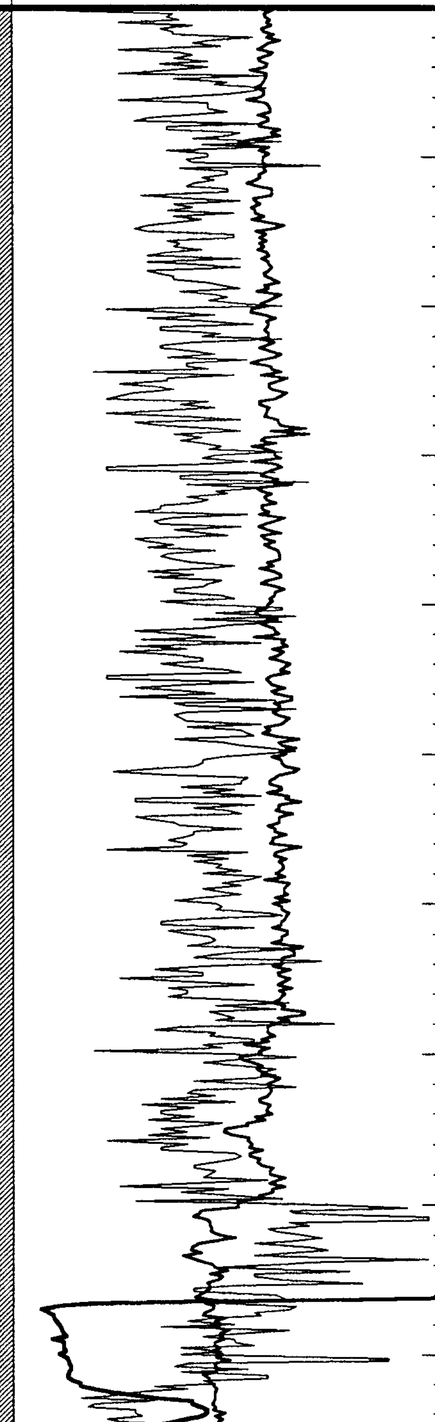
Reviewed By: LEO LEONHART

LOG OF TEST HOLE No.: W313

DATE: 1/12/92 SURFACE ELEVATION: 5049.1' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	DESCRIPTION	STRATUM EL / DEPTH
	- @ 35' split spoon sample collected >100 blows for 6", recovery consisted of 2 inches of hard clay.	5013.1 / 36.0
40, 45, 50, 55	GRAVEL and CLAY (interbedded) CLAY FRACTION: very hard, dry, gravelly, silty, cuttings are powdery,fine to coarse gravels of gypsum and chert. GRAVEL FRACTION: fine to coarse gravel, cuttings from coarse grained intervals were mixed with clay from finer grained intervals, split spoon samples showed very poor recovery, gravels observed in cuttings were primarily rounded chert, platey highly weathered sandstone and fragments of petrified wood. - @ 40'no cuttings return from 40' to 50', material appears to be free flowing sands - @ 50' cuttings return resumes	4989.1 / 60.0
60, 65, 70, 75, 80	BEDROCK Formation: Moenkoi, Member: Mouqi Shale, siltstone and sandstone, deeply weathered, very soft (sandstones are friable), fine grained fraction is moderate brown (5 YR 4/4), while sandstone fraction is greyish brown (5 YR 3/2) to moderate brown (5 YR 3/4) with some greyish green (10 GY 5/2) to greyish green (5 GY 5/2), - @ 80' encountered a 3' thick lense of abundant gypsum	

GAMMA (NATURAL)--API-GR 0 — 200
DENSITY--G-CC 0 — 5
RESISTIVITY(16N)--OHM-M 0 — 100

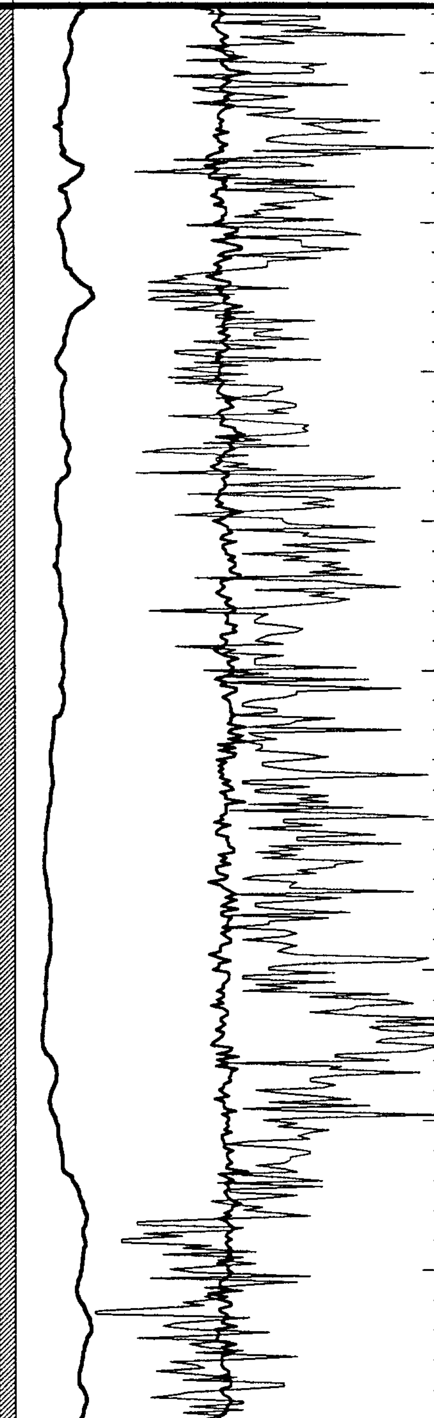


Completion Depth: 293.0 Ft.
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.
Project No.: 914X236B
Project Name: APS - CHOLLA POWER PLANT
Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W313

DATE: **1/12/92** SURFACE ELEVATION: **5049.1' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100
85, 90		- @ 81' Bedrock becomes less weathered, harder and more dominated by siltstone, no sandstone, bedding is on the order of 6 inches to 6 feet, colors are moderate reddish brown (10 YR 4/6) to dark reddish brown (10 YR 3/4) with some lenses of greyish green (10 GY 5/2) to pale green 5 G 7/2) frequent lenses of abundant gypsum moderate to fast reaction to HCl			
95		- @ 94' abundant gypsum			
		- @ 96' abundant gypsum			
100		- @ 100' abundant gypsum			
105, 110, 115					
120		- @ 117' abundant gypsum	4926.1		
125, 130		SANDSTONE, (mouqi interbed) , silty, moderately hard, cuttings form angular disk to platey shaped chips, color is dark yellowish brown (10 YR 4/2) to moderate brown (5 YR 3/4), gypsum mineralization noted on parting surfaces, moderate reaction to HCl when crushed	123.0		



Completion Depth: **293.0 Ft.**

Water Depth: ____ ft., After ____ hrs.
____ ft., After ____ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W313

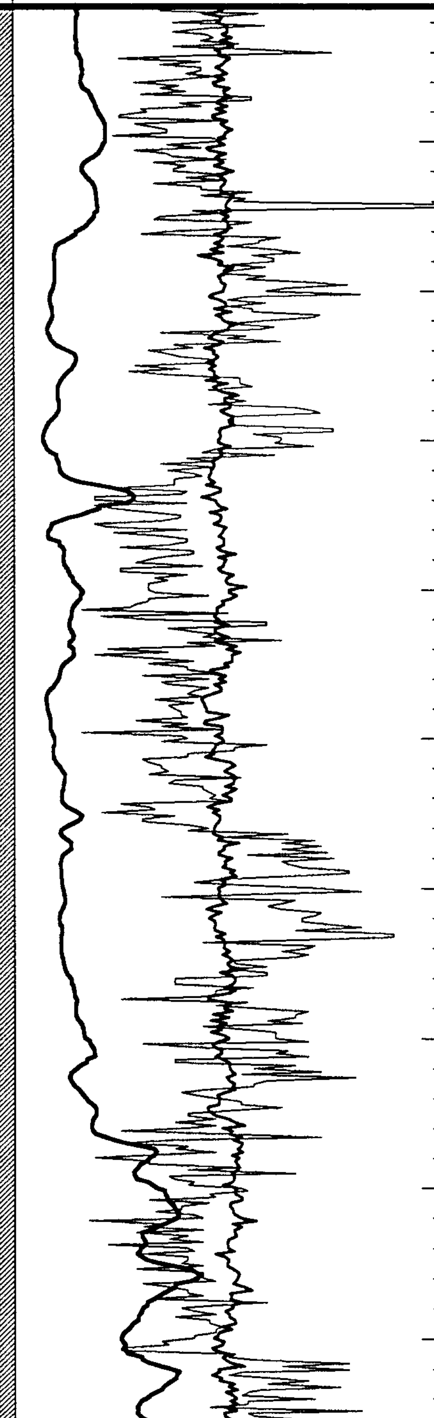
DATE: **1/12/92** SURFACE ELEVATION: **5049.1' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
135–141			4907.1	
142–178		SILTSTONE (Mouqi), sandy to shaley , low to moderately hard, greyish red (5 R 4/2) to greyish brown (5 YR 3/2), to dark reddish brown (10 R 3/4), to moderate brown (5 YR 3/4) with some greyish green (10 GY 5/2) to greyish green (5 G 5/2), frequent gypsum lenses, moderate to fast reaction to HCl. - @ 243' NOTE: WATER LEVEL INFORMATION; On January 11, 1992 (7:30 am) with the hole open to 243 feet after approximately 13 hours the static water level was 76.13 feet below grade. Steel casing at the time of the reading was set at ~82 feet below	142.0	

GAMMA (NATURAL)–API-GR 0 – 200

DENSITY–G-CC 0 – 5

RESISTIVITY(16N)–OHM-M 0 – 100



Depth scale: 135, 140, 145, 150, 155, 160, 165, 170, 175

Completion Depth: **293.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

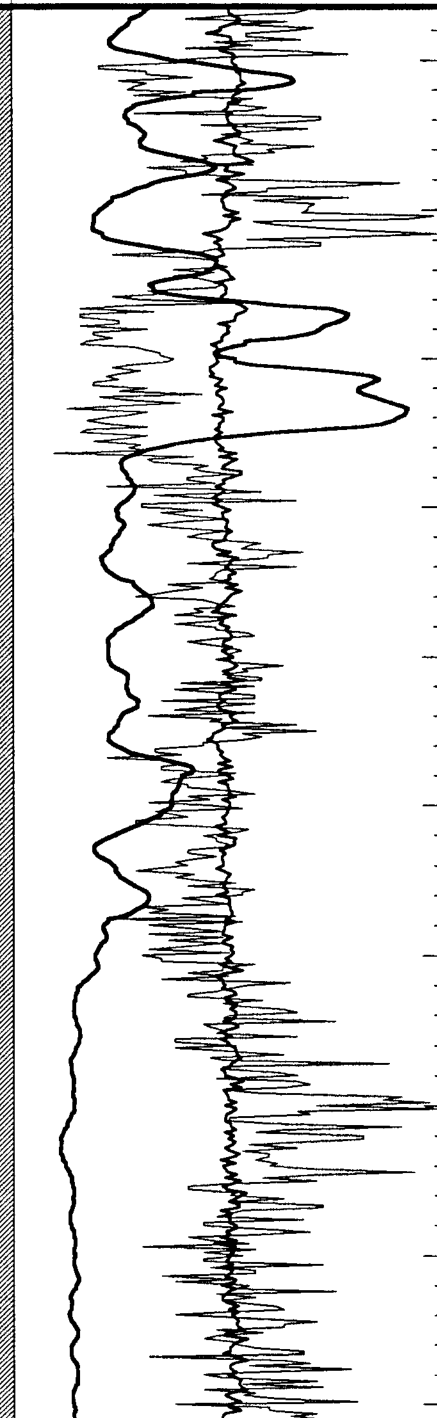
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W313

DATE: 1/12/92 SURFACE ELEVATION: 5049.1' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)–API-GR 0–200; DENSITY–G-CC 0–5; RESISTIVITY(16N)–OHM-M 0–100
180		grade. No evidence of cascading waters could be observed as the casing was set below the water level.			
185					
190					
195					
200					
205					
210					
215					
220					
225					



Completion Depth: 293.0 Ft.

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

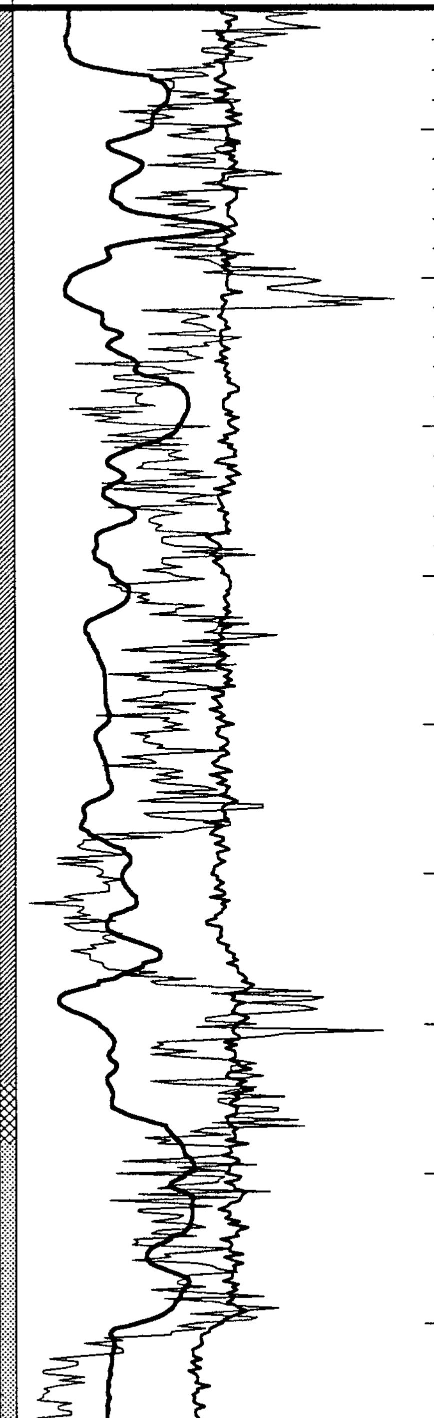
Drilling Method: DUAL AIR ROTARY

LOG OF TEST HOLE No.: W313

DATE: **1/12/92** SURFACE ELEVATION: **5049.1' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
230			4817.1 232.0	
235		Formation: Moenkopi, Member: Wupatki SANDSTONE, Hard, very fine grained, moderately well sorted, silty, micaceous, color is greyish red (5 R 4/2) to greyish brown (5 YR 3/2) , very reactive to HCl when crushed		
240		- @ 243 WATER LEVEL INFORMATION (see previous page) - @ 243' becomes moderately hard, very fine grained, well sorted, clean, very finely micaceous, slightly friable, color is greyish red (5R 4/2) to moderate brown (5 YR 3/4), moderate reaction to HCl when crushed		
245				
250				
255		- @ 253' becomes very hard to hard, very fine grained, well sorted, clean, very finely micaceous, non-friable, color is dark reddish brown (10 R 3/4) to dusky red (5 r 3/4), moderate reaction to HCl when crushed	4790.1 259.0	
260		SANDSTONE, (Wupatki), hard to moderately hard, very fine to fine grained, well sorted, color is yellowish grey (5 Y 8/1) to pinkish grey (5 YR 8/1) slow to moderate reaction to HCl when crushed.	4788.1 261.0	
265		SILTSTONE (Wupatki),moderately hard to hard, clayey, sandy, color is moderate brown (5 YR 3/4), moderate to fast reaction to HCl when crushed	4784.1 265.0	
270		Formation: uncertain, (possibly Kaibab limestone) SILTSTONE, moderately hard to hard, dolomitic, shaley, sandy, color is light olive grey (5 Y 5/2) to greyish green (10 GY 5/2) slow to moderate reaction to HCl	4776.1	

GAMMA (NATURAL)–API-GR 0 – 200
DENSITY–G-CC 0 – 5
RESISTIVITY(16N)–OHM-M 0 – 100



Completion Depth: **293.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

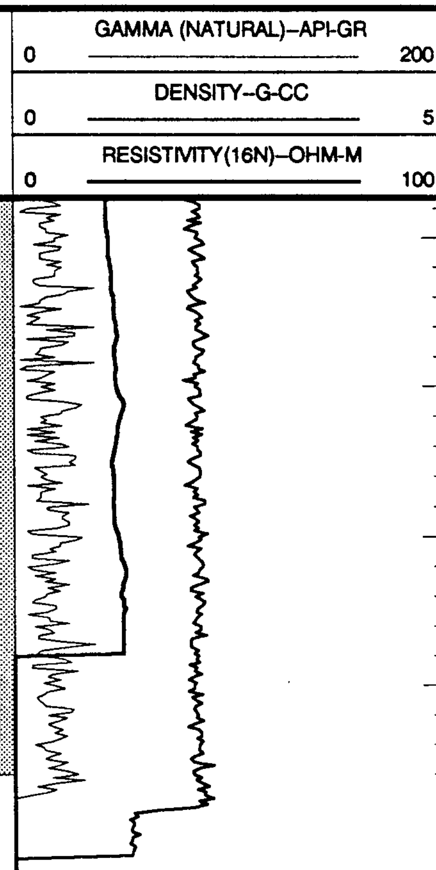
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W313

DATE: 1/12/92 SURFACE ELEVATION: 5049.1' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
275–290		Formation: Coconino SANDSTONE, hard, fine grained, very well sorted, color is yellowish grey (5 Y 8/1) to light olive grey (5 YG 6/1), no reaction to HCl.	273.0 4756.1	
		TOTAL DEPTH OF HOLE @ 293 FEET BELOW GRADE. Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet below grade.	293.0	



Completion Depth: 293.0 Ft.

Water Depth: ______ ft., After ______ hrs.

______ ft., After ______ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W314

DATE: 1/25/92 SURFACE ELEVATION: 5049.1' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
0–30		ALLUVIUM CLAY, very hard to hard, dry, fat, (to 12'), silty lenses, indistinct laminations, color is pale brown (5 YR 5/2), to moderate brown (5 YR 4/4) to moderate brown (5 YR 3/4), (CH) - @12' damp - @14' moist - @16' slightly moist to damp - @20' clay balls in cuttings - @23' color change to moderate brown (5 YR 4/4) - @26' gypsum in cuttings - @27' moist with abundant gypsum	5019.1		
30		CLAY, hard to stiff, very fine sand, slightly moist, with fine rounded chert gravels, color is moderate brown (5 YR 4/4) to light brown (5 YR 5/6)	30.0		

Casing Material: 4" SCHEDULE 40 PVC
Casing Inner Dia: 3.96 INCHES
Slot Size: 0.01 INCH
Screened Interval: 46' TO 61'
Filter Pack Material: 20-40 SILICA SAND
Casing Connection: FLUSH THREAD W/ O-RING GASKET
Temporary Steel Casing (TSC) Dia: 10 INCH
TSC Depth Of Penetration: 62'
Drilling Method: DUAL AIR ROTARY

Completed Well Head Elev: 5051.10' MSL
Geologist: STEVEN C KAMINSKI
Bit Diameter: 7.87
Drill Rig: BARBER
Drill Contractor: MAHER ENVIRONMENTAL
Geophysic Contractor: NOT CONDUCTED
Initial Water: 31' BG, POSSIBLY 15'

Completion Depth: **63.0 Ft.**
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.
Project No.: **914X236B**
Project Name: **APS - CHOLLA POWER PLANT**
Drawn By: STEVEN C KAMINSKI
Reviewed By: LEO LEONHART

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W314

DATE: 1/25/92 SURFACE ELEVATION: 5049.1' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	DESCRIPTION	STRATUM EL / DEPTH
	- @31' wet - @37' less sand, damp, forms clay balls	5010.1
40, 45, 50, 55	GRAVEL, dense to very dense, wet, clayey, sandy, fine to coarse gravels of fine grained very friable, very dusky red (10 R 2/2) to dark reddish brown (10 R 3/4) sandstone,with chert and petrified wood of various colors, silty clay interbeds ranging up to 4 feet in thickness are moderate brown (5 YR 4/4) to moderate reddish brown (10 R 4/6)	39.0 4989.1
60	BEDROCK Formation: Moenkopi, Member: Mouqi Shale, siltstone and sandstone, very soft (sandstones are friable), deeply weathered, fine grained fraction is moderate brown (5 YR 4/4), while sandstone fraction is greyish brown (5 YR 3/2) to moderate brown (5 YR 3/4) with some greyish green (10 GY 5/2) to greyish green (5 GY 5/2) - @62' Standard penetration split spoon sample collected produced poor recovery of deeply weathered pale brown (5 YR 5/2) to moderate brown (5 YR 3/4) sandy siltstone bedrock	60.0 4986.1 63.0
	TOTAL DEPTH OF HOLE AT 63 FEET BELOW GRADE Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet	

WELL | GAMMA (NATURAL)–API-GR 0–200 | DENSITY–G-CC 0–5 | RESISTIVITY(16N)–OHM-M 0–100

Completion Depth: 63.0 Ft. Water Depth: ____ ft., After ____ hrs. ____ ft., After ____ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 **DATE** 11-9-11 to 11-10-11

LOCATION N1434987.0 E659595.2

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5022.27'
DATUM AEZ 0201; NAVD88

Depth in Feet	Sample Type	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0	A	ML to CL	moist	**Little Colorado River Alluvium** **CLAYEY SILT WITH SAND locally grading to SILTY CLAY,** predominantly fine to medium grained sand, uncemented, medium plasticity with some high plasticity zones, dark brown note: some gravel on the ground surface
	A	SP	slightly moist	**SAND,** predominantly fine grained, subangular to subrounded, uncemented, nonplastic, light brown note: zones with a trace to some clay below 5'
5	A			
	A			
10	A			
	A			
		SC	slightly moist	**CLAYEY SAND,** predominantly fine grained, subangular, low to medium plasticity, brown note: some calcium carbonate note: ring sample pushed from 15'6" to 16'6"
15	A, U			
		CL to CH with SP zones	moist	**CLAY WITH SAND ZONES,** medium to high plasticity, dark brown note: occasional thin lenses of fine grained sand note: some calcium carbonate
	A			
20	A			
	A	SP	slightly moist	**SAND,** fine grained, subangular to subrounded, nonplastic, light brown to brown note: some calcium carbonate
25				

GROUNDWATER

DEPTH(ft)	HOUR	DATE
41.0	0900	11-10-11
40.1	0640	11-11-11

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. W-317

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

JOB NO. 17-2011-4054 **DATE** 11-9-11 to 11-10-11

LOCATION	N1434987.0 E659595.2
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	8" Casing
SURFACE ELEV.	5022.27'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				A				SP	slightly moist	**SAND,** continued
								CL-CH with SP zones	very moist	**CLAY,** uncemented, medium to high plasticity, dark brown note: occasional lenses of fine grained sand ranging up to 6" in thickness
				A						
30				A			13.3			
				A						
								SC with CH zones	very moist	**CLAYEY SAND WITH CLAY ZONES,** fine grained, subangular to subrounded, low plasticity, brown
35				A						
				A						
40				A				SC-SM with CH zones	wet at 41'	**CLAYEY TO SILTY SAND WITH CLAY ZONES,** predominantly fine grained with some coarse grained zones, subangular to subrounded, uncemented, predominantly low plasticity with high plasticity zones, light brown with dark brown zones note: ring sample pushed from 40' to 41'
				U						
				A						
45				A						note: occasional zones with gravel below 45'
				A						
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	41.0	0900	11-10-11
▼	40.1	0640	11-11-11

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. W-317

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 11-9-11 to 11-10-11

LOCATION N1434987.0 E659595.2

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5022.27'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				A				SP-SM with CH zones	wet	**SAND TO SILTY SAND WITH OCCASIONAL CLAY ZONES,** predominantly fine grained with occasional coarse grained zones, subangular to subrounded, uncemented, nonplastic, light brown
				A						
55				A						
				A		110.2				note: increase in medium to coarse grained sand below 57'6"
60				A						note: no recovery at 60', probably due to presence of loose, medium to coarse grained sand
				U	NR					note: ring sample pushed from 60' to 61'
				A						
65				A						note: predominantly fine to medium grained sand with zones of coarse grained sand, coarse grained gravel & clay ranging up to 8" in thickness
				A						note: occasional lenses of fine to medium grained sand & lenses of clay with gravel ranging up to 8" in thickness
70				A						
				A						
75										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
41.0	0900	11-10-11
40.1	0640	11-11-11

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. W-317

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 11-9-11 to 11-10-11

LOCATION	N1434987.0 E659595.2
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	8" Casing
SURFACE ELEV.	5022.27'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				A				SP-SM with CH zones	wet	**SAND TO SILTY SAND WITH OCCASIONAL CLAY ZONES,** continued
				A						
80				A						
				A						
85				A						note: some well graded, subangular to subrounded gravel below 85'
				A						
90				A						
				A						
95				A						
				A						
100										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	41.0	0900	11-10-11
▼	40.1	0640	11-11-11

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. W-317

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 11-9-11 to 11-10-11

LOCATION N1434987.0 E659595.2

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5022.27'
DATUM AEZ 0201; NAVD88

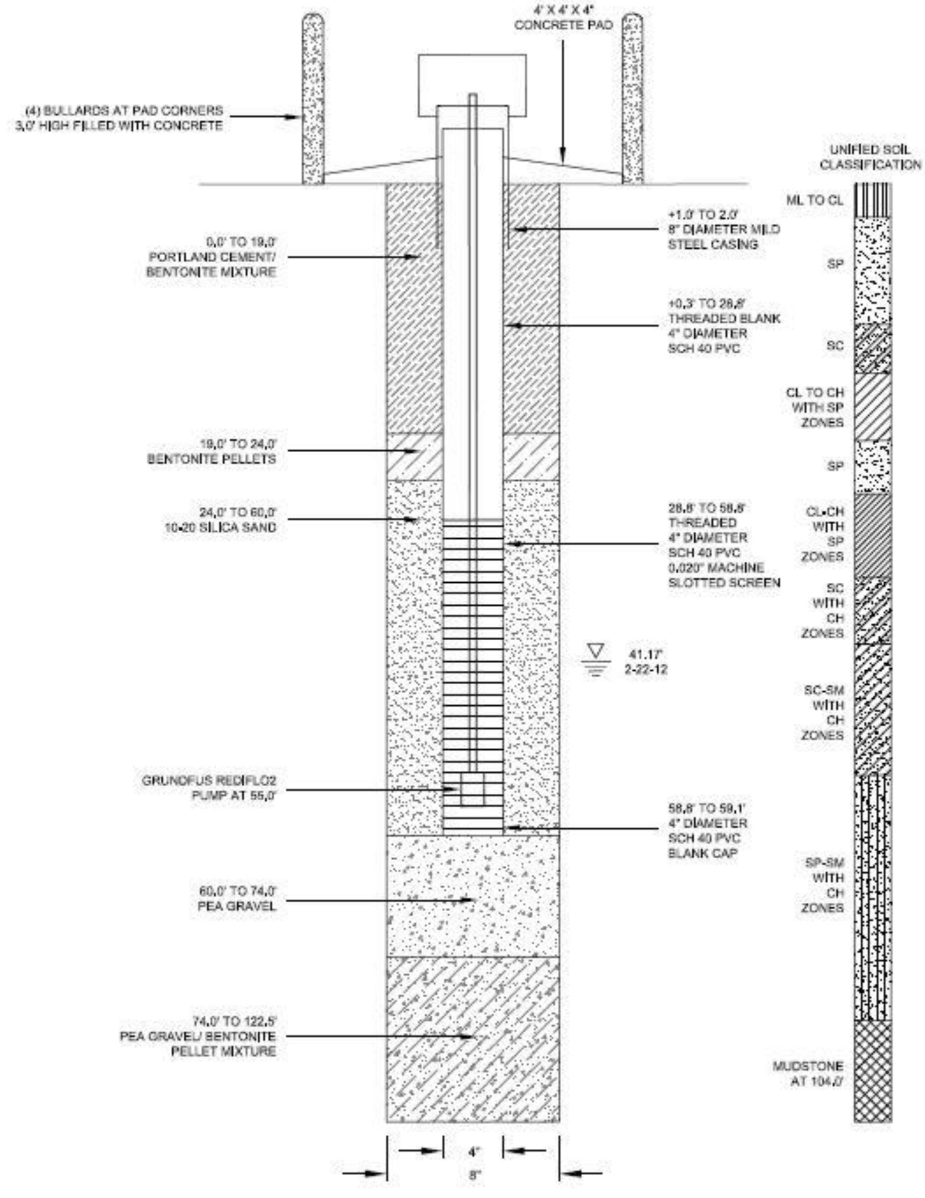
Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
100				A				SP-SM with CH zones	wet	**SAND TO SILTY SAND WITH OCCASIONAL CLAY ZONES,** continued note: considerable coarse grained sand & gravel below 103'
				A						
		+ +								**Moenkopi Formation - Moqui Member** **CALCAREOUS MUDSTONE,** medium bedded, highly weathered to decomposed, very soft to soft, dark reddish-brown with green zones note: slightly to moderately weathered below 108' note: mudstone breaks down to medium to high plasticity clay
105		+ +		A						
		+ +		A						
110		+ +		A						
		+ +		A						
115		+ +		A						
		+ +		A						
120		+ +		A						
										Stopped Drilling at 122'6" Installed 4" Diameter Schedule 40 PVC Monitor Well
125										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	41.0	0900	11-10-11
▼	40.1	0640	11-11-11

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. W-317



JOB NO.	17-2011-4054
DESIGN:	MAK
DRAWN:	GWH
DATE:	3/2012
SCALE:	NOT TO SCALE

MONITOR WELL W-317
ADWR REGISTRATION NO. 55-913770

ARIZONA PUBLIC SERVICE - CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

amec
Environment & Infrastructure
4600 East Washington Street, Suite 600
Phoenix, Arizona

SUMMARY OF LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS SAMPLES
PRODUCTION WELL DM-4R (55-910008)
ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT
JOSEPH CITY, ARIZONA

DRILLING METHOD:	0 to 90 feet drilled with 9.625-inch hammer bit using an air-assisted, reverse circulation, hammer drilling rig.
METHOD FOR LITHOLOGIC SAMPLE COLLECTION:	Composite, unwashed samples obtained at 10-foot intervals from cuttings collected at land surface.
DETAILED LITHOLOGIC LOGS:	On file at Montgomery & Associates.
SAMPLE PRESERVATION:	Plastic sample trays stored at Montgomery & Associates.

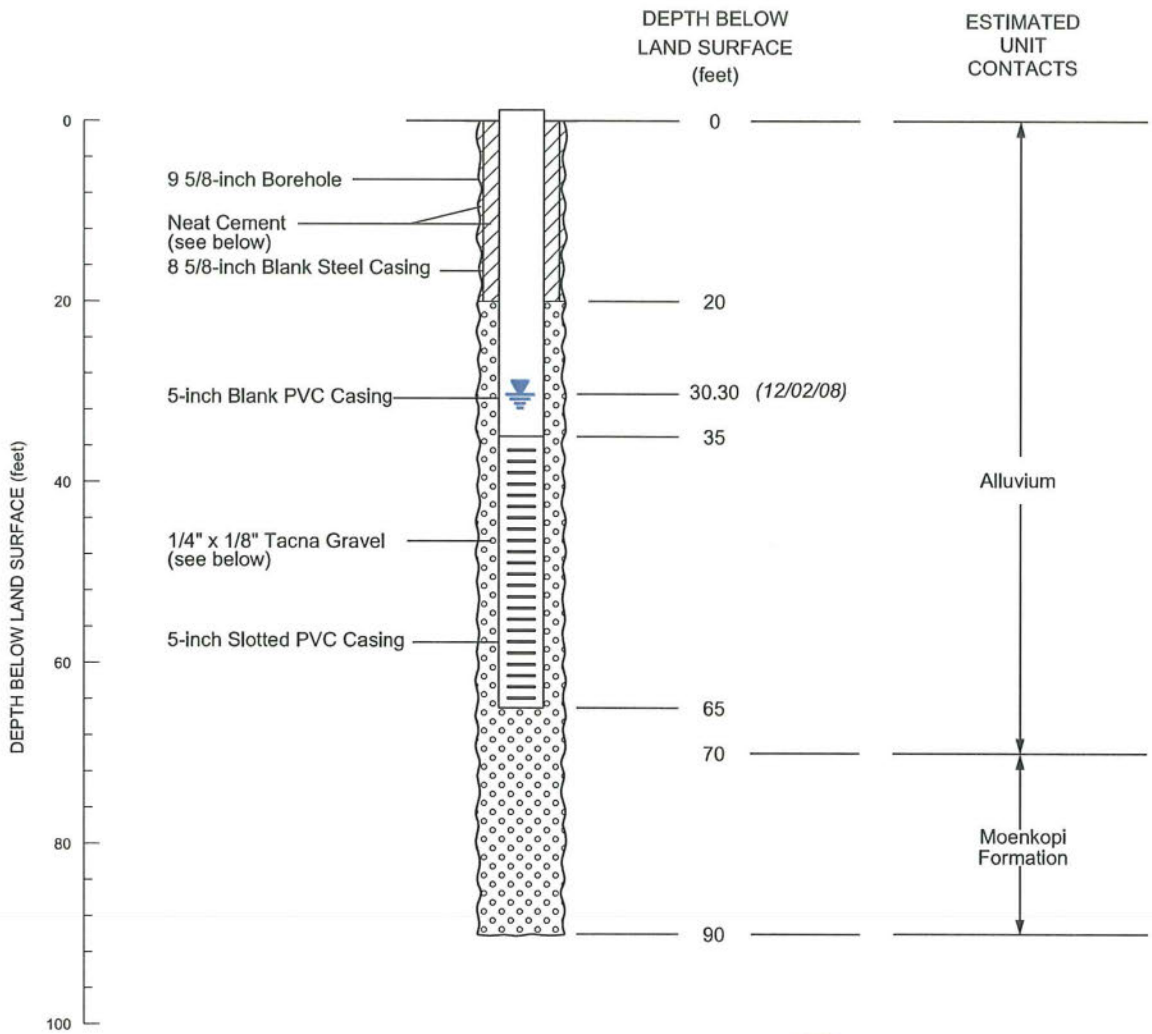
DEPTH (feet)	DESCRIPTION
	QUATERNARY ALLUVIUM
0-10	Brown (7.5 YR 5/3). Silty sand (SW-SM); sand 60%, silt 30%, and gravel 10%; poorly sorted; sand is fine to coarse grained, subrounded to rounded; gravel is subangular to subrounded, up to 10 millimeters (mm). Reaction to acid: moderate.
10-20	Brown (7.5 YR 5/3). Silty sand (SW-SM); sand 60%, silt 40%; poorly sorted; sand is very fine to medium grained, subrounded to rounded. Reaction to acid: moderate.
20-30	Brown (7.5 YR 5/3). Silty sand (SW-SM); sand 70%, silt 30%, and trace gravel; poorly sorted; sand is fine to very coarse grained, subrounded to rounded. Reaction to acid: moderate.
30-40	Brown (7.5 YR 5/3). Sand (SW); sand 90% and gravel 10%; poorly sorted; sand is fine to very coarse grained, subrounded to rounded; gravel is subangular to subrounded, up to 12 mm. Reaction to acid: moderate.
40-70	Brown (7.5 YR 5/3). Sand (SP); sand 100%; well sorted; sand is very fine to medium grained, subrounded to rounded. Reaction to acid: weak to moderate.
	MOENKOPI FORMATION
70-80	Brown (7.5 YR 4/4). Transitional sandy clay (CL); clay 60% and sand 40%; well sorted; sand is very fine to fine grained. Reaction to acid: moderate.
80-90	Dark reddish brown (5 YR 3/4). Sandy siltstone chips and transitional clay; weakly to moderately lithified. Reaction to acid: moderate.

TOTAL DEPTH DRILLED: 90 feet; drilling completed November 23, 2008.

Lithologic descriptions prepared by John Laney.

Quaternary alluvium was described using the Unified Soil Classification System.

Color reference system used in this log from Macbeth Division of Kollmorgen Instruments Corp., **Munsell Soil Color Charts**, 1994 Revised Edition.



REGISTERED GEOLOGIST
CERTIFICATE NO.
28245
LESLIE T.
KATZ
Date Signed 12/13/10
ARIZONA, U.S.A.

Expires 9/30/12

GRAVEL		
Fraction Equivalents	U.S. Standard Sieve	Percent Passed
1/4"	1/4"	90.1
3/16"	#4	32.4
1/8"	#6	2.5
3/32"	#8	0.7

EXPLANATION

Non-pumping Water Level

Monitor well completed with an above surface locking monument.

Well casing is 5-inch schedule 80 PVC. Slots in well screen are 0.030-inch wide with 1/4-inch spacing.

Neat cement slurry consisting of 5.2 gallons of water per 94.6-pound bag of class A Portland cement, with a slurry density of 15.6 pounds per gallon.

WELL: (A-18-19) 26dab2	REGISTRATION: 55-910008
STATE: Arizona	COUNTY: Navajo
LATITUDE: 34°55'42.85"N	CLIENT: Arizona Public Service
LONGITUDE: 110°17'26.13"W	CHECKED BY: J. Laney

MONITOR WELL DM-4R
APS CHOLLA POWER PLANT
DISCHARGE POND AREA

MONTGOMERY & ASSOCIATES

890.11\DM-4R_WS2_LL\02Dec2010

SUMMARY OF LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS SAMPLES
PRODUCTION WELL M-43A (55-910013)
ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT
JOSEPH CITY, ARIZONA

DRILLING METHOD:	0 to 80 feet drilled with 13.38-inch hammer bit using an air-assisted, reverse circulation, hammer drilling rig.
METHOD FOR LITHOLOGIC SAMPLE COLLECTION:	Composite, unwashed samples obtained at 10-foot intervals from cuttings collected at land surface.
DETAILED LITHOLOGIC LOGS:	On file at Montgomery & Associates.
SAMPLE PRESERVATION:	Plastic sample trays stored at Montgomery & Associates.

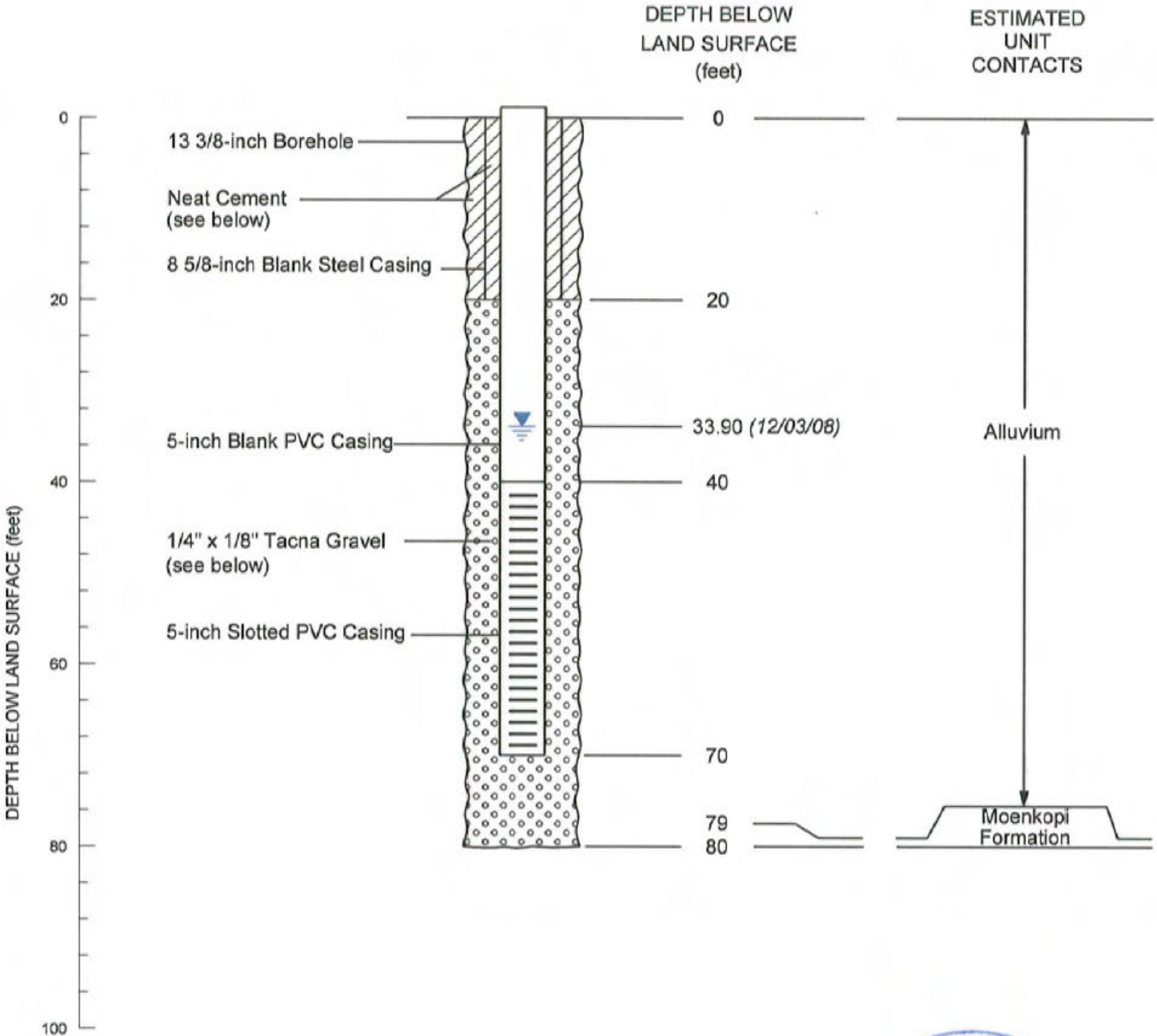
DEPTH (feet)	DESCRIPTION
	QUATERNARY ALLUVIUM
0-10	Reddish brown (5 YR 5/4). Silt with sand (ML); silt 80% and sand 20%; well sorted; sand is very fine to fine grained. Reaction to acid: moderate.
10-20	Reddish brown (5 YR 5/4). Sandy silt (ML); silt 60% and sand 40%; well sorted; sand is very fine to fine grained. Reaction to acid: strong.
20-50	Reddish brown (5 YR 4/4). Silty sand (SM); sand 60-70% and silt 30-40%; well sorted; sand is very fine to fine grained. Reaction to acid: moderate.
50-79	Brown (7.5 YR 5/3). Sand (SP); sand 100%; well sorted; sand is very fine to medium grained; subangular to subrounded. Reaction to acid: weak.
	MOENKOPI FORMATION
79-80	Dark reddish brown (5 YR 3/4). Sandy siltstone chips and clay; weakly to moderately lithified. Reaction to acid: moderate.

TOTAL DEPTH DRILLED: 80 feet; drilling completed November 21, 2008.

Lithologic descriptions prepared by John Laney.

Quaternary alluvium was described using the Unified Soil Classification System.

Color reference system used in this log from Macbeth Division of Kollmorgen Instruments Corp., **Munsell Soil Color Charts**, 1994 Revised Edition.



REGISTERED GEOLOGIST CERTIFICATE NO. 28245 LESLIE T. KATZ Date Signed 9/23/09 ARIZONA, U.S.A.

GRAVEL		
Fraction Equivalents	U.S. Standard Sieve	Percent Passed
1/4"	1/4"	90.1
3/16"	#4	32.4
1/8"	#6	2.5
3/32"	#8	0.7

EXPLANATION

Non-pumping Water Level

Monitor well completed with an above surface locking monument.

Well casing is 5-inch schedule 80 PVC. Slots in well screen are 0.030-inch wide with 1/4-inch spacing.

Neat cement slurry consisting of 5.2 gallons of water per 94.6-pound bag of class A Portland cement, with a slurry density of 15.6 pounds per gallon.

WELL: (A-18-19) 25acd	REGISTRATION: 55-910013
STATE: Arizona	COUNTY: Navajo
NORTHING: 1430933.68	CLIENT: Arizona Public Service
EASTING: 666102.6	CHECKED BY: J. Laney

MONITOR WELL M-43A
APS CHOLLA POWER PLANT
DISCHARGE POND AREA

MONTGOMERY & ASSOCIATES

890.11\M-43A_WS2\22Sept2009

MONTGOMERY & ASSOCIATES

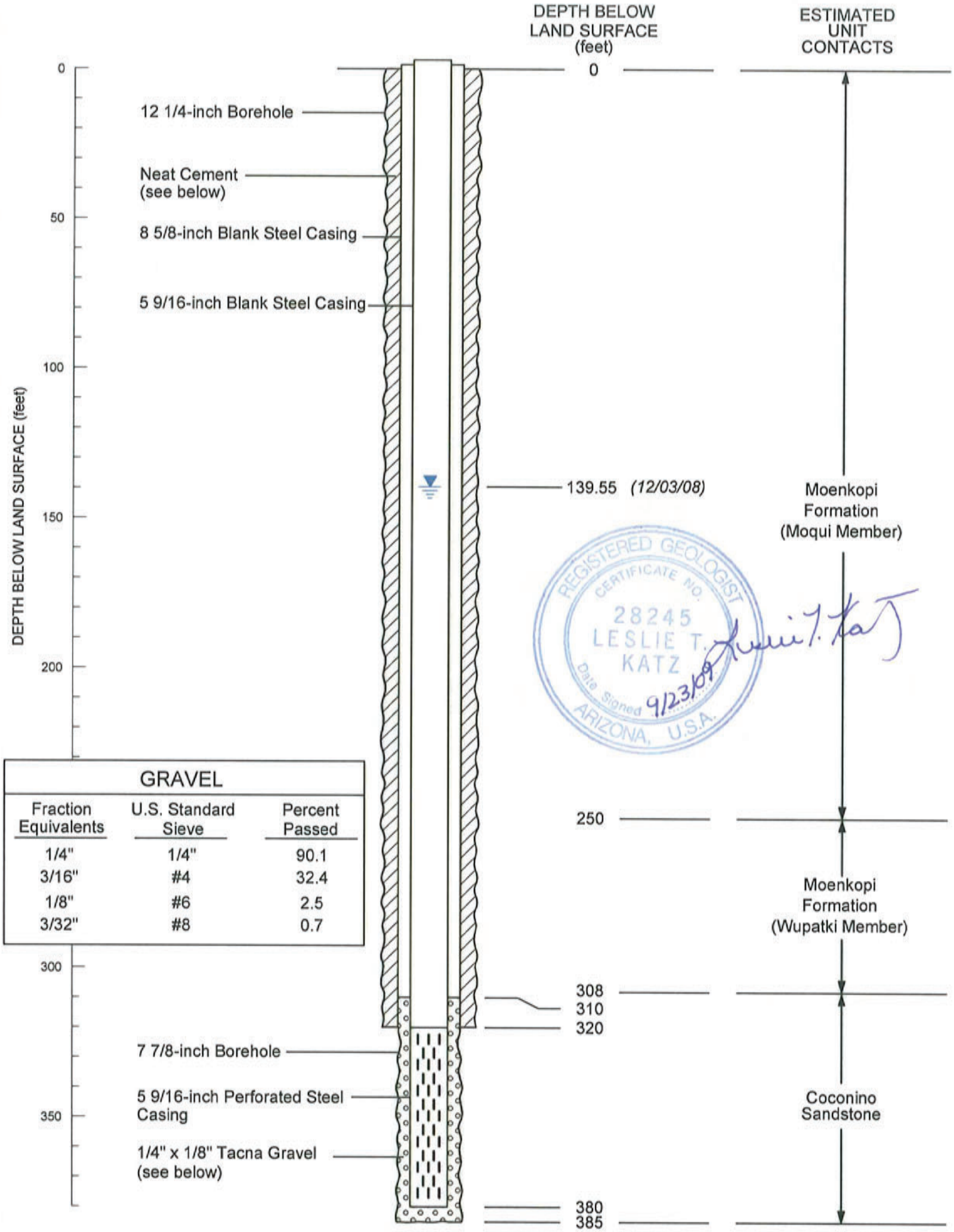
SUMMARY OF LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS SAMPLES
MONITOR WELL M-44D (55-909988)
ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT
JOSEPH CITY, ARIZONA

DRILLING METHOD:	0 to 320 feet drilled with 12.25-inch hammer bit using an air-assisted, reverse circulation, hammer drilling rig; 320 to 385 feet drilled with 8-inch tricone bit.
METHOD FOR LITHOLOGIC SAMPLE COLLECTION:	Composite, unwashed samples obtained at 10-foot intervals from cuttings collected at land surface.
DETAILED LITHOLOGIC LOGS:	On file at Montgomery & Associates.
SAMPLE PRESERVATION:	Plastic sample trays stored at Montgomery & Associates.

DEPTH (feet)	DESCRIPTION
	MOENKOPI FORMATION
0-10	Yellow (2.5 Y 7/6). Sandy siltstone chips with sandy clay; weakly to moderately lithified. Reaction to acid: weak.
10-20	Greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: weak.
20-50	Reddish brown (2.5 YR 4/4 – 5 YR 4/4). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
50-80	Reddish brown (2.5 YR 4/4) and greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
80-100	Reddish brown (2.5 YR 4/4 – 5 YR 4/4). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
100-170	Reddish brown (2.5 YR 4/4) and greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate to strong.
170-210	Reddish brown (2.5 YR 4/4) and greenish gray (5 BG 5/1). Sandy siltstone chips with trace white gypsum; moderately lithified. Reaction to acid: moderate to strong.
210-230	Reddish brown (2.5 YR 4/3). Sandy siltstone chips with trace white gypsum; moderately lithified. Reaction to acid: moderate.
230-250	Reddish brown (2.5 YR 4/3). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate to strong.
250-290	Weak red (2.5 YR 5/2). Silty sandstone; very fine grained; moderately lithified. Reaction to acid: moderate to strong.
290-308	Weak red (2.5 YR 5/2) and greenish gray (5 BG 6/1). Silty sandstone; very fine grained; moderately lithified. Reaction to acid: moderate.
	COCONINO FORMATION
308-330	Light yellowish brown (10 YR 6/4). Sand 100%; very fine grained; well sorted; sub-rounded to round quartz. Reaction to acid: weak.
330-340	Light gray (10 YR 7/2). Sand 100%; very fine grained; well sorted; sub-rounded to round quartz. Reaction to acid: weak.
340-385	White (10 YR 8/1). Sand 100%; very fine grained; well sorted; sub-rounded to round quartz. Reaction to acid: weak.

TOTAL DEPTH DRILLED: 385 feet; drilling completed November 13, 2008.
Lithologic descriptions prepared by John Laney.

Color reference system used in this log from Macbeth Division of Kollmorgen Instruments Corp., **Munsell Soil Color Charts**, 1994 Revised Edition.



GRAVEL		
Fraction Equivalents	U.S. Standard Sieve	Percent Passed
1/4"	1/4"	90.1
3/16"	#4	32.4
1/8"	#6	2.5
3/32"	#8	0.7

EXPLANATION

Non-pumping Water Level

Monitor well completed with an above surface locking monument.

Perforated Steel Casing: 1/8 x 3-inch vertical saw-cut perforations, with 6 perforations per round and 4 rounds per foot.

Neat cement slurry consisting of 5.2 gallons of water per 94.6-pound bag of class A Portland cement, with a slurry density of 15.6 pounds per gallon.

WELL: (A-18-20) 30bba2	REGISTRATION: 55-909988
STATE: Arizona	COUNTY: Navajo
NORTHING: 1434068.84	CLIENT: Arizona Public Service
EASTING: 669668.18	CHECKED BY: J. Laney

MONITOR WELL M-44D
APS CHOLLA POWER PLANT
FLY ASH POND AREA

MONTGOMERY & ASSOCIATES

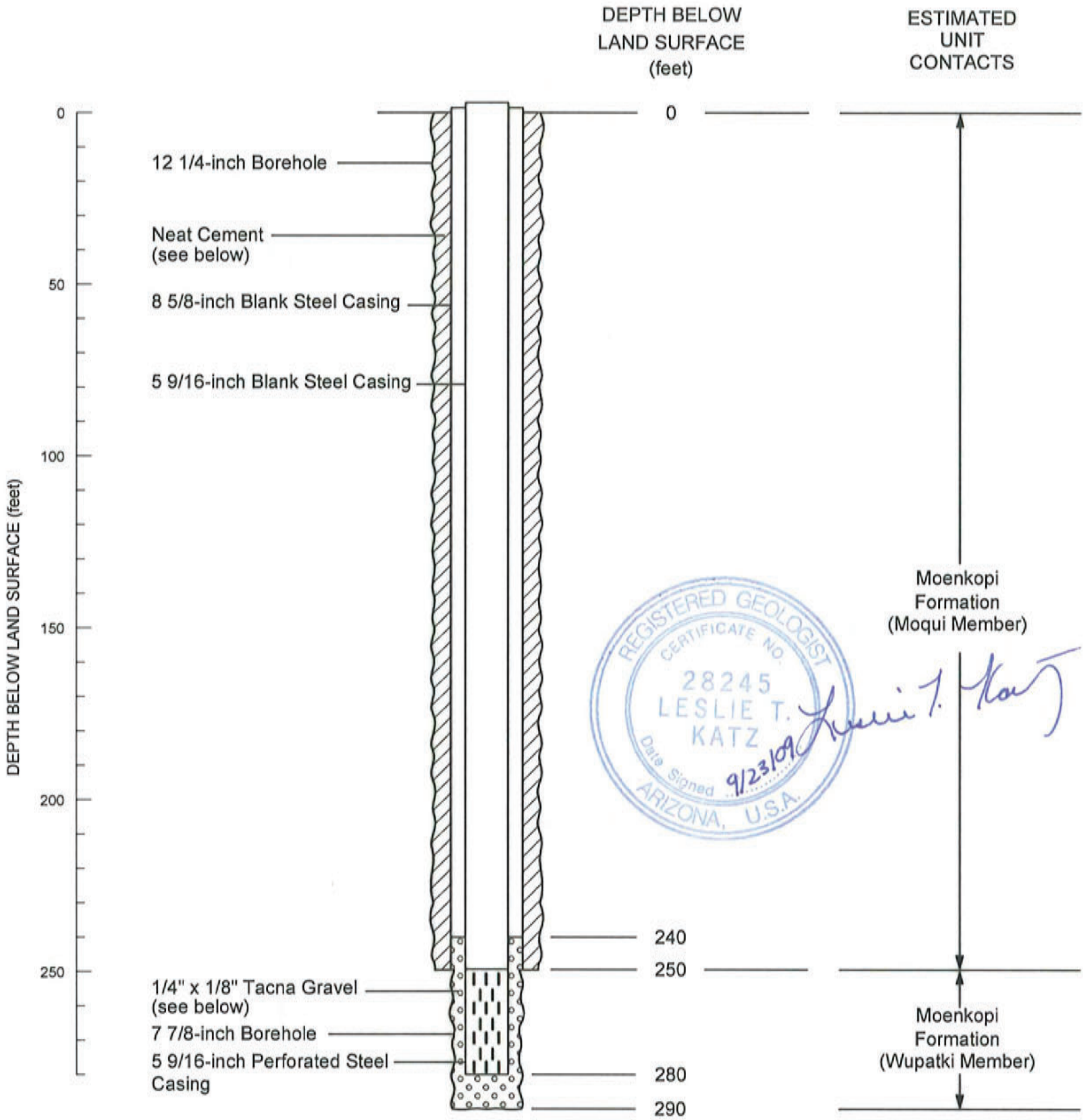
890.11\M-44D_WS2\22Sept2009

SUMMARY OF LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS SAMPLES
MONITOR WELL M-44S (55-909987)
ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT
JOSEPH CITY, ARIZONA

DRILLING METHOD:	0 to 250 feet drilled with 12.25-inch hammer bit using an air-assisted, reverse circulation, hammer drilling rig; 250 to 290 feet drilled with 8-inch tricone bit.
METHOD FOR LITHOLOGIC SAMPLE COLLECTION:	Composite, unwashed samples obtained at 10-foot intervals from cuttings collected at land surface.
DETAILED LITHOLOGIC LOGS:	On file at Montgomery & Associates.
SAMPLE PRESERVATION:	Plastic sample trays stored at Montgomery & Associates.

DEPTH (feet)	DESCRIPTION
	MOENKOPI FORMATION
0-20	Yellow (2.5 Y 7/6) to grayish brown (2.5 Y 5/2). Sandy siltstone chips with sandy clay; weakly to moderately lithified. Reaction to acid: weak.
20-30	Brown (7.5 YR 4/3). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
30-40	Greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
40-50	Reddish brown (2.5 YR 4/4). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
50-60	Greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
60-80	Reddish brown (2.5 YR 4/4). Sandy siltstone chips; moderately lithified. Reaction to acid: strong.
80-90	Greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate.
90-160	Reddish brown (2.5 YR 4/3-4/4). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate to strong.
160-170	Greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate.
170-190	Reddish brown (2.5 YR 4/3). Sandy siltstone chips with trace white gypsum; moderately lithified. Reaction to acid: moderate.
190-200	Greenish gray (5 BG 5/1). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate.
200-250	Reddish brown (2.5 YR 4/3). Sandy siltstone chips; moderately lithified. Reaction to acid: moderate to strong.
250-290	Weak red (2.5 YR 5/2). Silty sandstone; very fine grained; moderately lithified. Reaction to acid: moderate to strong.

MONTGOMERY & ASSOCIATES



GRAVEL

Fraction Equivalents	U.S. Standard Sieve	Percent Passed
1/4"	1/4"	90.1
3/16"	#4	32.4
1/8"	#6	2.5
3/32"	#8	0.7

EXPLANATION

Monitor well completed with an above surface locking monument.

Perforated Steel Casing: 1/8 x 3-inch vertical saw-cut perforations, with 6 perforations per round and 4 rounds per foot.

Neat cement slurry consisting of 5.2 gallons of water per 94.6-pound bag of class A Portland cement, with a slurry density of 15.6 pounds per gallon.

WELL: (A-18-20) 30bba1	REGISTRATION: 55-909987
STATE: Arizona	COUNTY: Navajo
NORTHING: 1434059.99	CLIENT: Arizona Public Service
EASTING: 669726.82	CHECKED BY: J. Laney

MONITOR WELL M-44S
APS CHOLLA POWER PLANT
FLY ASH POND AREA

MONTGOMERY & ASSOCIATES

PROJECT: Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 11/12/11

LOCATION	N1432931.3 E665632.0
RIG TYPE	Boart Longyear Rotosonic 300
BORING TYPE	8" Casing
SURFACE ELEV.	5025.57'
DATUM	AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL	slightly moist	**Man-made Fill** **SILTY CLAY,** medium plasticity, brown
				A						
								CH	moist	**Little Colorado River Alluvium** **CLAY,** high plasticity, dark brown note: some to considerable calcium carbonate (stringers/filaments)
5				A						
				A						
10				A						
				A						
15				A						
				A						
20				A						
								SP	slightly moist	**SAND WITH CLAY ZONES,** predominantly fine grained, subangular to subrounded, uncemented, nonplastic, light orangish-to reddish-brown with green zones
				A						
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1230	11-12-11
▼	40.5	0800	11-13-11

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-45A

PROJECT: Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 11/12/11

LOCATION: N1432931.3 E665632.0
RIG TYPE: Boart Longyear Rotosonic 300
BORING TYPE: 8" Casing
SURFACE ELEV.: 5025.57'
DATUM: AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				A				SP	slightly moist	**SAND WITH CLAY ZONES,** continued note: sand with well graded gravel from 25' to 31'
				A						
30				A		8.1				
								ML	moist	**SILT WITH CLAY ZONES,** uncemented, low to medium plasticity, brown to dark brown
				A				SC to CL	slightly moist to moist	**CLAYEY SAND locally grading to CLAY WITH SAND,** predominantly fine to medium grained, subangular sand, uncemented, medium plasticity, dark reddish-brown
35				A				CL-ML	very moist to wet below 37'6"	**CLAY & SILT WITH SAND,** predominantly fine to medium grained sand, uncemented, low to medium plasticity, dark reddish-brown with green inclusions
				A						
40				A, U						
								SP	wet	**SAND,** predominantly fine grained, subangular to subrounded, uncemented, nonplastic, light brown note: ring sample pushed from 40' to 41'
				A						
45				A						
				A				CL to SC	wet	**CLAY WITH SAND locally grading to CLAYEY SAND,** predominantly fine grained sand with occasional fine grained gravel, uncemented, medium plasticity, dark reddish-brown
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
40.0	1230	11-12-11
40.5	0800	11-13-11

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-45A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 **DATE** 11/12/11

LOCATION N1432931.3 E665632.0
RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5025.57'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				A U				CL to SC	wet	**CLAY WITH SAND locally grading to CLAYEY SAND,** continued note: ring sample pushed from 50' to 51'
				A						
55				A						
				A						
60				A U						**Moenkopi Formation - Moqui Member CALCAREOUS MUDSTONE,** slightly to moderately weathered, soft to very soft, dark reddish-brown with green zones note: occasional gypsum stringers ranging up to 3" in thickness note: ring sample pushed from 60' to 61'
				A						
65				A						
				A						
70										Stopped Drilling at 68'6" Installed 4" Diameter Schedule 40 PVC Monitor Well
75										

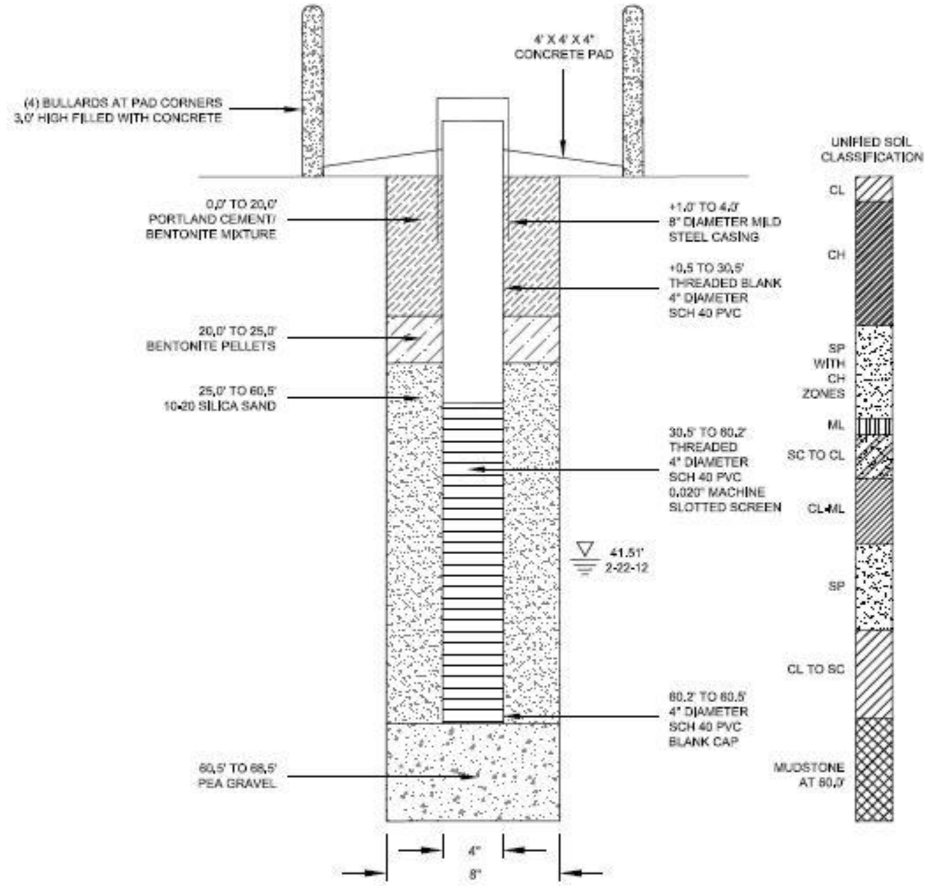
GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.0	1230	11-12-11
▼	40.5	0800	11-13-11
▽			
▼			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-45A



JOB NO.	17-2011-4054	MONITOR WELL M-45A ADWR REGISTRATION NO. 55-913769	amec *Environment & Infrastructure* *4600 East Washington Street, Suite 600* *Phoenix, Arizona*
DESIGN:	MAK		
DRAWN:	GWH		
DATE:	3/2012	ARIZONA PUBLIC SERVICE - CHOLLA POWER PLANT NAVAJO COUNTY, ARIZONA	
SCALE:	NOT TO SCALE		

PROJECT	
	Arizona Public Service Company (APS)
	Cholla Power Plant
	Navajo County, Arizona

JOB NO. 17-2011-4054 DATE 11/14/11

LOCATION N1429132.2 E667780.6

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5025.36'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CH	slightly moist	**Little Colorado River - Alluvium** **CLAY,** high plasticity, dark brown with white streaks
				A						
5				A						note: trace sand below 5'
										note: some to considerable short calcium carbonate filaments
				A						
10				A						
				A						
15				A						note: some sand from 15' to 17'6"
				A						
20				A						
								CH to SC	moist to very moist	**CLAY WITH SAND locally grading to CLAYEY SAND,** predominantly fine grained, subangular to subrounded sand, uncemented, high plasticity, dark brown to brown
				A				SP	very moist	**SAND WITH CLAY**
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	28.5	1230	11-14-11
▼	26.8	1450	11-14-11
▽	25.7	0900	11-15-11
▽			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-46A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

JOB NO. 17-2011-4054 **DATE** 11/14/11

LOCATION N1429132.2 E667780.6

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5025.36'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				A				SP	very moist	**SAND WITH CLAY,** fine grained, subangular to subrounded, uncemented, nonplastic, light brown to brown note: occasional lenses of high plasticity clay
				A				CH	moist	**CLAY,** high plasticity, dark reddish-brown note: trace calcium carbonate
30				A, A, A				CL	wet below 30'	**SANDY CLAY,** predominantly fine to medium grained, subangular to subrounded sand, uncemented, medium plasticity, dark reddish-brown
35				A, A						**Moenkopi Formation - Moqui Member** **CALCAREOUS MUDSTONE,** medium bedded, slightly to moderately weathered, soft to very soft with moderately soft zones below 37'6", dark reddish-brown with yellowish-green & light brown zones
40										Stopped Drilling at 40' Installed 4" Diameter Schedule 40 PVC Monitor Well
45										
50										

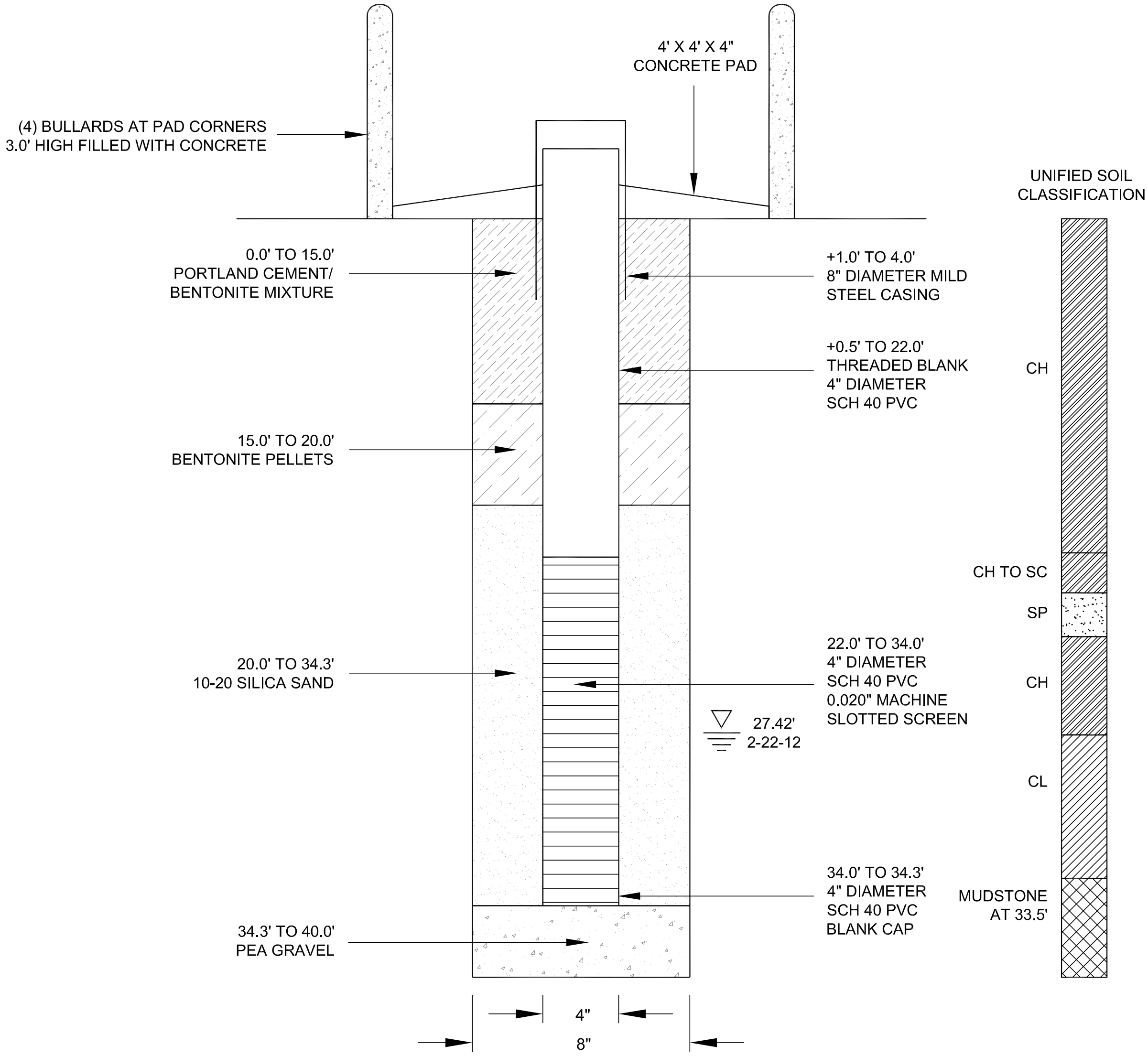
GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	28.5	1230	11-14-11
▼	26.8	1450	11-14-11
▽	25.7	0900	11-15-11
▽			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-46A



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JOB NO.	17-2011-4054
DESIGN:	MAK
DRAWN:	GWH
DATE:	3/2012
SCALE:	NOT TO SCALE

MONITOR WELL M-46A
ADWR REGISTRATION NO. 55-913771

ARIZONA PUBLIC SERVICE - CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

amec

Environment & Infrastructure
4600 East Washington Street, Suite 600
Phoenix, Arizona

TABLE A-01. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM Monitoring Well M-49A [*55-918639*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING METHOD / COMPANY: ARCH / National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION (Approx.): 35.0 feet / 4950 feet msl	DATE DRILLED: 9/15 - 9/16/2015
CADASTRAL / NAD27 : (A-18-19)36adb / 3864125 N / 566388 E	BOREHOLE DIAMETER: 13 3/8 inches

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 80%, silt and clay 20%, trace gravel. Gravel fraction: gravel to 0.2 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**CLAYEY SAND WITH GRAVEL (SC)**: Reddish brown [5YR5/3]; subangular to rounded, fine to coarse sand 60%, silt and clay 25%, gravel 15%. Gravel fraction: gravel to 0.4 in. consisting of chert and stilstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
10.0 - 15.0	**Qal**	**CLAYEY SAND WITH GRAVEL (SC)**: Reddish brown [5YR5/3]; subangular to rounded, fine to coarse sand 60%, silt and clay 25%, gravel 15%. Gravel fraction: gravel to 0.4 in. consisting of chert and stilstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
15.0 - 20.0	**Qal**	**WEATHERED SILTSTONE**: Reddish brown [5YR4/3]; Moderately lithified. Reaction to acid: strong.
TRIASSIC MOENKOPI FORMATION (TRm)		
20.0 - 25.0	**TRm**	**SILTSTONE**: Reddish brown [5YR4/3]; Well lithified. Reaction to acid: strong.
25.0 - 30.0	**TRm**	**SILTSTONE**: Moderate brown [5YR4/4]; Well lithified. Reaction to acid: moderate.
30.0 - 35.0	**TRm**	**SILTSTONE**: Moderate brown [5YR4/4]; Well lithified. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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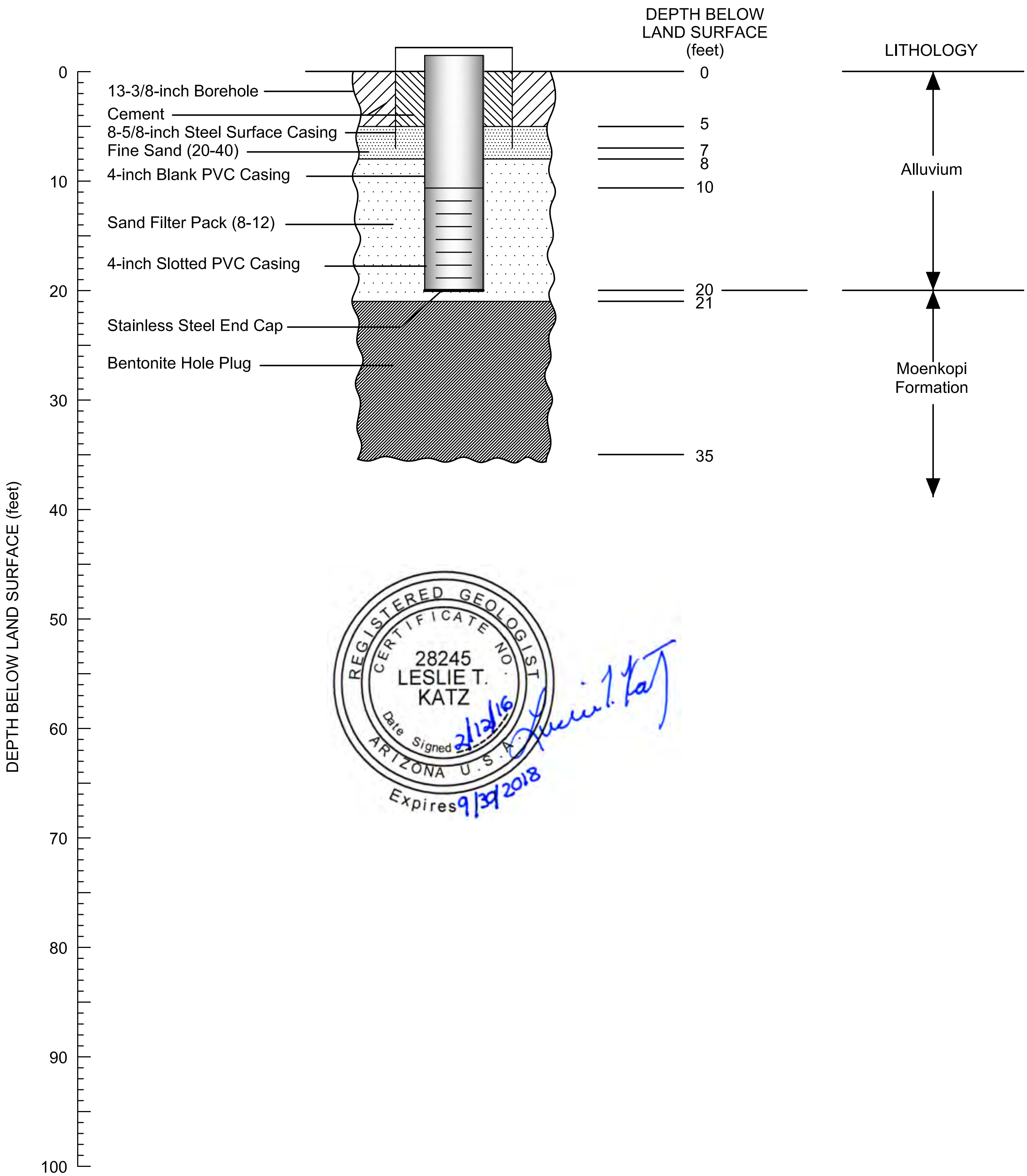

EXPLANATION

Note: Co-ordinates from hand-held GPS unit.
All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-49A (LCR-1U)	NORTHING: 1425911.106
REGISTRATION: 55-918639	EASTING: 667858.823
COUNTY: Navajo, Arizona	MP Elevation:
DATE COMPLETED: 09/16/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-49A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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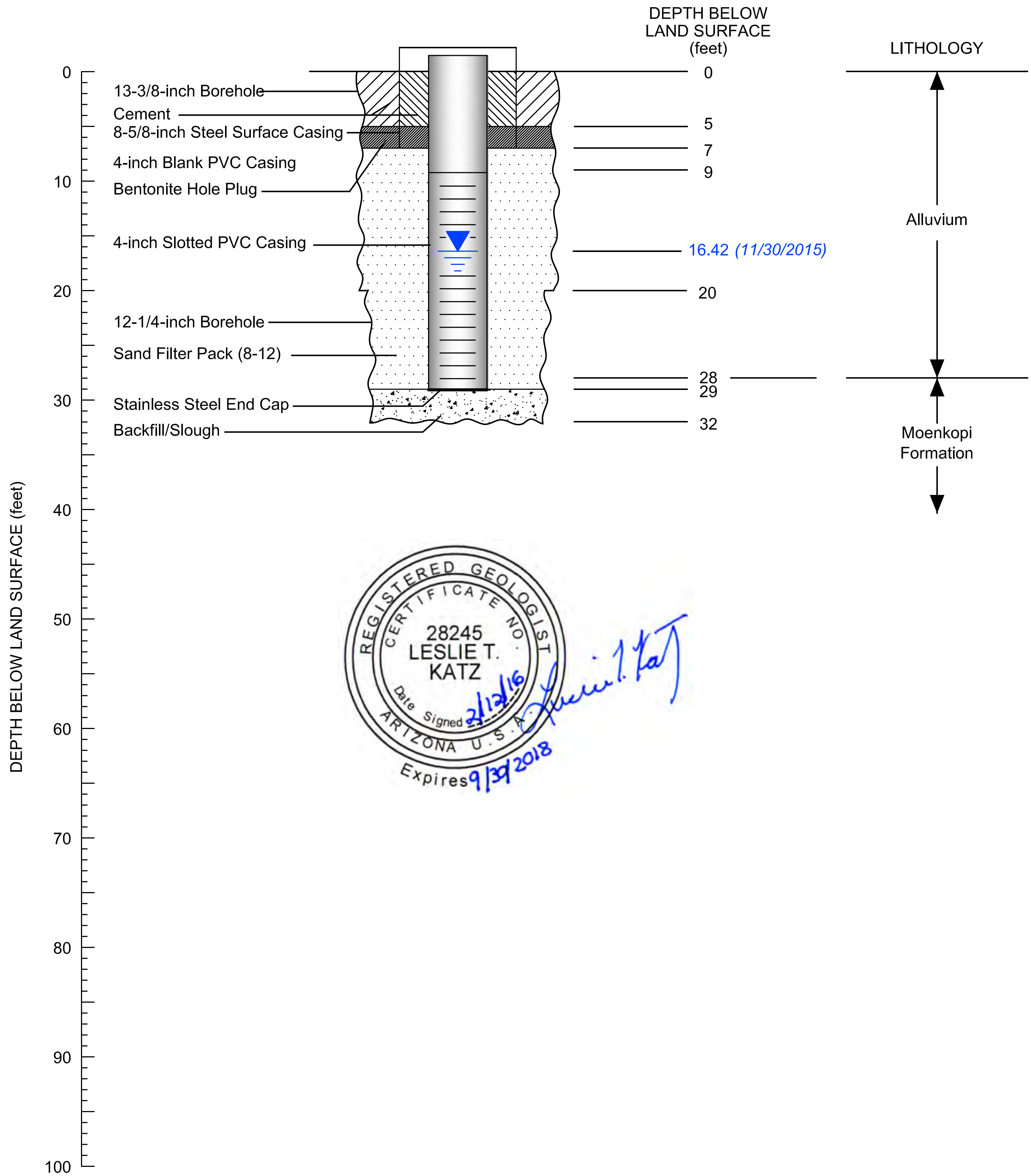
TABLE A-1. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM Monitoring Well M-50A [*55-918641*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 32.0 feet / 5035.649 feet msl	DATE DRILLED: 9/18/2015
CADASTRAL / NAD83 : (A-18-20)30bbc / 1429799.423 N / 669243.755 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded, fine to coarse sand 60%, silt and clay 40%, trace gravel. Gravel fraction: rounded to angular gravel to 1.3 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**CLAYEY SAND (SC)**: Dark reddish gray [5YR4/2]; subangular to rounded, fine to coarse sand 60%, silt and clay 40%, trace gravel. Gravel fraction: rounded to angular gravel to 1 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
10.0 - 15.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 50%, silt and clay 50%, trace gravel. Gravel fraction: rounded to angular gravel to 0.3 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
15.0 - 20.0	**Qal**	**CLAYEY SAND (SC)**: Moderate brown [5YR4/4]; subangular to rounded, fine to coarse sand 60%, silt and clay 30%, gravel 10%. Gravel fraction: gravel to 0.5 in. consisting of gypsum and trace chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
20.0 - 28.0	**Qal**	**WELL GRADED GRAVEL WITH CLAY (GW-GC)**: Yellowish red [5YR4/6]; gravel 80%, subangular to rounded, fine to medium sand 10%, silt and clay 10%. Gravel fraction: gravel to 0.8 in. consisting of gypsum and siltstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
TRIASSIC MOENKOPI FORMATION (TRm)		
28.0 - 32.0	**TRm**	**WEATHERED SILTSTONE**: Moderate brown [5YR4/4]; Moderately lithified. Well graded. Reaction to acid: strong.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-50A (FAP-2D)	NORTHING: 1429799.42
REGISTRATION: 55-918641	EASTING: 669243.76
COUNTY: Navajo, Arizona	MP Elevation: 5038.179 feet amsl
DATE COMPLETED: 09/18/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-50A APS CHOLLA POWER PLANT

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2016

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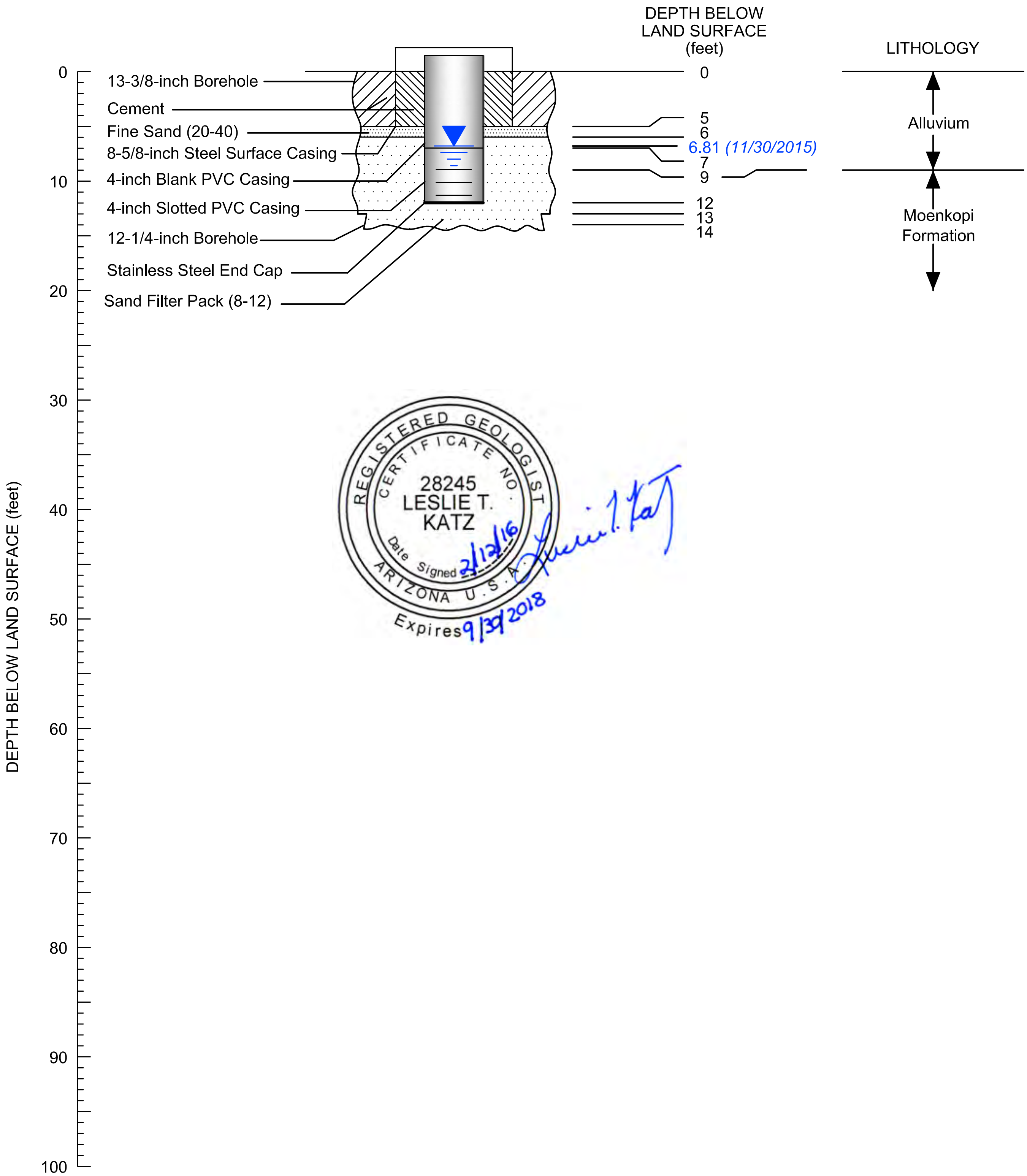
TABLE A-2. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM Monitoring Well M-51A [*55-918640*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 14.0 feet / 5039.100 feet msl	DATE DRILLED: 9/18/2015
CADASTRAL / NAD83 : (A-18-19)25add / 1430360.144 N / 668733.143 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY GRAVEL WITH SAND (GC)**: Moderate brown [5YR4/4]; gravel 50%, subangular to rounded, fine to coarse sand 25%, silt and clay 25%. Gravel fraction: gravel to 1.6 in. consisting of chert and gypsum. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: strong.
5.0 - 9.0	**Qal**	**WELL GRADED GRAVEL WITH SILT (GW-GM)**: Yellowish red [5YR4/6]; gravel 80%, subangular to rounded, fine to coarse sand 10%, silt and clay 10%. Gravel fraction: gravel to 1.2 in. consisting of weathered siltstone and fine sandstone, and trace gypsum. Weakly lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
9.0 - 14.0	**TRm**	**WEATHERED SILTSTONE AND FINE SANDSTONE WITH TRACE GYPSUM**: Moderate brown [5YR4/4]; Moderately lithified. Reaction to acid: strong.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-51A (FAP-1D)	NORTHING: 1430360.14
REGISTRATION: 55-918640	EASTING: 668733.14
COUNTY: Navajo, Arizona	MP Elevation: 5041.765 feet amsl
DATE COMPLETED: 9/19/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-51A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

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TABLE A-15. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-63A [*55-918638*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING METHOD / COMPANY: ARCH / National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 57.0 feet / 5018.900 feet msl	DATE DRILLED: 11/18 - 11/19/2015
CADASTRAL / NAD83 : (A-18-19)25cdc / 1427872.126 N / 665237.632 E	BOREHOLE DIAMETER: 13 3/8 inches

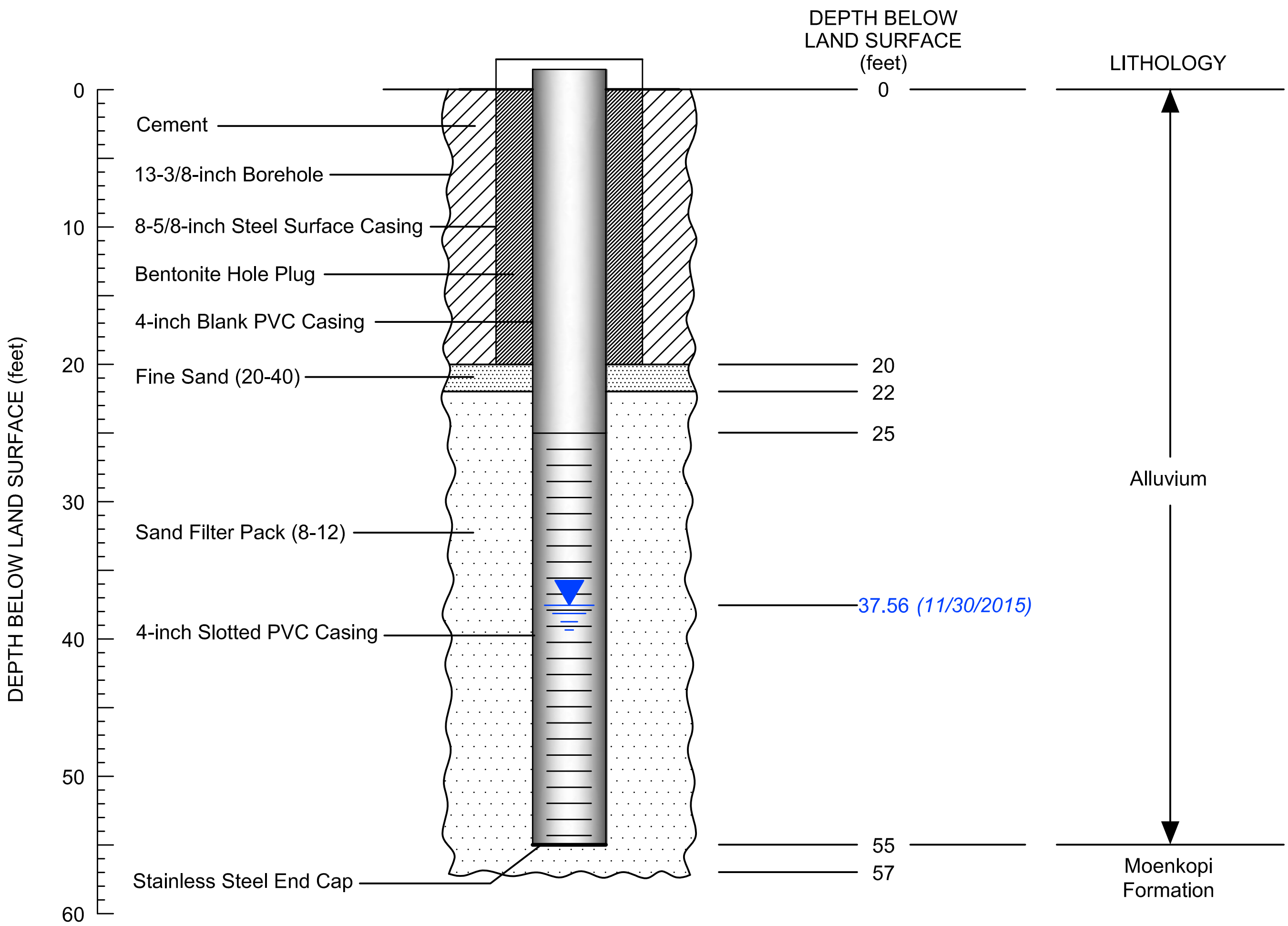
DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SILT (ML)**: Reddish brown [2.5YR5/4]; silt and clay 90%, subrounded to rounded fine sand 10%. Non-lithified. Low plasticity. Poorly graded. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**SILT WITH CLAY (ML)**: Light reddish brown [2.5YR6/3]; silt and clay 80%, subrounded to rounded fine sand 20%. Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
10.0 - 15.0	**Qal**	**POORLY GRADED SAND (SP)**: Pinkish gray [7.5YR6/2]; subrounded, fine to medium sand 95%, gravel 5%. Gravel fraction: subangular gravel to 0.4 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: weak.
15.0 - 20.0	**Qal**	**POORLY GRADED SAND (SP)**: Pinkish gray [7.5YR6/2]; subrounded, fine to medium sand 90%, gravel 10%. Gravel fraction: subangular gravel to 0.8 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
20.0 - 25.0	**Qal**	**WELL GRADED SAND (SW)**: Brown [7.5YR5/3]; subrounded, fine to coarse sand 90%, gravel 10%. Gravel fraction: subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
25.0 - 30.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Brown [7.5YR5/3]; subrounded, fine to coarse sand 50%, gravel 30%, silt and clay 20%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of sandstone and chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: strong.
30.0 - 35.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Brown [7.5YR5/3]; subrounded, fine to coarse sand 55%, gravel 40%, silt 5%. Gravel fraction: subangular to rounded gravel to 1.6 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: strong.
35.0 - 40.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/3]; subrounded, fine to coarse sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 0.3 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Brown [7.5YR5/3]; subrounded, fine to coarse sand 75%, gravel 20%, silt 5%. Gravel fraction: subangular to subrounded gravel to 0.3 in. consisting of sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Reddish brown [2.5YR4/4]; subrounded, fine to coarse sand 60%, gravel 30%, silt 10%. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-15. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-63A [*55-918638*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
50.0 - 55.0	**Qal**	**WELL GRADED GRAVEL WITH SAND AND SILT (GW-GM)**: Reddish brown [2.5YR4/4]; gravel 55%, subrounded, fine to coarse sand 35%, silt 10%. Gravel fraction: subangular to subrounded gravel to 1.6 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
55.0 - 57.0	**TRm**	**FINE TO MEDIUM GRAINED SANDSTONE**: Weak red [2.5YR4/2]; Gravel fraction: gravel to 2 in.. Well lithified. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.



EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-63A (DM-3R)	NORTHING: 1427872.13
REGISTRATION: 55-918638	EASTING: 665237.63
COUNTY: Navajo, Arizona	MP Elevation: 5021.823 feet amsl
DATE COMPLETED: 11/19/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION
FOR ALLUVIAL WELL M-63A
APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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TABLE A-13. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-64A [*55-920353*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: Yellow Jacket Drilling	LOGGED BY: C.Stielstra, M. Zelazny
DEPTH DRILLED / LAND SURFACE ELEVATION: 69.0 feet / 4988.904 feet msl	DATE DRILLED: 2/8/2017
CADASTRAL : (A-18-19)21ccb / 1434030.012 N / 647702.043 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**FAT CLAY (CH)**: Reddish brown [5YR4/3]; silt and clay 92%, sand 8%. Non-lithified. High plasticity. Well sorted. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 50%, silt 50%. Non-lithified. Very low plasticity. Moderately sorted. Reaction to acid: weak to moderate.
10.0 - 15.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 80%, silt 20%. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
15.0 - 20.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 75%, silt 25%. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
20.0 - 25.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR4/3]; sand 70%, silt 25%, gravel 5%. Gravel fraction: subangular gravel to 1 in. consisting of Sandstone, chert, siltstone and quartzite. Non-lithified. Non-plastic. Moderately sorted. Reaction to acid: weak to moderate.
25.0 - 30.0	**Qal**	**SILTY SANDS WITH GRAVEL (SM)**: Brown [7.5YR4/3]; sand 55%, gravel 25%, silt 20%. Gravel fraction: subangular gravel to 2 in. consisting of Chert, sandstone, coal and limestone. Non-lithified. Non-plastic. Moderately sorted. Reaction to acid: strong.
30.0 - 35.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR4/2]; sand 80%, silt 19%, gravel 1%. Gravel fraction: subangular gravel to 1.5 in. consisting of Chert, limestone, sandstone and quartzite. Non-lithified. Non-plastic. Moderately sorted. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR4/3]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 1.5 in. consisting of Clay stone, sandstone and quartzite. Non-lithified. Non-plastic. Well sorted. Reaction to acid: very strong.
40.0 - 45.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/3]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 1 in. consisting of Clay stone, chert, limestone and sandstone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak.
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/2]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 1.8 in. consisting of Clay stone, chert and sandstone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: moderate.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/2]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 2.5 in. consisting of Clay stone, sandstone, chert and limestone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.

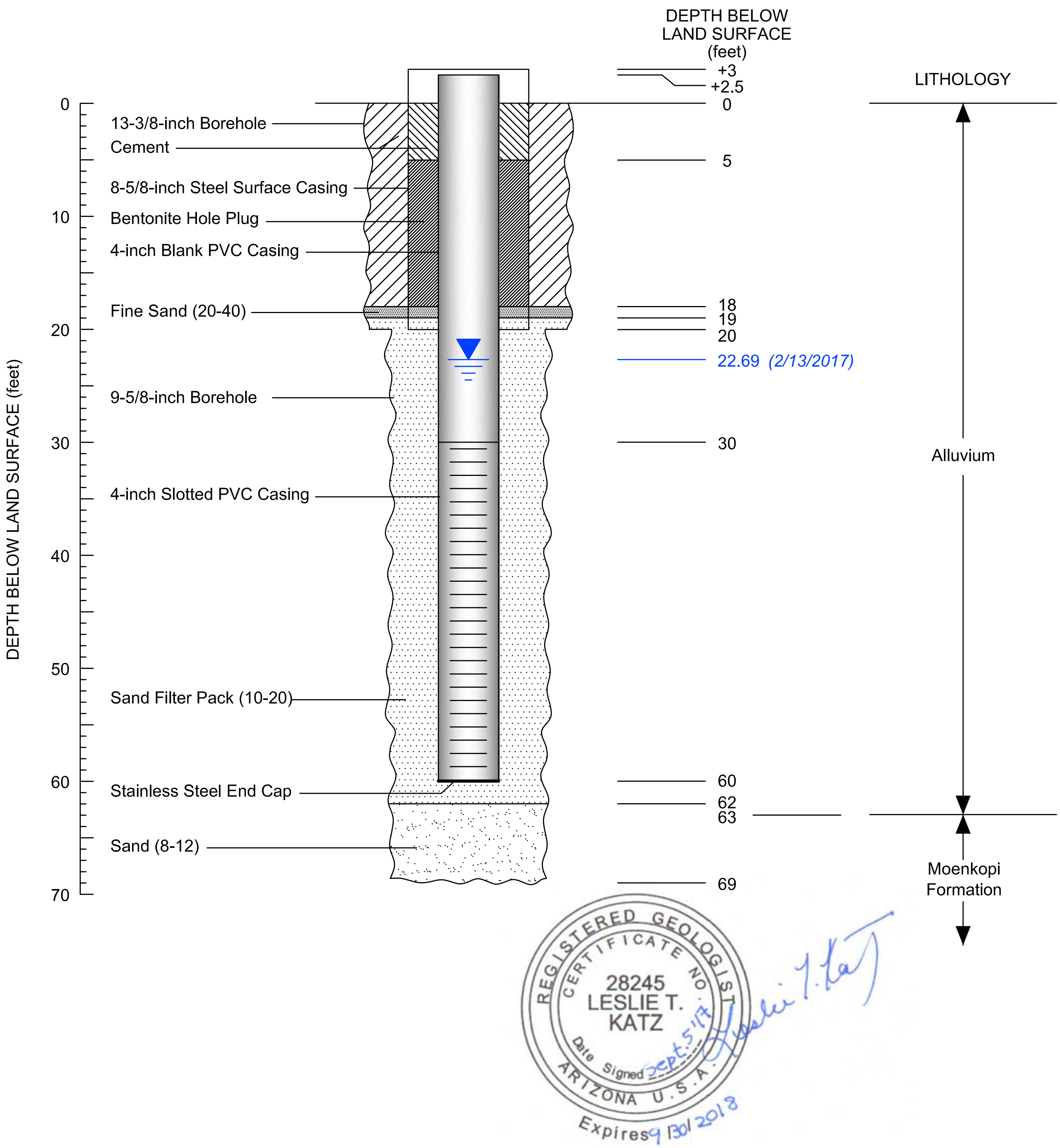
Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-13. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-64A [*55-920353*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
55.0 - 60.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/2]; sand 80%, silt 20%, trace gravel. Gravel fraction: subangular gravel to 1.3 in. consisting of Clay stone, sandstone, chert and limestone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
60.0 - 65.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 75%, silt 25%, trace gravel. Gravel fraction: subangular gravel to 1.3 in. consisting of Clay stone, sandstone, chert and limestone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		.
65.0 - 69.0	**TRm**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 55%, silt 42%, gravel 3%. Gravel fraction: subangular gravel to 1.3 in. consisting of Moenkopi chips. Non-lithified. Very low plasticity. Moderately sorted. Reaction to acid: weak to moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

MONTGOMERY & ASSOCIATES



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-64A	NORTHING: 1434030.012
REGISTRATION: 55-920353	EASTING: 647702.043
COUNTY: Navajo, Arizona	MP Elevation: 4,988.904
DATE COMPLETED: 2/9/2017	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-64A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2017

FIGURE A-13

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wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

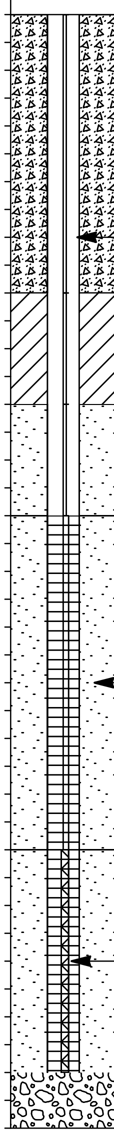
BORING LOG I.D.: MW-65A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	Isaac Torres	**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	Darius Cervantez	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-922299
RIG I.D.:	- - -	**COORDINATES:**	N1429134.06, E669178.50
RIG TYPE:	Rotosonic	**COORDINATE SYS:**	Arizona State Plane East Zone 0201, International Feet
BORING TYPE:	- - - **BORING DIA.:** 8"	**SURFACE ELEV. (FT):**	5026.21'
ORIENTATION:	90°	**MEAS. PT. ELEV. (FT):**	5027.86'
HAMMER TYPE:	Not Applicable	**VERTICAL DATUM:**	NAVD88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**COMPLETION DATE:**	11-14-2018 **COMPLETION TIME:** 11:45
START DATE:	11-14-2018 **START TIME:** 11:15		

Elevation in Feet	Depth in Feet	Unified Soil Classification	Sample ID. or Date (Time)	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
5026.2	0	ML		**SANDY SILT,** 75% fines, 25% fine to coarse grained, subrounded sand, brown (7.5YR 4/3), nonlithified, granular to angular blocky soil structure, weakly effervescent, nonplastic, slightly moist, loose density, low dry strength, no stains, no odors note: at 2.5' coarse grained sand increases, gradational basal contact
		SW-SM	11-14-18 (11:15)	**WELL GRADED SAND WITH SILT & GRAVEL,** 65% fine to coarse grained, subrounded to subangular sand, 25% fine to coarse grained, subrounded to subangular gravel, 10% fines, brown (7.5YR 4/2), nonlithified, single grain soil structure, weakly effervescent, nonplastic, slightly moist, very loose density, no dry strength, no stains, no odors note: at 5.5' sharp basal contact
5021.2	5	CL	11-14-18 (11:17)	**SILTY CLAY,** 85% fines, 15% fine to coarse grained, subrounded to subangular sand, dark brown (7.5YR 3/3), predominate calcium carbonate filaments, weakly cemented, highly effervescent, thin laminae (<1 mm), nonplastic, slightly moist, very firm to hard, medium to high dry strength, friable, no stains, no odor note: at 10.5' coarse grained sand increase note: from 11' to 12.5' soil is moist, massive, and trace calcium carbonate nodules note: at 13' soil slightly moist, blocky soil, and calcium carbonate nodules increase; gradational basal contact at 13.5'
5016.2	10			
5011.2	15	MH	11-14-18 (11:28)	**SANDY ELASTIC SILT,** 60% fines, 40% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2), lenses with an increase of coarse grained sand (50%) starting at 15', nonlithified, effervescent, wet, low to medium plasticity, soft firmness, medium density, no stains, no odors note: at 14' calcium carbonate nodules absent; note: lenses of coarse grained sand (50%) present at 16.5', 17.5', 19'
5006.2	20		11-14-18 (11:35)	

Graphical Log | PID Meter Reading (ppm)

WELL INFORMATION
(Construction Details and/or Drilling Remarks)



- Steel casing stick up +2', minimum 8" clearance between top of steel casing and top of 4" PVC well casing
- 4000 PSI Concrete Mix from 0 to 5'
- 4" Nominal Diameter Schedule 80 PVC Blank Casing from +1' to 9'
- Bentonite Plug from 5' to 7'
- Filter Pack (8-12) from 7' to 19'
- 4" Nominal Diameter Schedule 80 PVC (0.020" Slot Screen) from 9' to 19'
- Dedicated submersible pump
- Pea Gravel from 19' to 20'

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	13.7	11:55	11/14/18
▼	14.1	10:30	11/17/18
▼			
▼			

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-65A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922299	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5006.2	20			MH	note: at 20.5' olive brown staining near basal gradational contact **SANDY ELASTIC SILT,** continued	(Continued)
					Trmhm - Moqui Member of Moenkopi Formation (mid-unit), mudstone, 60% clay, 30% silt, 10% fine grained sand, dark reddish brown (5YR 3/4) with considerable olive brown staining (2.5Y 4/4), thin laminae (<0.5 mm), effervescent, wet, medium plasticity, medium stiff, ductile, no odors note: from 20.5' to 23' core sample is more compact in diameter note: from 22' to 23' gypsum nodules (<5 mm) present near sharp basal contact	Bentonite Chips from 20' to 25'
		11-14-18 (11:45)			**Trmhm - Moqui Member of Moenkopi Formation (mid-unit), silty mudstone,** 55% clay, 40% silt, 5% fine grained sand, dark reddish-brown (5YR 4/4), some filaments of gypsum (at about 23'), predominant lenses of gypsum (23.5' to 25'), thin laminae (<1 mm), weakly cemented, slightly moist, low to medium plasticity, hard, medium dry strength, friable, no odors	
5001.2	25					Total Depth = 25'
4996.2	30				Total Depth = 25'	
4991.2	35					
4986.2	40					
4981.2	45					

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	13.7	11:55	11/14/18
▼	14.1	10:30	11/17/18

METHOD Not Applicable

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-66A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	Isaac Torres	**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	Darius Cervantez	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-922300
RIG I.D.:	- - -	**COORDINATES:**	N1429526.69, E668254.52
RIG TYPE:	Rotosonic	**COORDINATE SYS:**	Arizona State Plane East Zone 0201, International Feet
BORING TYPE:	- - - **BORING DIA.:** 8"	**SURFACE ELEV. (FT):**	5032.46'
ORIENTATION:	90°	**MEAS. PT. ELEV. (FT):**	5033.35'
HAMMER TYPE:	Not Applicable	**VERTICAL DATUM:**	NAVD88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**COMPLETION DATE:**	11-12-2018 **COMPLETION TIME:** 15:40
START DATE:	11-12-2018 **START TIME:** 09:35		

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5032.5	0				ML	**SANDY SILT,** 80% fines, 15% fine to coarse grained, subrounded sand, 5% fine to coarse grained, subrounded to subangular gravel, brown (7.5 YR 4/3), nonlithified, granular to single grain soil structure, weakly effervescent, nonplastic, slightly moist, loose density, low dry strength, no stains, no odors note: at 2.5' sharp basal contact	0	Steel casing stick up +2', minimum 8" clearance between top of steel casing and top of 4" PVC well casing 4000 PSI Concrete Mix from 0 to 5'
					CL	**SILTY CLAY,** 90% fines, 10% fine to coarse grained, subrounded to subagular sand, dark brown (7.5YR 3/3), predominant calcium carbonate filaments, angular blocky soil structure, weakly cemented, highly effervescent, thin laminae (<1 mm), nonplastic, slightly moist, very firm to hard, low medium dry strength, friable, no stains, no odors		4" Nominal Diameter Schedule 80 PVC Blank Casing from +1' to 24'
5027.5	5		11-12-18 (09:35)				5	
5022.5	10		11-12-18 (09:45)			note: at 13' calcium carbonate filaments absent; gradational basal contact	10	Portland Neat Cement from 5' to 20'
					CL	**CLAY,** 90% to 95% fines, 5% to 10% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/4), massive, effervescent, medium plasticity, moist, soft firmness, medium dry strength, ductile, no stains, no odors		
5017.5	15		11-12-18 (09:58)				15	
			11-12-18 (10:10)					
5012.5	20						20	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	31.9	15:50	11/12/18
▼	29.3	08:00	11/13/18
▼	28.9	07:35	11/14/18
▼	28.5	09:30	11/16/18

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-66A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922300	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5012.5	20			CL	**CLAY,** continued note: at 23' sand decreases; gradational basal contact	(Continued) Bentonite Plug from 20' to 22' Filter Pack (8-12) from 22' to 49'
				CL	**CLAY,** 98% fines, 2% fine to coarse grained, subrounded to subangular sand, dark brown (7.5YR 3/3), effervescent, medium to high plasticity, moist, soft to stiff firmness, medium dry strength, ductile, no stains, no odors note: at 25.5' sand slightly increases; gradational basal contact	
5007.5	25	11-12-18 (10:35)				
				CL	**CLAY,** 95% fines, 5% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2), trace gypsum nodules (~3 mm) and occ filaments (~1 cm), effervescent, medium to high plasticity, moist, medium stiff to stiff firmness, medium dry strength, ductile, no stains, no odors note: at 32.5' gypsum filaments increase in length (~2.5 cm) note: at 33.0' clay decreases while silt increases note: at 37.5' bgs gypsum nodules decrease and no filaments, sand decreases, core sample more compact in diameter; gradational basal contact	
5002.5	30	11-12-18 (12:20)				
4997.5	35	11-12-18 (12:40)				4" Nominal Diameter Schedule 80 PVC (0.020" Slot Screen) from 24' to 49'
				CL	**CLAY,** 98% fines, 2% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/3), occasional gypsum nodules, massive, effervescent, high plasticity, moist, soft to medium stiff firmness, medium dry strength, ductile, no stains, no odors note: at about 40' sand decreases; sharp basal contact	
4992.5	40	11-12-18 (13:06)		CL	**SILTY CLAY,** 95% to 98% fines, 2% to 5% fine to coarse grained, subrounded to subangular sand, dark-reddish brown (5YR 3/4), rare gypsum nodules, massive, effervescent, medium to high plasicity wet, soft to medium stiff firmness, medium dry strength, ductile, no stains, no odors note: at about 40' core samples more compact in diameter	
4987.5	45					

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	31.9	15:50	11/12/18
▼	29.3	08:00	11/13/18
▼	28.9	07:35	11/14/18
▼	28.5	09:30	11/16/18

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-66A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922300	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
4987.5	45		11-12-18 (13:22)		CL	**SILTY CLAY,** continued note: at 47.5' trace gravels (<1 cm), sand increases; gradational basal contact	45	(Continued) Dedicated submersible pump
					CL	**GRAVELLY CLAY,** 75% fines, 20% fine to coarse grained, subrounded to subangular gravel, 5% fine to coarse grained, subrounded to subangular sand, dark-reddish brown (5YR 4/3), nonlithified, massive, slightly effervescent, low to medium plasticity, wet, soft firmness, low to medium dry strength, no odors note: at 52.5' core samples expanded back to normal, lenses of olive-brown staining, gradational basal contact		
4982.5	50						50	Pea Gravel from 49' to 51'
						Trmhm - Moqui Member of Moenkopi Formation (mid-unit), mudstone, 60% clay, 25% to 30% silt, 10% to 15% fine grained, subrounded to subangular sand, dark brown (7.5YR 3/3) with conssiderable lenses of olive brown staining (2.5Y 4/4), lithified, thin laminae (<0.5 mm), highly effervescent, slightly moist, medium to high plasticity, medium stiff, ductile, no odors. note: from 55' to 57' color dark reddish-brown (5YR 4/4), lithified samples in loose soil, trace gypsum nodules (mm), slightly moist, friable note: at 58' sharp basal contact with silty sandstone		
4977.5	55						55	Bentonite Chips from 51' to 60'
4972.5	60					Total Depth = 60'	60	Total Depth = 60'
4967.5	65						65	
4962.5	70						70	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	31.9	15:50	11/12/18
▼	29.3	08:00	11/13/18
▼	28.9	07:35	11/14/18
▼	28.5	09:30	11/16/18

METHOD Not Applicable

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-67A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	Isaac Torres	**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	Darius Cervantez	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-922301
RIG I.D.:	- - -	**COORDINATES:**	N1428367.45, E668014.79
RIG TYPE:	Rotosonic	**COORDINATE SYS:**	Arizona State Plane East Zone 0201, International Feet
BORING TYPE:	- - - ; **BORING DIA.:** 8"	**SURFACE ELEV. (FT):**	5024.05'
ORIENTATION:	90°	**MEAS. PT. ELEV. (FT):**	5025.38'
HAMMER TYPE:	Not Applicable	**VERTICAL DATUM:**	NAVD88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**COMPLETION DATE:**	11-15-2018 ; **COMPLETION TIME:** 10:20
START DATE:	11-14-2018 ; **START TIME:** 17:12		

Elevation in Feet	Depth in Feet	Graphical Log	Sample I.D. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5024.1	0				ML	**SANDY SILT,** 80% fines, 15% fine to coarse grained, subrounded sand, 5% fine to coarse grained, subrounded to subangular gravel, brown (7.5 YR 4/3), nonlithified, granular to single grain soil structure, weakly effervescent, nonplastic, slightly moist, loose density, low dry strength, no stains, no odors note: at 2.5' sharp basal contact	0	Steel casing stick up +2', minimum 8" clearance between top of steel casing and top of 4" PVC well casing 4000 PSI Concrete Mix from 0 to 5' 4" Nominal Diameter Schedule 80 PVC Blank Casing from +<6" to 15'
	2.5				CL	**SILTY CLAY,** 95% to 98% fines, 2% to 5% fine to coarse grained, subrounded to subangular sand, dark brown (7.5YR 3/3), considerable to predominate calcium carbonate lenses and filaments, weakly cemented, highly effervescent, thin laminae (<1 mm), low plasticity, slightly moist, hard firmness, medium dry strength, friable to ductile, no stains, no odors		
5019.1	5		11-14-18 (17:12)			note: at 7.5' color slightly changes to dark brown (7.5YR 3/2) sand slightly increases (5%)	5	Portland Neat Cement from 5' to 10'
5014.1	10		11-14-18 (17:18)			note: at 10' moderate cementation and high dry strength, increased with depth	10	Bentonite Plug from 10' to 13' Filter Pack (8-12) from 13' to 45'
5009.1	15		11-14-18 (17:33)			note: at 17.5' calcium carbonate filaments decrease (occasional to trace), clay decreases while silt & sand increase; sharp basal contact	15	
	17.5				ML	**SANDY SILT,** 85% to 90% fines, 10% to 15% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 4/3), angular blocky soil structure, nonlithified, massive, moderately effervescent, low to medium		
5004.1	20						20	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	35.8	09:30	11/15/18
▼	34.4	09:40	11/15/18
▼	33.9	07:15	11/16/18
▼			

METHOD Not Applicable

(Continued Next Page)

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-67A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922301	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5004.1	20	11-15-18 (07:50)			plasticity, slightly moist, loose to medium density, medium to hard dry strength, friable, no stains, no odors note: at 22.5' calcium carbonate lenses to filaments absent; gradational basal contact	(Continued)
				CL	**CLAY,** 95% fines, 5% fine grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2), weakly cemented, effervescent, low plasticity, slightly moist, very firm, high to very high dry strength, ductile, no stains, no odors note: at 26' sand & silt decrease while clay increases; gradational basal contact	
4999.1	25	11-15-18 (08:20)				
				CL	**CLAY,** 99% fines, fine grained, subrounded sand, dark brown (7.5YR 3/3), occasional gypsum nodules (<3 mm), massive, effervescent, medium to high plasticity, moist, stiff to very stiff firmness, medium dry strength, ductile, gray staining, no odors	4" Nominal Diameter Schedule 80 PVC (0.020" Slot Screen) from 15' to 45'
4994.1	30	11-15-18 (08:34)				
					note: at 35.0' gypsum nodules decrease (rare)	
4989.1	35	11-15-18 (08:53)			note: at 36.0' wet sandy elastic silt lense, ~1.5' (see MW-65A log for unit description) note: at 37.5' sharp basal contact	
				CL	**SILTY CLAY,** 99% fines, 1% fine grained, subrounded sand, dark reddish-brown (5YR 3/4), gypsum nodules absent, massive, effervescent, medium to high plasticity, moist to wet, stiff, medium to high dry strength, ductile, rare gray staining, no odors note: from 40' to 43' core samples more compact in diameter note: at ~43' medium stiffness, sand increases, gravel present (0.5-7.5 cm), core sample diameter expanded, and gradational basal contact	
4984.1	40	11-15-18 (09:11)				
				CL	**GRAVELLY CLAY,** 70% fines, 20% fineto coarse grained, subrounded to subangular gravel, 10% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2),	Dedicated submersible pump
4979.1	45					

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	35.8	09:30	11/15/18
▼	34.4	09:40	11/15/18
▼	33.9	07:15	11/16/18
▼			

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-67A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922301	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
4979.1	45		11-15-18 (09:40)		CL	nonlithified, massive, effervescent, medium to high plasticity, wet, soft to very soft firmness, medium dry strength, no odors. note: at 45' wet sandy elastic silt lense, ~1.5' (see MW-65A log for unit descrip.) note: at 47' sharp basal contact with siltstone to mudstone	45	(Continued) Pea Gravel from 45' to 47.5' Bentonite Chips from 47.5' to 50'
4974.1	50		11-15-18 (10:00)			**Trmhm - Moqui Member of Moenkopi Formation (mid-unit), SANDY SILT WITH SAND & Interbedded mudstone,** 65% fines, 25% fine to coarse grained, subangular sand, dark reddish-brown (7.5YR 3/4) with rare olive brown staining (2.5Y 4/4), granular to rounded blocky soil structure, lithified mudstone samples, mudstone with thin laminae (<0.5mm), effervescent, slightly moist, medium plasticity, low to medium dry strength, friable, no odors	50	Total Depth = 50'
						Total Depth = 50'		
4969.1	55						55	
4964.1	60						60	
4959.1	65						65	
4954.1	70						70	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	35.8	09:30	11/15/18
▼	34.4	09:40	11/15/18
▼	33.9	07:15	11/16/18
▼			

METHOD Not Applicable

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-68M (abandoned)

PROJECT:	APS Cholla Plant Hydrogeologic Investigation			**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	D. Andersen			**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	D. Cervantez			**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear			**ADWR REG. #:**	55-923346
RIG I.D.:	LT4634			**STATION/OFFSET:**	N/A
RIG TYPE:	Sonic			**REFERENCE:**	N/A
BORING TYPE:	N/A	**BORING DIA.:**	8"	**COORDINATES:**	N1429535.367, E668309.992
ORIENTATION:	90°			**COORDINATE SYS:**	NAD83
HAMMER TYPE:	N/A			**SURFACE ELEV. (FT):**	5026.45
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:			N/A	**VERTICAL DATUM:**	NAVD88
START DATE:	9/16/2019	**START TIME:**	12:20	**COMPLETION DATE:**	9/16/2019
				COMPLETION TIME:	17:32

Elevation in Feet	Depth in Feet	Graphical Log	Date and Time	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5026.5	0			ML	**SILT WITH SAND,** 80% low plastic fines, 20% fine to medium-grained, sub-rounded to sub-angular sand. Non-cemented, reacts with HCl. 10 YR7/3 (very pale brown). Dry.	0	Concrete pad at surface
5025.5	1					1	
5024.5	2			SW	**WELL GRADED SAND WITH GRAVEL,** 55% fine to medium-grained, sub-rounded to angular sand, 40% fine to medium-grained, rounded to sub-rounded gravel, 5% non-plastic fines. Non-cemented, weak reaction to HCl. 10YR 5/2 (greyish brown). Dry. note: fining up sequence observed.	2	
5023.5	3					3	Neat Cement Grout From 0.0 to 25.6'
5022.5	4					4	
5021.5	5			CL	**LEAN CLAY WITH SAND,** 80% low to medium-plastic fines, 20% fine-grained, sub-angular to angular sand. Non-cemented, reacts with HCl. 5YR 4/3 (reddish-brown). Moist.	5	4" Nominal Diameter Flush Threaded Schedule 80 PVC Blank Casing From +0.5" to 29.74'
5020.5	6					6	
5019.5	7					7	
5018.5	8					8	
5017.5	9					9	Centralizer
5016.5	10					10	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	18.3	09:22	9/17/19
▼	17.8	17:23	9/17/19
▼	16.8	07:37	9/18/19
▼			

METHOD N/A

(Continued Next Page)

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-68M (abandoned)

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923346	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5016.5	10	CL	**LENA CLAY WITH SAND,** continued	(Continued)
5015.5	11			
5014.5	12			4" Nominal Diameter Flush Threaded Schedule 80 PVC Blank Casing From +0.5" to 29.74'
5013.5	13	CL	**SANDY LEAN CLAY WITH GRAVEL,** 60% low to medium plastic fines, 20% fine to medium-grained, sub-rounded to sub-angular sand, 20% fine-grained, sub-rounded to rounded gravel. Non-cemented, weak HCl reaction. 5YR 4/3 (reddish-brown). Moist. note: Lens of wet, medium-grained, sub-rounded to rounded sand from 14' to 14.5'.	
5012.5	14			
5011.5	15	CL	**LEAN CLAY,** 90% low to medium-plastic fines, 10% medium-grained, sub-angular to angular sand. Non-cemented, weak reaction with HCl. 5YR 4/3 (reddish-brown). Minor calcite throughout. Moist.	
5010.5	16			
5009.5	17	SM	**SILTY SAND WITH GRAVEL,** 50% fine to medium-grained, sub-rounded to well-rounded sand, 30% non-plastic fines, 20% fine-grained, well-rounded gravel. Non-cemented, strong HCL reaction. 10 YR 6/2 (light brownish gray). Dry.	
5008.5	18	SP	**POORLY GRADED SAND WITH GRAVEL,** 80% fine to medium-grained, sub-rounded to well-rounded sand, 15% medium-grained, well-rounded gravel, 5% non-plastic fines. Non-cemented, no reaction with HCL. 2.5YR 5/3 (reddish-brown). Wet. note: free water observed. Fining up sequence observed.	
5007.5	19	SM	**SILTY SAND,** 60% fine-grained, sub-rounded to well-rounded sand, 40% non-plastic fines. Non-cemented, no HCl reaction. 5YR 4/2 (dark reddish-gray). Wet.	Centralizer
5006.5	20			Neat Cement Grout From 0.0 to 25.6'
5005.5	21		**MOQUI MEMBER OF THE MOENKOPI FORMATION,** highly-weathered, maroon-red colored mudstone and claystone with 1-2 inch sub-rounded fragments of competent, fine-grained, yellow-green colored siltstone. Mudstone and claystone	
5004.5	22			

GROUNDWATER

DEPTH(ft bgs)	HOUR	DATE
18.3	09:22	9/17/19
17.8	17:23	9/17/19
16.8	07:37	9/18/19

METHOD N/A

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-68M (abandoned)

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	PROJECT LOCATION:	APS Cholla Power Plant
ADWR REG. #:	55-923346	PROJECT FEATURE:	Fly Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Date and Time	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5003.5	23				weathered to clay consistency, competent siltstone fragments present in clay matrix. Trace gypsum. No HCl reaction on fresh surfaces. Wet.	23	(Continued)
5002.5	24				**MOQUI MEMBER OF THE MOENKOPI FORMATION,** weathered maroon-red colored mudstone and claystone mixed with weathered, fine-grained, yellow-green colored siltstone. Mixture of mudstone, claystone, and siltsone has "swirled' appearance, possibly representing deformation structures or weathering. Reacts w/ HCl on fresh surfaces. Moist, though much less so than previous inteval. Decreasing moisture with depth.	24	Neat Cement Grout From 0.0 to 25.6'
5001.5	25					25	
5000.5	26				**MOQUI MEMBER OF THE MOENKOPI FORMATION,** maroon-red colored mudstone and claystone alternating with fine-grained, yellow-green colored siltstone. Decreased weathering. Gypsum stringers throughout. Strong HCl reaction on fresh surfaces. Slightly moist.	26	Bentonite Hole Plug From 25.6' to 27.7'
4999.5	27					27	
4998.5	28				**MOQUI MEMBER OF THE MOENKOPI FORMATION,** competent, unweathered, maroon-red colored mudstone and claystone alternating with fine-grained, yellow-green colored siltstone. Gypsum stringers throughout. Strong HCl reaction on fresh surfaces. Dry. Hard drilling at 35'.	28	Transition Sand 20/40 Silica Sand From 27.7' to 28.5'
4997.5	29				note: rig shutdown for 1.5 hours at 35' interval. Upon resuming drilling, moisture present from 35' to 36' interval and dry underneath. Moisture likely due to introduced alluvial groundwater.	29	Centralizer; Filter Pack 8/12 Silica Sand From 28.5' to 50.27'
4996.5	30					30	
4995.5	31					31	4" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 29.74' to 49.84'
4994.5	32					32	
4993.5	33					33	
4992.5	34					34	
4991.5	35					35	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	18.3	09:22	9/17/19
▼	17.8	17:23	9/17/19
▼	16.8	07:37	9/18/19
▼			

METHOD N/A

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-68M (abandoned)

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923346	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Date and Time	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
4991.5	35				**MOQUI MEMBER OF THE MOENKOPI FORMATION,** continued	35	(Continued)
4990.5	36					36	4" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 29.74' to 49.84'
4989.5	37					37	
4988.5	38					38	Filter Pack 8/12 Silica Sand From 27.7' to 50.27'
4987.5	39					39	
4986.5	40					40	
4985.5	41					41	
4984.5	42					42	
4983.5	43					43	
4982.5	44					44	
4981.5	45					45	
4980.5	46					46	
4979.5	47					47	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	18.3	09:22	9/17/19
▼	17.8	17:23	9/17/19
▼	16.8	07:37	9/18/19
▼			

METHOD N/A

(Continued Next Page)

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-68M (abandoned)

PROJECT:	APS Cholla Plant Hydrogeologic Investigation	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-923346	**PROJECT FEATURE:**	Fly Ash Pond

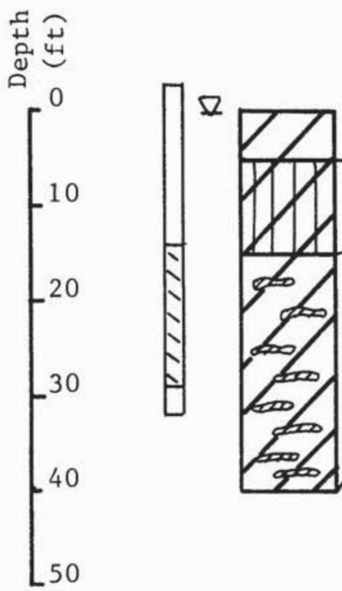
Elevation in Feet	Depth in Feet	Graphical Log	Date and Time	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
					MOQUI MEMBER OF THE MOENKOPI FORMATION, continued		(Continued)
4978.5	48					48	4" Nominal Diameter Schedule 80 PVC Screen (slots 0.02") from 29.74' to 49.84'
4977.5	49					49	Filter Pack 8/12 Silica Sand From 27.7' to 50.27'
4976.5	50				Total Depth = 50.35'	50	End Cap Total Depth = 50.27'
4975.5	51					51	
4974.5	52					52	
4973.5	53					53	
4972.5	54					54	
4971.5	55					55	
4970.5	56					56	
4969.5	57					57	
4968.5	58					58	
4967.5	59					59	
4966.5	60					60	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	18.3	09:22	9/17/19
▼	17.8	17:23	9/17/19
▼	16.8	07:37	9/18/19
▼			

METHOD N/A

Log of Well: W-123



<u>Description</u> <u>1</u>/

<u>Alluvium</u>

0-5 Red clay, damp

5-15 Silty red clay, saturated

15-40 Red clay and gypsum, saturated

<u>1</u>/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

LOG OF TEST HOLE No.: W124

DATE: **2/14/92** SURFACE ELEVATION: **5036.0' MSL** LOCATION: **FLY ASH POND**

DEPTH, ft.	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200 / DENSITY--G-CC 0–5 / RESISTIVITY(16N)--OHM-M 0–100
	FILL Newly placed road fill.	5033.5 2.5		
	ALLUVIUM CLAY, moderately stiff, moist, silty, moderate brown (5 YR 3/4) to moderate brown (5 YR 4/4).	5031.0 5.0		
5	SILT, moderately stiff, moist, clayey, sandy, moderate brown (5 YR 4/4) to light brown (5 YR 5/6). @~10' color change to light brown (5 YR 6/4) to moderate brown (5 YR 4/4)	5021.5 14.5		
15	SAND, medium dense, wet, fine grained, poorly graded, occasional fine gravels, subangular to angular grains are quartz, feldspar and chert, moderate brown (5 YR 3/4) . @~15' while new casing was welded onto stand, driller says water rises to 12 feet @~15' Modified California Sample recovered ~9" for 5 blows, NMC=24.5%, and dry density = 101.9 pcf. @~20' clay lens, abundant gravel sized cuttings of clay/gypsum agglomerate	5007.0 29.0		
29	CLAY, stiff, moist, moderate brown (5 YR 3/4) with occasional fine gravel and gypsum			

Depth scale: 5, 10, 15, 20, 25, 30

Casing Material:	4" SCHEDULE 40 PVC	Completed Well Head Elev:	5037.530 MSL
Casing Inner Dia:	3.96 INCHES	Geologist:	STEVEN C KAMINSKI
Slot Size:	0.01 INCH	Bit Diameter:	7.87
Screened Interval:	76' TO 96'	Drill Rig:	BARBER
Filter Pack Material:	20-40 SILICA SAND	Drill Contractor:	MAHER ENVIRONMENTAL
Casing Connection:	FLUSH THREAD W/ O-RING GASKET	Geophysic Contractor:	NOT CONDUCTED
Temporary Steel Casing (TSC) Dia:	10 INCH	Initial Water:	15' BELOW GRADE
TSC Depth Of Penetration:	54'		
Drilling Method:	DUAL AIR ROTARY		

Completion Depth: **96.0 Ft.** Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drawn By: STEVEN C KAMINSKI Reviewed By: LEO LEONHART

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W124

DATE: **2/14/92** SURFACE ELEVATION: **5036.0' MSL** LOCATION: **FLY ASH POND**

DEPTH, ft.	DESCRIPTION	STRATUM EL / DEPTH
	@~35' Modified California sample recovered ~9" and contained a NMC of 22.6% and a dry density of 93.3 pcf.	4996.0
40	GRAVEL, dense, sandy, clayey, wet, fine grained gravels, well graded sand, mostly chert and quartzite fragments with petrified wood	40.0
45		
		4986.0
50	BEDROCK Formation: Moenkopi, Member: Mouqi SILTSTONE, soft to moderately hard, very clayey, very fine sandy, with alternating medium to thick beds of moderate reddish orange (10 R 6/6) to moderate reddish brown (10 YR 4/6) and generally thinner beds of pale green (10 G 6/2) to greyish green (10 GY 5/2), abundant lenses of deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet,	50.0
55		
60		
65		
70		
		4962.0
75	Formation: Moenkopi, Member: Wupatki SANDSTONE, Hard, very fine grained, moderately well sorted, silty, micaceous, color is greyish red (5 R 4/2) to greyish brown (5 YR 3/2), very reactive to HCl when crushed	74.0
80		

GAMMA (NATURAL)--API-GR: 0 – 200
DENSITY--G-CC: 0 – 5
RESISTIVITY(16N)--OHM-M: 0 – 100

Completion Depth: **96.0 Ft.**
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.
Project No.: **914X236B**
Project Name: **APS - CHOLLA POWER PLANT**
Drilling Method: **DUAL AIR ROTARY**

LOG OF TEST HOLE No.: W124

Sheet 3 of 3

DATE: **2/14/92** SURFACE ELEVATION: **5036.0' MSL** LOCATION: **FLY ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
85					
		@~87' water			
90					
95					
		@ bottom of hole abundant water ~90 gpm	4940.0		
		TOTAL DEPTH OF HOLE AT 96 FEET BELOW GRADE Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet below grade.	96.0		

Completion Depth: **96.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

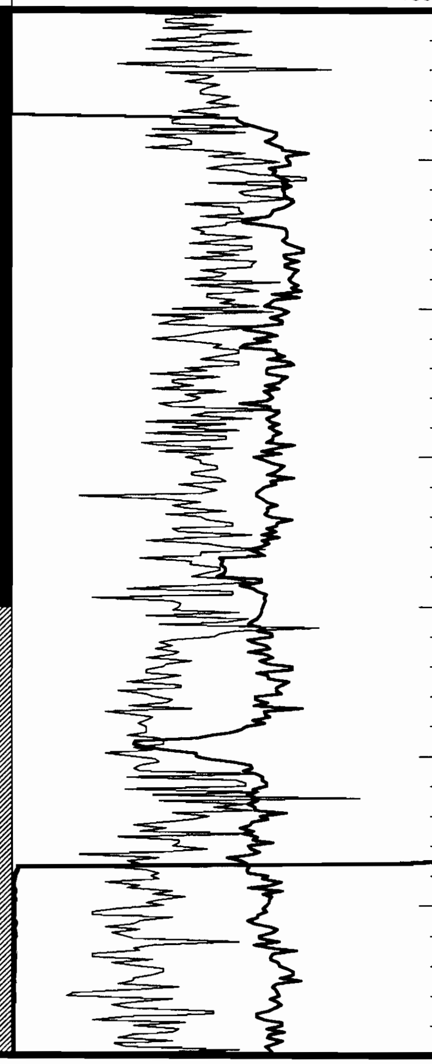
LOG OF TEST HOLE No.: W125

DATE: **2/13/92** SURFACE ELEVATION: **5036.0' MSL** LOCATION: **FLY ASH POND**

DEPTH, ft.	DESCRIPTION	STRATUM EL / DEPTH
	FILL Newly placed road fill.	5034.0 2.0
5	ALLUVIUM INTERBEDDED SILT AND SAND SILT fraction, stiff, damp to slightly moist, clayey, sandy, moderate brown (5 YR 4/4) to light brown (5 YR 3/4). SAND fraction, medium dense, damp to slightly moist, very fine to medium, moderate to fast reaction to HCl. @~5.5' Modified California sample recovered ~9" with 22 blows for 1' of penetration @ a NMC of 8.2% and dry density of 110.9 pcf	5028.0 8.0
10–30	CLAY, stiff, slightly moist to moist, silty, moderate brown (5 YR 3/4) to moderate brown (5 YR 4/4). @~15' Modified California sample recovered ~9" of clay with 9 blows and contained a NMC of 24.0% and dry density of 99.1 pcf. @~15' no cuttings return to 19' @~19' cuttings return resumes as mixed sandy clay in the form of clay balls @~23' sandy cuttings much gypsum to 35'	5001.0

Depth scale: 5, 10, 15, 20, 25, 30

Columns: SYMBOL; WELL



Casing Material:	4" SCHEDULE 40 PVC	Completed Well Head Elev:	5038.510 MSL
Casing Inner Dia:	3.96 INCHES	Geologist:	STEVEN C KAMINSKI
Slot Size:	0.02 INCH	Bit Diameter:	7.87
Screened Interval:	120' TO 140'	Drill Rig:	BARBER
Filter Pack Material:	10-20 SILICA SAND	Drill Contractor:	MAHER ENVIRONMENTAL
Casing Connection:	FLUSH THREAD W/ O-RING GASKET	Geophysic Contractor:	CENTURY GEOPHYSICS
Temporary Steel Casing (TSC) Dia:	10 INCH	Initial Water:	15' BELOW GRADE
TSC Depth Of Penetration:	54'		
Drilling Method:	DUAL AIR ROTARY		

Completion Depth: **141.0 Ft.**

Water Depth: ________ ft., After ________ hrs.
________ ft., After ________ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drawn By: STEVEN C KAMINSKI   Reviewed By: LEO LEONHART

3/28/92 WCGEOP 1236A

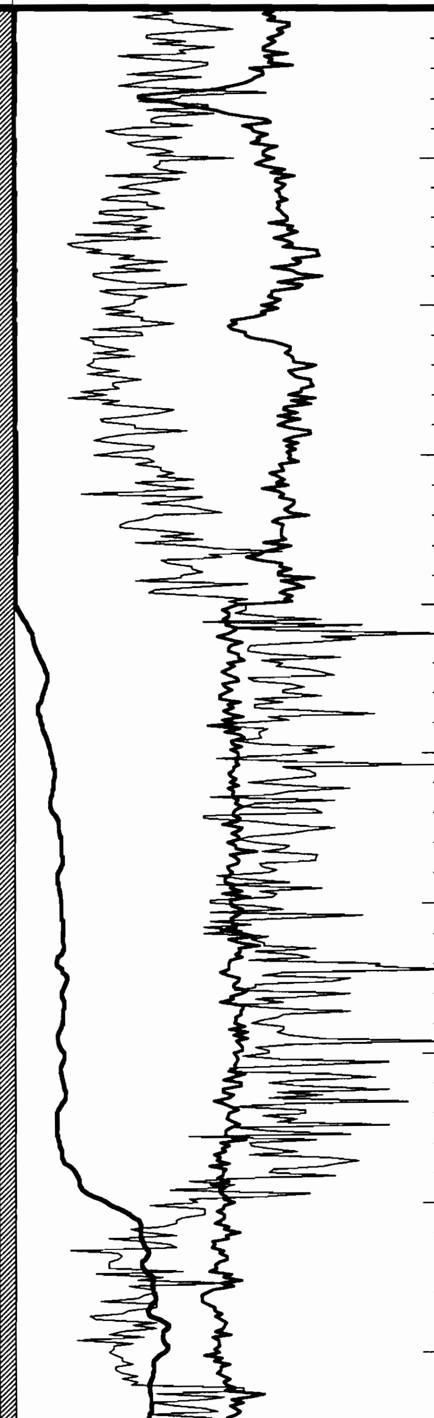
Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W125

DATE: **2/13/92** SURFACE ELEVATION: **5036.0' MSL** LOCATION: **FLY ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
35–42		CLAY, medium stiff, very moist, silty, fine sandy, laminated, moderate brown (5 YR 3/4) to moderate brown (5 YR 4/4).	35.0 / 4994.0	
42–52		GRAVEL, dense, sandy, clayey, wet, fine grained gravels, well graded sand, mostly chert and quartzite fragments with petrified wood	42.0 / 4984.0	
52–74		BEDROCK Formation: Moenkopi, Member: Mouqi SILTSTONE , soft to moderately hard, very clayey, very fine sandy, with alternating medium to thick beds of moderate reddish orange (10 R 6/6) to moderate reddish brown (10 YR 4/6) and generally thinner beds of pale green (10 G 6/2) to greyish green (10 GY 5/2), abundant lenses of deeply weathered bedrock, fast reaction to HCl, abundant layers of gypsum ranging in thickness from 2 inches to 2 feet,	52.0 / 4962.0	
74–		Formation: Moenkopi, Member: Wupatki SANDSTONE, Hard, very fine grained, moderately well sorted, silty, micaceous, color is laminated or variagated and predominently moderate brown (5 YR 3/4) with lesser amounts of dark yellowish brown (10 YR 6/6) to moderate yellowish brown (10 YR 5/4). Yellowish material shows iron mineralization, very reactive to HCl when crushed	74.0	

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75, 80



Completion Depth: **141.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

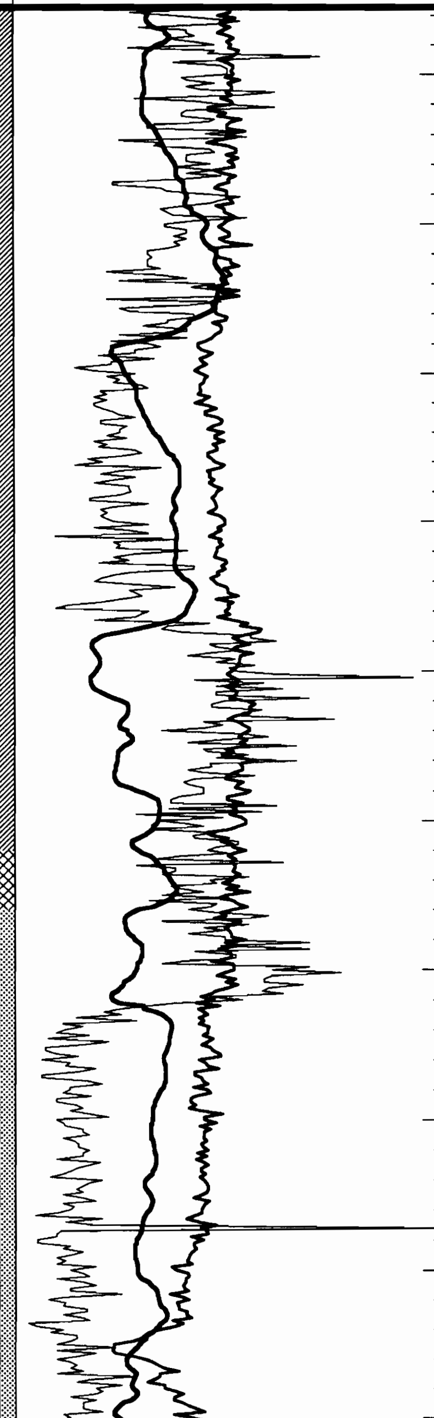
Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W125

DATE: **2/13/92** SURFACE ELEVATION: **5036.0' MSL** LOCATION: **FLY ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL
85–104			4932.0	
105		SILTSTONE (Wupatki), moderately hard, clayey, sandy, color is moderate brown (5 YR 3/4), moderate reaction to HCl when crushed	104.0 / 4927.0	
110		SANDSTONE (Wupatki), hard very fine grained, silty, well sorted, color is moderate brown (5 YR 3/4), moderate reaction to HCl when crushed	109.0 / 4925.0	
115		SHALE, hard, dolomitic, sandy, color is moderate yellowish brown (10 YR 5/4) to dark yellowish brown (10 YR 4/2), slow reaction to HCl when crushed @~113 silty, micaceous, color change to light olive grey (5 Y 6/1) to greyish yellow green (5 GY 7/2) moderate reaction to HCl when crushed.	111.0 / 4920.0	
120–130		Formation: Coconino SANDSTONE, hard, fine grained, very well sorted, color is yellowish grey (5 Y 8/1) to light olive grey (5 YG 6/1), with abundant staining of pale yellowish orange (10 YR 8/6), greyish orange (10 YR 7/4) to dark yellowish orange (10 YR 6/6), with laminations or parting coatings of moderate brown (5 YR 4/4), yellow and orange tint in rock appear to be associated with weathering around planar	116.0	

GAMMA (NATURAL)–API-GR 0 – 200
DENSITY–G-CC 0 – 5
RESISTIVITY(16N)–OHM-M 0 – 100



Completion Depth: **141.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

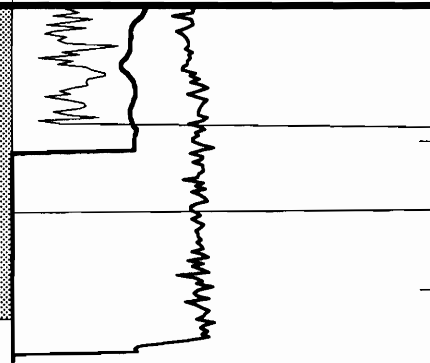
Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W125

DATE: 2/13/92 SURFACE ELEVATION: 5036.0' MSL LOCATION: FLY ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
135 140		features that may be cross bedding, fractures or joints, evidence of these planar features is observed as iron mineralization on flat surfaces of cuttings chips, no reaction to HCl.	4895.0		
		TOTAL DEPTH OF HOLE AT 141 FEET BELOW GRADE Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet below grade.	141.0		

Completion Depth: 141.0 Ft.

Water Depth: ____ ft., After ____ hrs.
____ ft., After ____ hrs.

Project No.: 914X236B

Project Name: APS - CHOLLA POWER PLANT

Drilling Method: DUAL AIR ROTARY

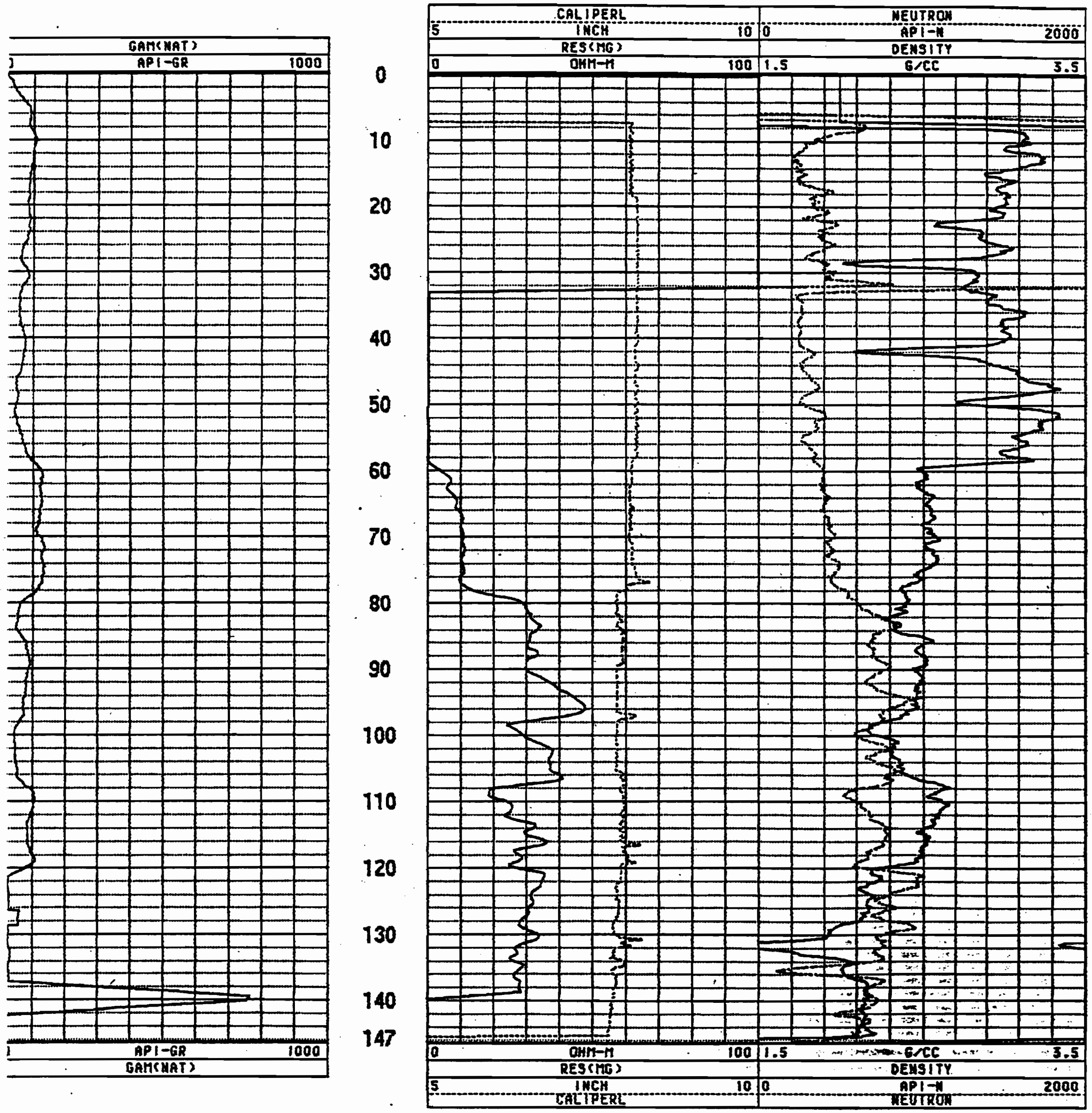
W-125

Century Geophysical Corp. (CGC)

W - 125

COMPANY	: WOODWARD CLYDE			OTHER SERVICES:	
WELL	: W - 125				
LOCATION/FIELD	: CHOLLA POWER				
COUNTY	: NAVAJO				
STATE	: ARIZONA				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 02/13/92	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 141	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 146.50	LOG MEASURED FROM	: TOC	DF	:
LOG TOP	: -0.10	DRL MEASURED FROM	: GL	GL	:
CASING DRILLER	: 54	LOGGING UNIT	: 9010		
CASING TYPE	: STEEL	FIELD OFFICE	: CHINO VALLEY		
CASING THICKNESS	: .25	RECORDED BY	: R. FEDERWISC		
BIT SIZE	: 7.875	BOREHOLE FLUID	: WATER	FILE	: PROCESSED
MAGNETIC DECL.	: 15	RM	: 0.0	TYPE	: 9030AA
MATRIX DENSITY	: 0	RM TEMPERATURE	: 0	LOG	: 4
FLUID DENSITY	: 1.0	MATRIX DELTA T	: 0	PLOT	: APS 0
NEUTRON MATRIX	:	FLUID DELTA T	: 0	THRESH	: 50000
REMARKS	:				

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS


GAM(NAT)
API-GR
1000
CALIPERL
5 INCH 10
RES(MG)
0 OHM-M 100
NEUTRON
0 API-N 2000
DENSITY
1.5 G/CC 3.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
147

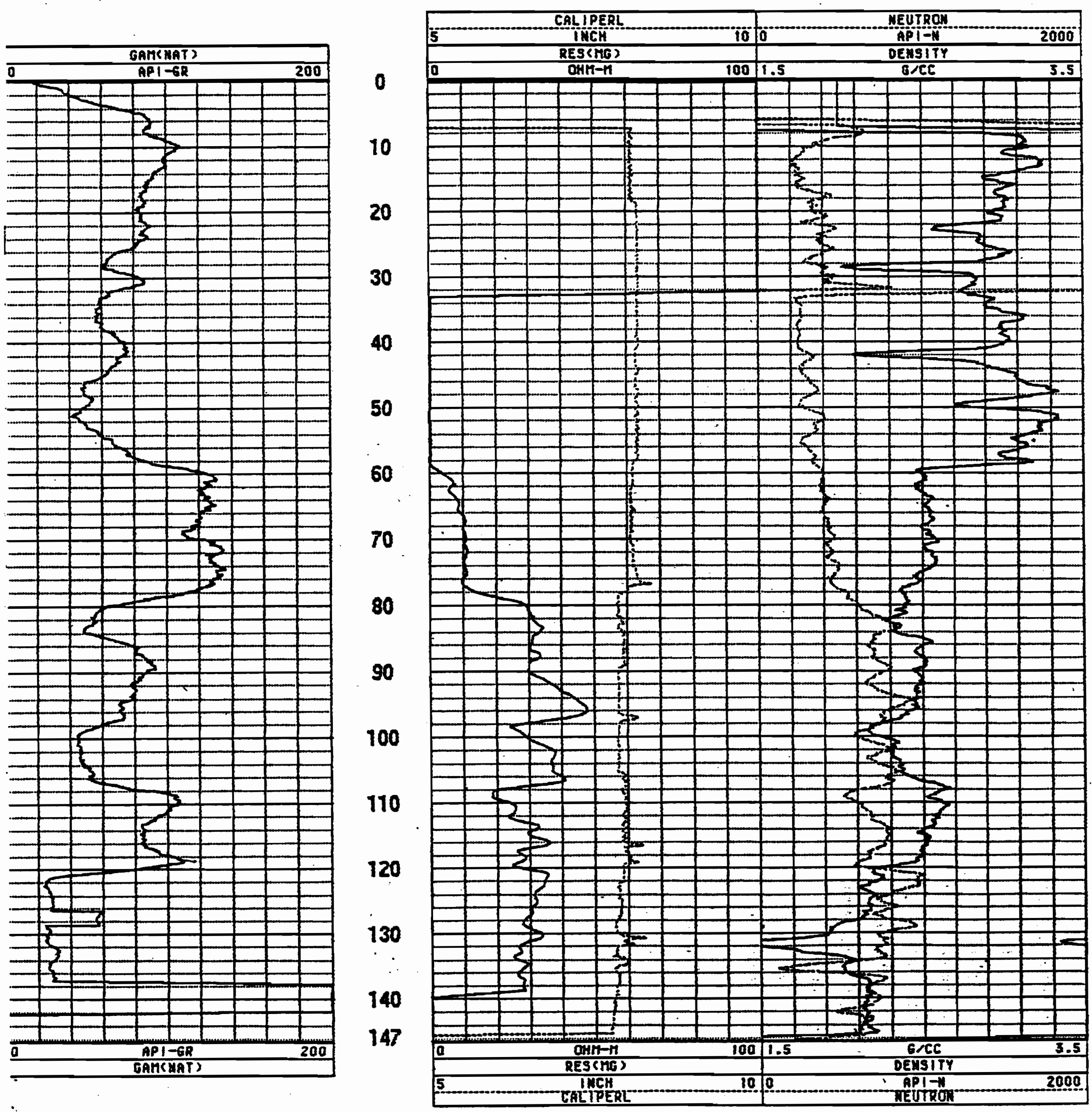
Century Geophysical Corp.

CGC

W - 125

COMPANY	: WOODWARD CLYDE			OTHER SERVICES:	
WELL	: W - 125				
LOCATION/FIELD	: CHOLLA POWER				
COUNTY	: NAVAJO				
STATE	: ARIZONA				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 02/13/92	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 141	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 146.50	LOG MEASURED FROM	: TOC 4.1 > G.S.	DF	:
LOG TOP	: -0.10	DRL MEASURED FROM	: GL	GL	:
CASING DRILLER	: 54	LOGGING UNIT	: 9010		
CASING TYPE	: STEEL	FIELD OFFICE	: CHINO VALLEY		
CASING THICKNESS	: .25	RECORDED BY	: R. FEDERWISC		
BIT SIZE	: 7.875	BOREHOLE FLUID	: WATER	FILE	: PROCESSED
MAGNETIC DECL.	: 15	RM	: 0.0	TYPE	: 9030AA
MATRIX DENSITY	: 0	RM TEMPERATURE	: 0	LOG	: 4
FLUID DENSITY	: 1.0	MATRIX DELTA T	: 0	PLOT	: APS 0
NEUTRON MATRIX	:	FLUID DELTA T	: 0	THRESH	: 50000
REMARKS	:				

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



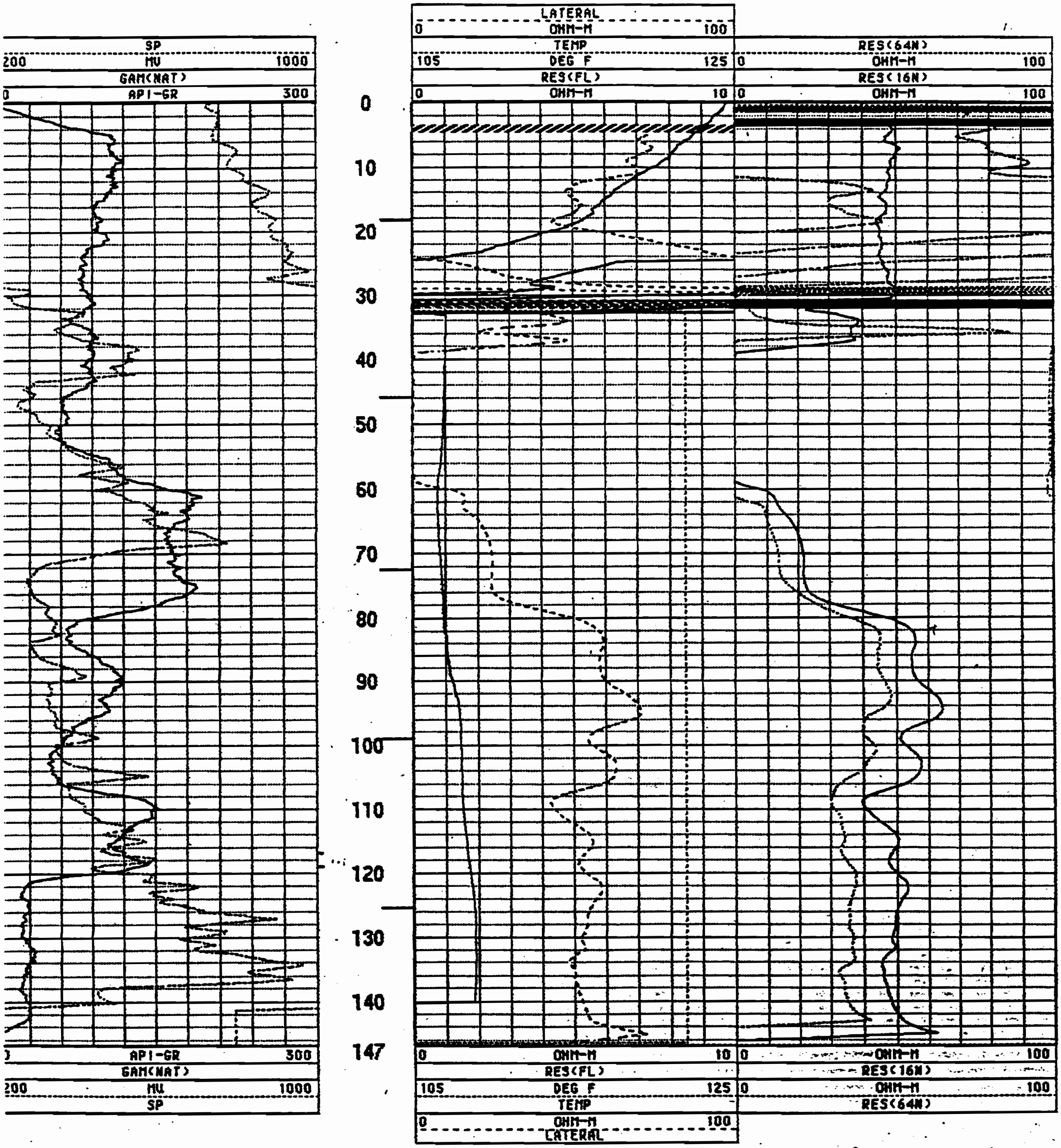
GAM(NAT)
0 API-GR 200
CALIPERL
5 INCH 10
RES(MG)
0 OHM-M 100
NEUTRON
0 API-N 2000
DENSITY
1.5 G/CC 3.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
147

CGC

Century GEOPHYSICAL CORP.

W - 125

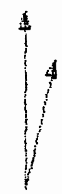
COMPANY	: WOODWARD CLYDE			OTHER SERVICES:	
WELL	: W - 125				
LOCATION/FIELD	: CHOLLA POWER				
COUNTY	: NAVAJO				
STATE	: ARIZONA				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 02/13/92	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 141	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 147.00	LOG MEASURED FROM	: TOC	DF	:
LOG TOP	: -2.20	DRL MEASURED FROM	: GL	GL	:
CASING DRILLER	: 54	LOGGING UNIT	: 9010		
CASING TYPE	: STEEL	FIELD OFFICE	: CHINO VALLEY		
CASING THICKNESS	: .25	RECORDED BY	: R. FEDERWISC		
BIT SIZE	: 7.875	BOREHOLE FLUID	: WATER	FILE	: ORIGINAL
MAGNETIC DECL.	: 15	RM	: 0.0	TYPE	: 9041A
MATRIX DENSITY	: 0	RM TEMPERATURE	: 0	LOG	: 0
FLUID DENSITY	: 1.0	MATRIX DELTA T	: 0	PLOT	: APS 1
NEUTRON MATRIX	:	FLUID DELTA T	: 0	THRESH	: 50000
REMARKS	:				


SP
200 MV 1000
GAM(NAT)
0 API-GR 300
LATERAL
0 OHM-M 100
TEMP
105 DEG F 125
RES(FL)
0 OHM-M 10
RES(64N)
0 OHM-M 100
RES(16N)
0 OHM-M 100
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
147

PLAN VIEW

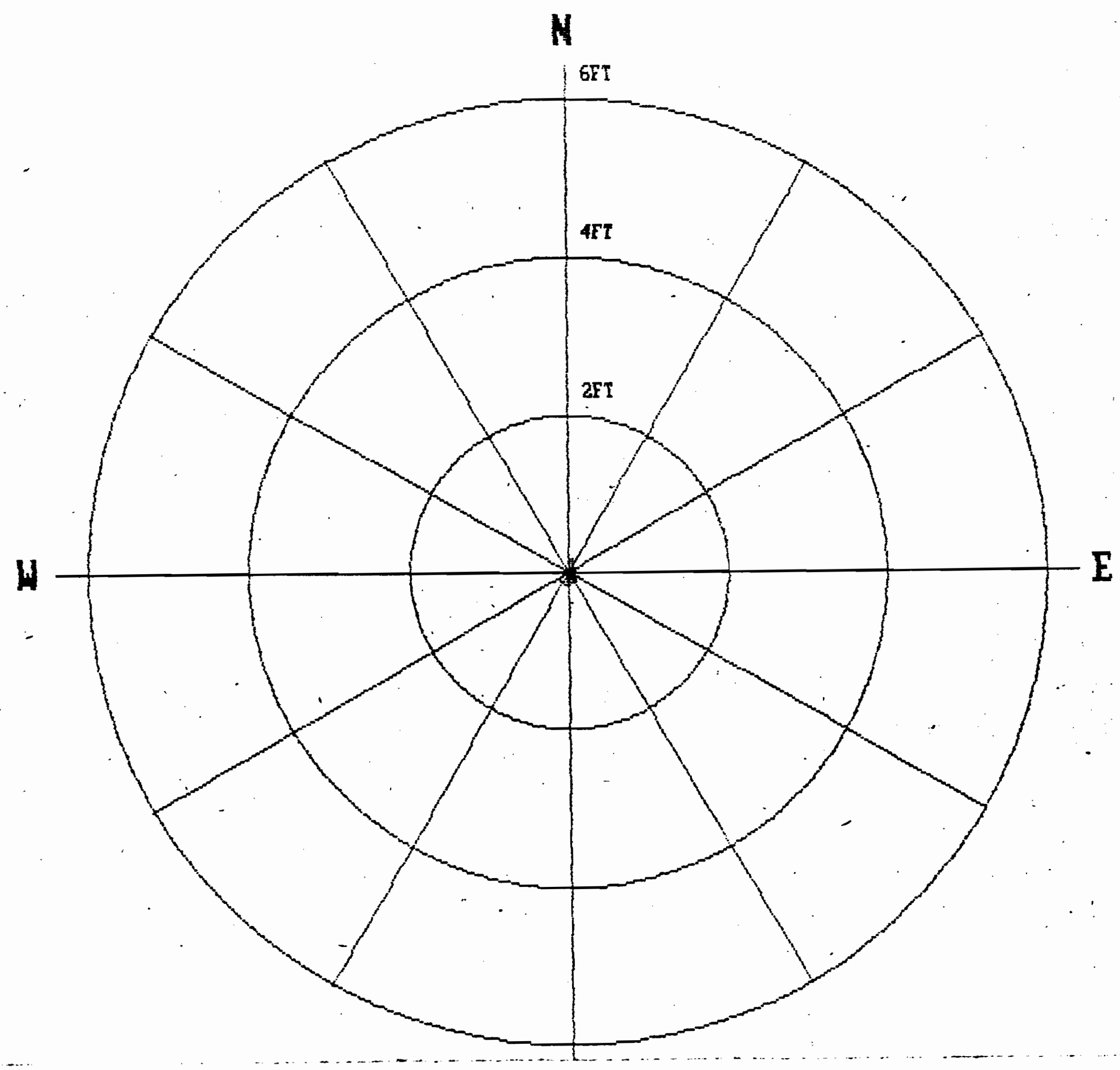
COMPU-LOG DEVIATION

CLIENT: WOODWARD CLYDE
LOCATION: CHOLLA POWER
HOLE ID: W - 125
DATE OF LOG: 02/13/92
PROBE: 9055A 247



MAG DECL: 13.5

SCALE: 2 FT/IN
TRUE DEPTH: 146.20 FT
AZIMUTH: 180.8
DISTANCE: 0.1 FT
+ = 50 FT INCR
○ = BOTTOM OF HOLE



ARIZONA PUBLIC SERVICE

PROJECT Hunt Seep Monitor Well and Extraction Well Installation Cholla Power Plant

JOB NO. 30-9147 DATE 12/19/95

LOG OF TEST BORING NO. W-126

RIG TYPE	CME-75
BORING TYPE	8-5/8” OD Hollow Stem Auger
SURFACE ELEV.	Estimate: 5031 ft.
DATUM	

Depth in Feet	Soil Sample	REMARKS
		NOTE: Drill site conditions-- grass covered saturated soils
0		0-5ft. Saturated red clay
5		5-10ft. Saturated red clay
10		10-15ft. Saturated red clay
15		15-20ft. Saturated red clay, drilling resistance is increasing
20		20-25ft. Saturated red clay, much harder drilling
25		25-30ft. Saturated red clay, drilling hard
30		30-35ft. Saturated red clay, drilling hard
35		35-40ft. Saturated red clay, drilling hard
40		40-45ft. Saturated red clay, drilling hard
45		Bottom of hole =45ft.
50		

GROUNDWATER

DEPTH	HOUR	DATE
2ft 11in*	14:35	12/19/95

WELL CONSTRUCTION

8 inch Steel Casing - 2ft. 4inches above grade to 7ft. 8inches below grade
4 inch Sch 40 PVC Casing - 1ft. 7 inches above grade to 15ft. below grade.
4 inch Sch 40, 0.010 well screen - 15ft. below grade to 45 ft. below grade.
Colorado silica (8-12) - 13ft. below grade to 45ft. below grade.
Sides of the hole came in after setting sand filter & prior to setting surface casing. Filled available space with bentonite.

* NOTE: Depth to water measured from top of PVC casing. Depth to water from ground surface was 1ft. 4 inches.

ARIZONA PUBLIC SERVICE

PROJECT: Hunt Seep Monitor Well and Extraction Well Installation Cholla Power Plant

JOB NO. 30-9147 DATE 12/21/95

LOG OF TEST BORING NO. W-127

RIG TYPE: CME-75
BORING TYPE: 6-5/8" OD Hollow Stem Auger
SURFACE ELEV.: Estimate: 5025 ft.
DATUM:

Depth in Feet	Split Spoon Sample	Blow Count	REMARKS
0			
			0-5ft. Reddish Brown Clay {5YR 3/4}
5			
			5-10ft. Red Clay {2.5YR 3/4}
10			
			10-15ft. Orange Red Silty Clay {5YR 4/6}
15			
			15-20ft. Silty Clay, {5YR 4/4}color grades from orange red to red to small layer of yellow, then back to red.
20			
	■	30-39	20-21ft Split Spoon Sample-- Dry Reddish Brown {5YR 4/4} Claystone with thin yellow green layer (2.5Y 8/2}
			20-25ft. Reddish Brown Clay {5YR 4/6}
25			
			25-30ft. Orange Red Clay {5YR 4/6}
30	■	75/3.5"	31ft. Split Spoon Sample--Dry Brown Claystone {5YR 6/3}
			Auger refusal 31ft.
			Dry hole, no saturated soils detected from ground surface to bottom of hole.
35			
40			
45			
50			

GROUNDWATER

DEPTH	HOUR	DATE
DRY		

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well **CR-1**

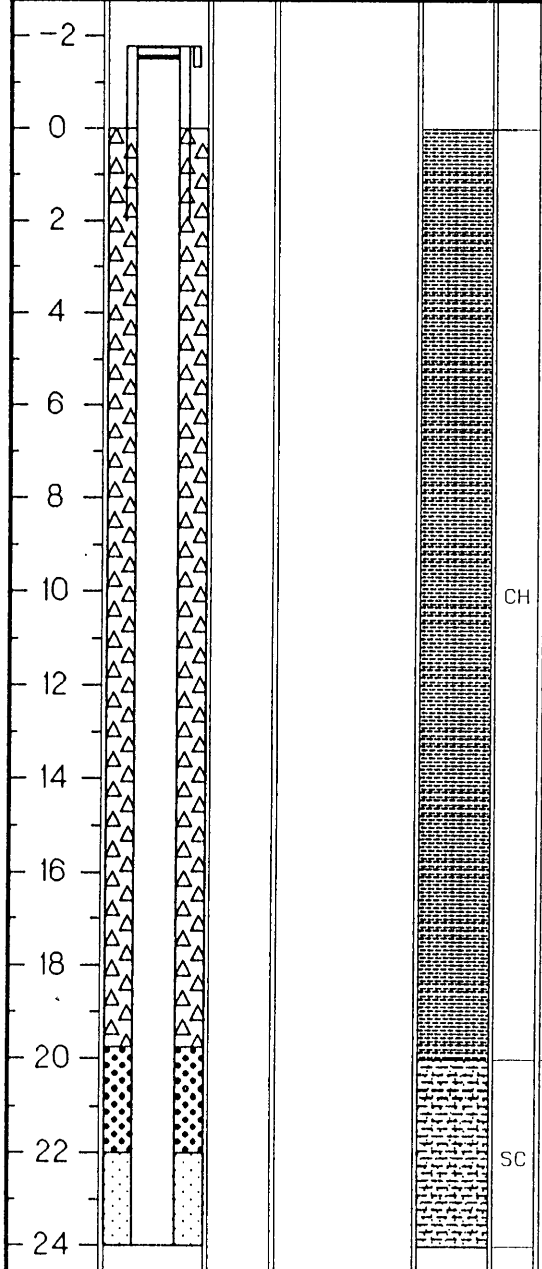
Project *APS/Cholla Plant* Owner *Arizona Public Service*
Location *Joseph City, Arizona* Proj. No. *023304868*
Surface Elev. ______ Total Hole Depth *45 ft.* Diameter *10 in.*
Top of Casing ______ Water Level Initial *18 ft.* Static ______
Screen: Dia *4 in.* Length *20 ft.* Type/Size *.010 in.*
Casing: Dia *4 in.* Length *27 ft.* Type *SCH40 PVC*
Fill Material *Colorado 10-20 sand* Rig/Core *CME-75*
Drill Co. *Enviro Drill* Method *Hollow stem auger*
Driller *V. Christenson* Log By *Matt Nation* Date *9/24/93* Permit # *540672*
Checked By *Elizabeth Miller* License No. *533*

See Site Map For Boring Location

COMMENTS:

Well completed in above-ground steel monument. Screen PVC is .010 continuous threaded slot.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



0-20 Feet: Sandy Clay Light-brown to gray-brown, very well-sorted, clay to fine sand. Moist to wet, soft, moderate to high plasticity. Sand is angular and fine grained. Sand <= 20%, Clay >= 80%.

Clay becomes wet below 15 feet.

Groundwater encountered at 18 feet.

20-25 Feet: Clayey Sand Light-gray, well-sorted, clay to medium sand. Wet and soft. Sand is angular to subangular and mostly fine-grained. Clay content decreases with depth. Clay 20-30%, Sand 70-80%.

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well **CR-1**

Project *APS/Cholla Plant* Owner *Arizona Public Service*
Location *Joseph City, Arizona* Proj. No. *023304868*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24–25					SC	
25–39					SP	25-39 Feet: Sand Light-tan or gray, well-sorted, poorly-graded, clay to medium sand. Wet and soft. Sand is subrounded to subangular and mostly medium grained. Clay/fines <= 20%, Sand >=80%.
39–45					SC	39-45 Feet: Clayey Sand Light-gray, well-sorted, clay to medium sand. Wet and soft. Sand is angular to subangular and mostly fine-grained. Clay 20-30%, Sand 70-80%.
45						45 Feet: Total depth of boring for CR-1.

Depth scale: 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 **DATE** 1-20-12 to 1-21-12

LOCATION N1434356.9 W657294.5

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5020.37'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				ML	slightly moist	**Little Colorado River Alluvium** **SILT WITH SAND,** fine grained sand, uncemented, low plasticity, light brown
				A						
								CL	slightly moist to moist	**CLAY WITH SILT,** predominantly medium to high plasticity, brown to dark brown note: silt content decreases with depth
5				A						
				A						
10				A						
				A						
15				A						
				A						
20				A						
				A						
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.2	0730	1-21-12
▼	38.9	0800	1-22-12
▽			
▽			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-48A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 **DATE** 1-20-12 to 1-21-12

LOCATION N1434356.9 W657294.5

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5020.37'
DATUM AEZ 0201; NAVD88

Depth in Feet	Sample Type	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25	A	CL	slightly moist to moist	**CLAY WITH SILT,** continued
	A			
30	A	SP with CL zones	slightly moist	**SAND,** predominantly fine grained, subangular to subrounded, uncemented, nonplastic, light brown note: some gravel-sized fragments of petrified wood
	A			
35	A	CH		**CLAY,** high plasticity, dark brown
		SM to ML	slightly moist	**SILTY SAND locally grading to SILT WITH SAND,** fine grained sand, subangular to subrounded, well stratified, nonplastic to low plasticity, alternating brownish-gray zones & brown zones
40	U A	SP	wet	**SAND,** considerable silt, fine grained, uncemented, nonplastic, light brown
	A			
45	U A			
	A			note: some medium grained sand & trace to some gravel below 47'6"
50				

Columns also present (no entries): Drill Rate Min/ft., Graphical Log, Sample, Blow Count, Dry Density lbs. per Cubic ft., Moisture Content Percent of Dry Weight.

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.2	0730	1-21-12
▼	38.9	0800	1-22-12

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
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P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-48A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

JOB NO. 17-2011-4054 **DATE** 1-20-12 to 1-21-12

LOCATION N1434356.9 W657294.5

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5020.37'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				A				SP with GP/SP zones	wet	**SAND WITH GRAVEL,** fine to medium grained sand with predominantly coarse grained subrounded gravel, subangular to subrounded, uncemented, nonplastic, brown note: some silty sand lenses
				A						
55				U A						
				A						
60				A						
				A						
65				A						note: rare small subrounded cobble below 65' note: yellowish-brown in zones below 65'
				A						
70				A						
				A						
75										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.2	0730	1-21-12
▼	38.9	0800	1-22-12
▽			
▽			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-48A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

JOB NO. 17-2011-4054 **DATE** 1-20-12 to 1-21-12

LOCATION N1434356.9 W657294.5

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5020.37'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				A				SP with GP/SP zones	wet	**SAND WITH GRAVEL,** continued
				A						
80				A						
				A						
								SM with SC zones	wet	**SILTY SAND WITH CLAYEY SAND ZONES,** fine grained, subangular to subrounded, stratified in zones, low plasticity with medium plasticity zones, brown
85				A						
				A						
90				A						
				A						
95				A				CH	slightly moist	**CLAY,** high plasticity, dark reddish-brown
				A						
100										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.2	0730	1-21-12
▼	38.9	0800	1-22-12
▽			
▽			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-48A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

amec

JOB NO. 17-2011-4054 DATE 1-20-12 to 1-21-12

LOCATION N1434356.9 W657294.5

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5020.37'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
100				A				CH	slightly moist	**CLAY,** continued
				A						
105				A						
				A						
								SP		**SAND WITH GRAVEL ZONES,** predominantly fine grained, subangular to subrounded, uncemented, nonplastic, grayish-brown
110				A					wet	
				A						note: fine to medium grained sand with considerable gravel lenses below 113'
115				A						note: predominantly medium to coarse grained sand below 115'
				A						
120				A						note: rare small subrounded cobble below 120'
				A						
125										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.2	0730	1-21-12
▼	38.9	0800	1-22-12
▽			
▽			

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-48A

PROJECT Arizona Public Service Company (APS)
Cholla Power Plant
Navajo County, Arizona

JOB NO. 17-2011-4054 **DATE** 1-20-12 to 1-21-12

LOCATION N1434356.9 W657294.5

RIG TYPE Boart Longyear Rotosonic 300
BORING TYPE 8" Casing
SURFACE ELEV. 5020.37'
DATUM AEZ 0201; NAVD88

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
125				A				SP		**SAND WITH GRAVEL,** continued
				A						
										Moenkopi Formation - Moqui Member **CALCAREOUS MUDSTONE,** fine grained texture, moderately to highly weathered, thinly bedded, soft to very soft, light & dark reddish-brown with green zones
130				A						
				A						
135				A						note: thin moderately hard zones from 135' to 137'6"
				A						
140				A						
				A						
145										Stopped Drilling at 145' installed 4-inch diameter Schedule 40 PVC monitor well
150										

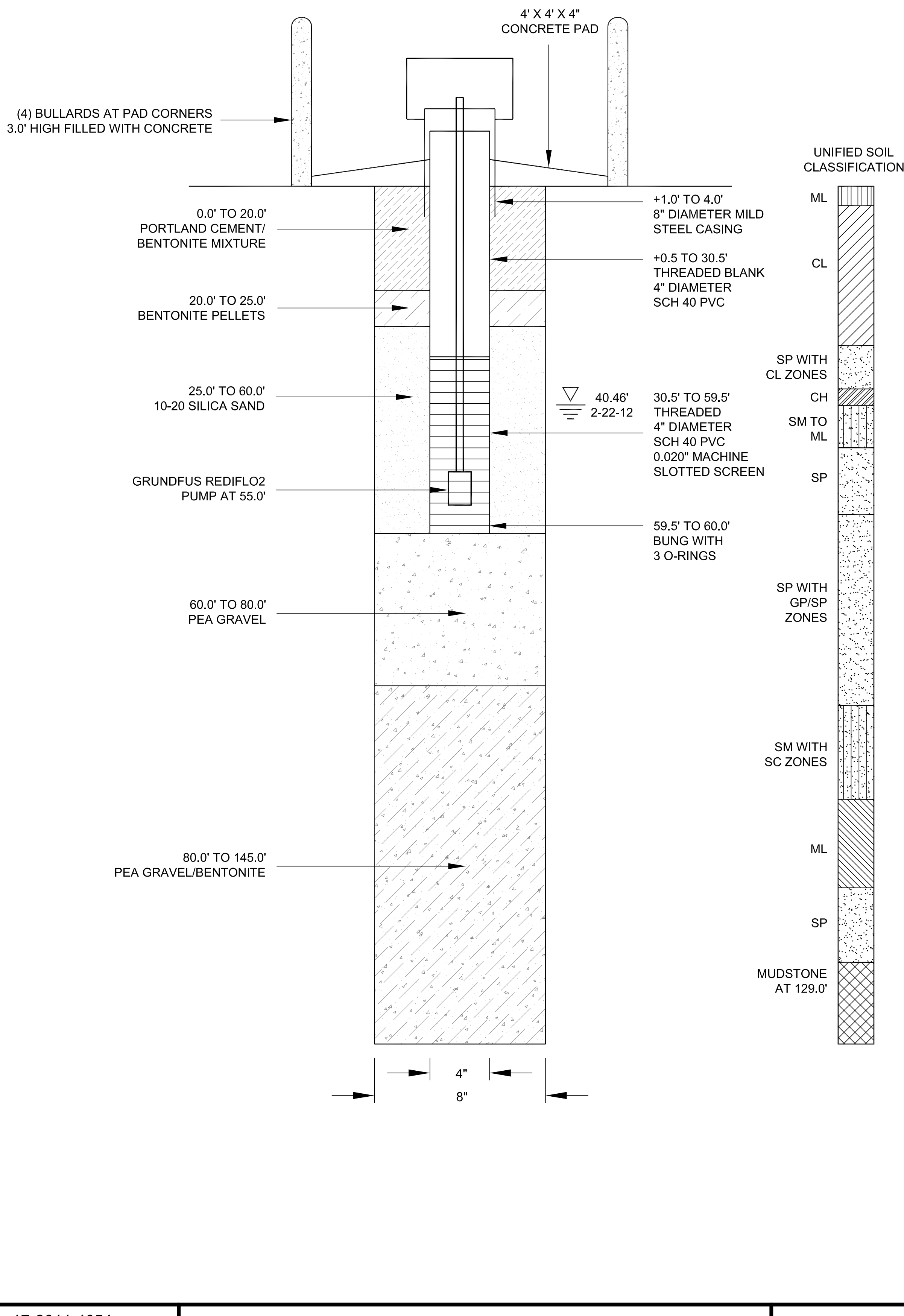
GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	40.2	0730	1-21-12
▼	38.9	0800	1-22-12

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. M-48A



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JOB NO.	17-2011-4054
DESIGN:	MAK
DRAWN:	GWH
DATE:	3/2012
SCALE:	NOT TO SCALE

MONITOR WELL M-48A
ADWR REGISTRATION NO. 55-913983

ARIZONA PUBLIC SERVICE - CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

amec

Environment & Infrastructure
4600 East Washington Street, Suite 600
Phoenix, Arizona

TABLE A-6. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-56A [*55-918661*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney, C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 100.0 feet / 5020.630 feet msl	DATE DRILLED: 10/4 - 10/7/2015
CADASTRAL / NAD83 : (A-18-19)23cbc / 1434257.733 N / 658887.345 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 65%, rounded fine sand 25%, gravel 10%. Gravel fraction: subangular gravel to 0.5 in. consisting of chert, coal (fill), and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong. Disturbed surface sample. Disturbed surface sample.
5.0 - 10.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 65%, rounded fine sand 30%, gravel 5%. Gravel fraction: subangular gravel to 0.2 in. consisting of chert, coal (fill), and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong. Disturbed surface sample. Disturbed surface sample.
10.0 - 15.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 20%, trace gravel. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Poorly graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 70%, rounded very fine sand 30%, trace gravel. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded very fine sand 15%, gravel 10%. Gravel fraction: subangular gravel to 0.2 in. consisting of chert, sandstone, and quartz. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 15%, gravel 5%. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 90%, rounded very fine sand 10%, trace gravel. Gravel fraction: subangular gravel to 0.1 in. consisting of chert. Non-lithified. High plasticity. Poorly graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt 95%, rounded very fine sand 5%. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Dark reddish gray [5YR4/2]; rounded very fine sand 45%, silt 40%, gravel 15%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert, sandstone, and green siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-6. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-56A [*55-918661*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded fine sand 80%, gravel 15%, silt 5%. Gravel fraction: subangular gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 75%, gravel 20%, silt 5%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 75%, gravel 25%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 70%, gravel 30%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
70.0 - 75.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subrounded gravel to 0.3 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subrounded gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
80.0 - 85.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded fine sand 20%. Gravel fraction: subangular to rounded gravel to 1.6 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
85.0 - 90.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded, fine to medium sand 20%. Gravel fraction: subangular to rounded gravel to 1.6 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
90.0 - 95.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 75%, subrounded, fine to coarse sand 20%, silt 5%. Gravel fraction: subangular to rounded gravel to 2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-6. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-56A [*55-918661*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
95.0 - 100.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, subrounded, fine to coarse sand 20%. Gravel fraction: angular to rounded gravel to 3.1 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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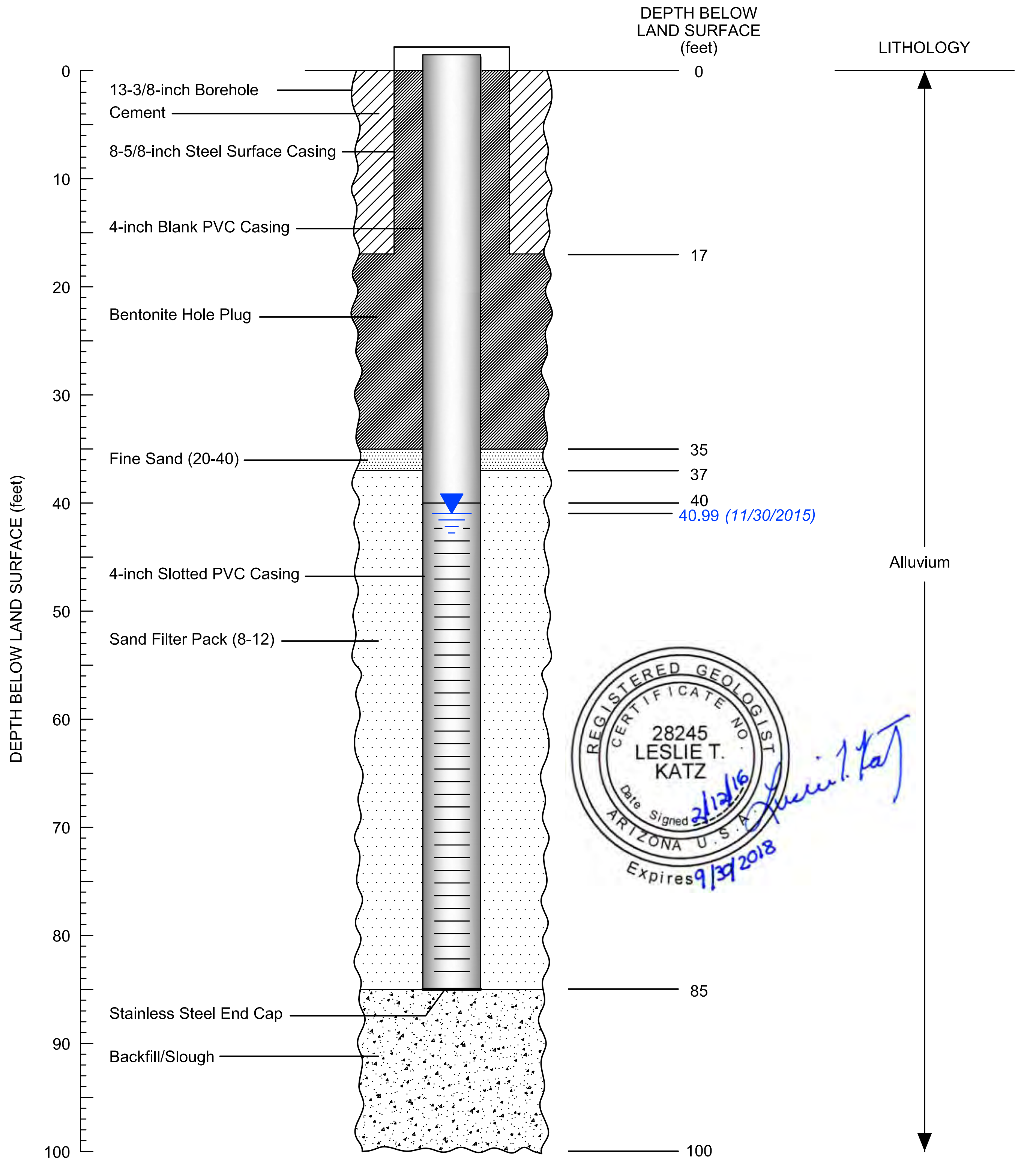

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-56A (SP-3D)	NORTHING: 1434257.73
REGISTRATION: 55-918661	EASTING: 658887.35
COUNTY: Navajo, Arizona	MP Elevation: 5023.165 feet amsl
DATE COMPLETED: 10/07/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-56A APS CHOLLA POWER PLANT

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TABLE A-7. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-57A [*55-918660*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 100.0 feet / 5021.164 feet msl	DATE DRILLED: 10/7 - 10/8/2015
CADASTRAL / NAD83 : (A-18-19)23cbc / 1434198.679 N / 658767.25 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY GRAVEL WITH SAND (GC)**: Dark reddish gray [5YR4/2]; silt and clay 50%, gravel 30%, rounded fine sand 20%. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, coal. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate. Disturbed surface sample. Disturbed surface sample.
5.0 - 10.0	**Qal**	**CLAYEY GRAVEL WITH SAND (GC)**: Dark reddish gray [5YR4/2]; silt and clay 50%, gravel 30%, rounded fine sand 20%. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, coal. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate. Disturbed surface sample. Disturbed surface sample.
10.0 - 15.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 60%, rounded very fine sand 30%, gravel 10%. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert, sandstone. Non-lithified. High plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded very fine sand 25%, trace gravel. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 20%, trace gravel. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 15%, gravel 5%. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert, sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 80%, gravel 10%, rounded very fine sand 10%. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of chert, sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 95%, rounded very fine sand 5%, trace gravel. Non-lithified. High plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 60%, silt and clay 35%, gravel 5%. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-7. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-57A [*55-918660*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

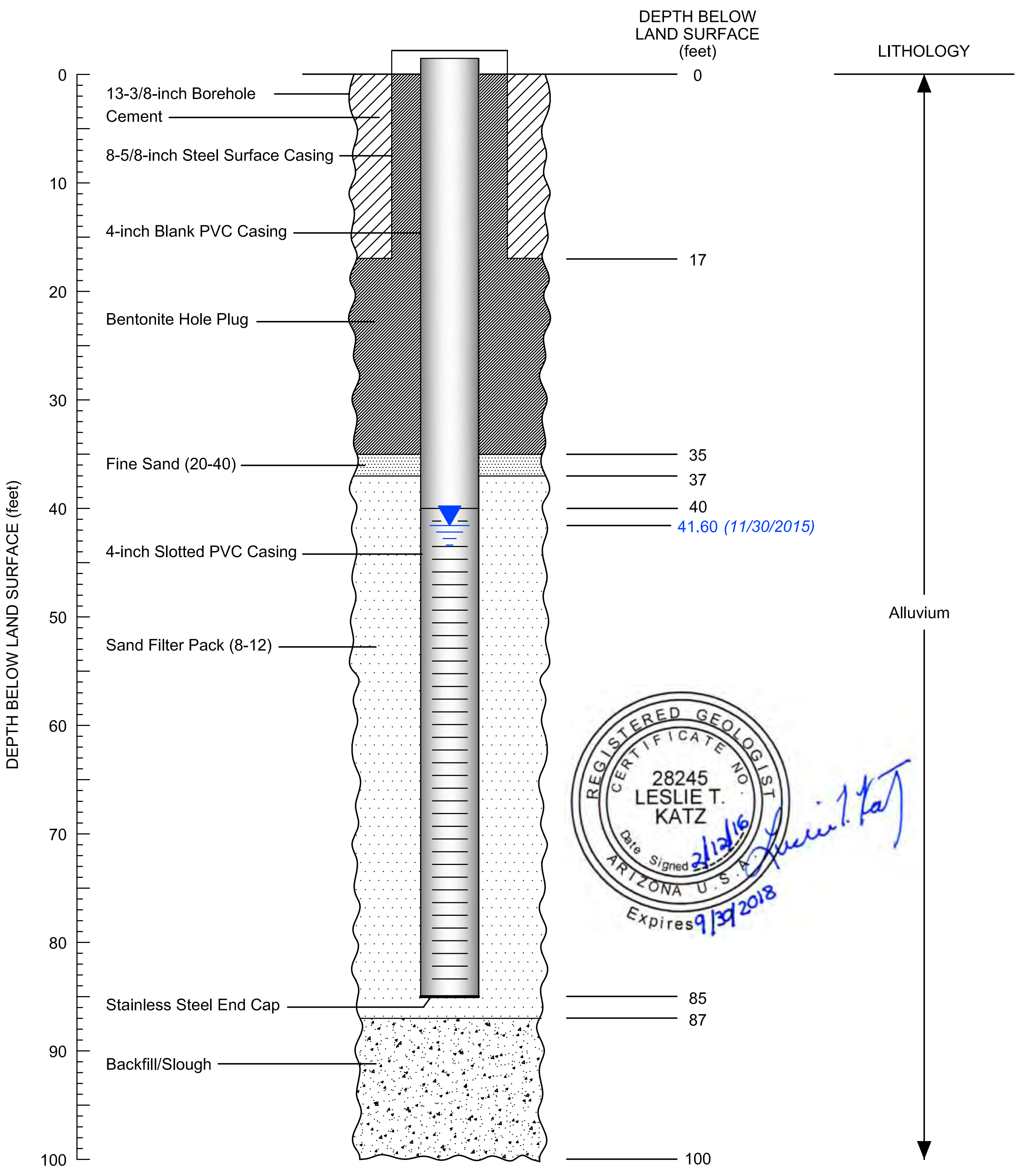
DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 80%, gravel 10%, silt 10%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: weak.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 65%, gravel 30%, silt 5%. Gravel fraction: subangular to rounded gravel to 0.8 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 15%, silt 5%. Gravel fraction: subrounded to rounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 60%, gravel 40%, trace silt. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 70%, gravel 30%, trace silt. Gravel fraction: subangular to subrounded gravel to 2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
70.0 - 75.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 20%, trace silt. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%, trace silt. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
80.0 - 85.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded, fine to coarse sand 20%, trace silt. Gravel fraction: subangular to rounded gravel to 2.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
85.0 - 90.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 70%, gravel 30%, trace silt. Gravel fraction: subangular to rounded gravel to 0.4 in. consisting of chert, sandstone, and petrified wood. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-7. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-57A [*55-918660*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
90.0 - 95.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 60%, gravel 40%, trace silt. Gravel fraction: subangular to subrounded gravel to 1.2 in. consisting of chert, sandstone, and petrified wood. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
95.0 - 100.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded, fine to coarse sand 20%, trace silt. Gravel fraction: subangular to rounded gravel to 2 in. consisting of chert, sandstone, and petrified wood. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.



EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-57A (SP-2D)	NORTHING: 1434198.68
REGISTRATION: 55-918660	EASTING: 658767.25
COUNTY: Navajo, Arizona	MP Elevation: 5023.816 feet amsl
DATE COMPLETED: 10/08/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-57A APS CHOLLA POWER PLANT

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TABLE A-8. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-58A [*55-918659*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 100.0 feet / 5021.237 feet msl	DATE DRILLED: 10/8 - 10/13/2015
CADASTRAL / NAD83 : (A-18-19)23cbc / 1434165.11 N / 658698.919 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 65%, rounded, very fine to fine sand 25%, gravel 10%. Gravel fraction: subrounded gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
5.0 - 10.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded, very fine to fine sand 20%, gravel 5%. Gravel fraction: subrounded gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
10.0 - 15.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded, very fine to fine sand 20%, trace gravel. Gravel fraction: angular gravel to 0.4 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 70%, rounded very fine sand 30%, trace gravel. Gravel fraction: angular gravel to 0.2 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded very fine sand 25%, trace gravel. Gravel fraction: angular gravel to 0.2 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 85%, rounded very fine sand 15%. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 90%, rounded very fine sand 10%. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 20%. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; rounded fine sand 50%, silt and clay 40%, gravel 10%. Gravel fraction: subangular to rounded gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 50%, gravel 40%, silt 10%. Gravel fraction: subangular to rounded gravel to 2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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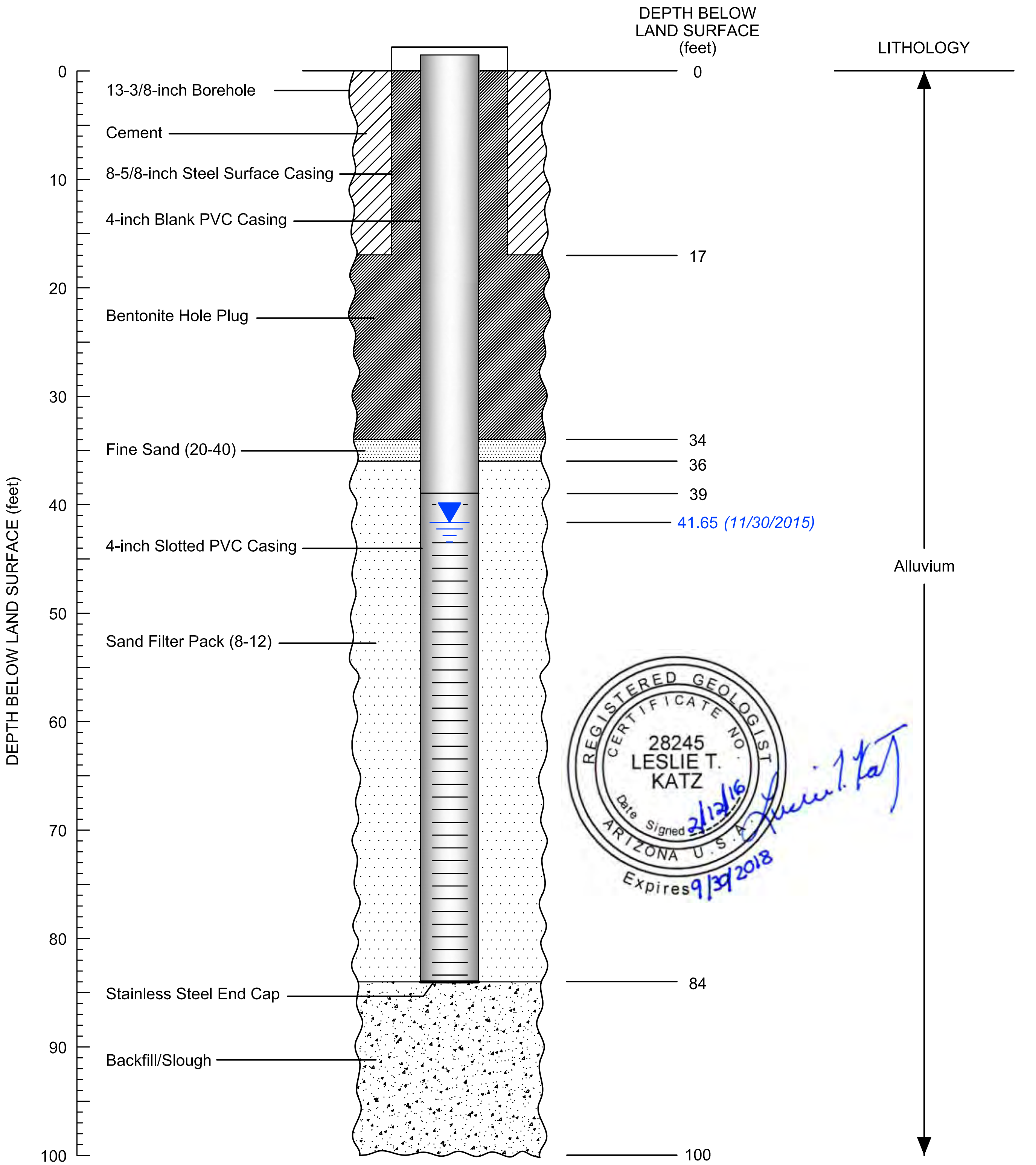
TABLE A-8. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-58A [*55-918659*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 1.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subangular to subrounded gravel to 2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 70%, gravel 30%. Gravel fraction: subangular to subrounded gravel to 1.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 85%, gravel 15%. Gravel fraction: subangular to subrounded gravel to 0.4 in. consisting of sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
70.0 - 75.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
80.0 - 85.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 0.4 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
85.0 - 90.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
90.0 - 95.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 70%, gravel 30%. Gravel fraction: subangular to subrounded gravel to 2 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
95.0 - 100.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 70%, gravel 30%. Gravel fraction: subangular to rounded gravel to 2.4 in. consisting of sandstone, chert, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.



EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-58A (SP-1D)	NORTHING: 1434165.11
REGISTRATION: 55-918659	EASTING: 658698.92
COUNTY: Navajo, Arizona	MP Elevation: 5023.841 feet amsl
DATE COMPLETED: 10/13/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-58A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2016

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TABLE A-12. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-62A [*55-918658*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney, M. Zelazny
DEPTH DRILLED / LAND SURFACE ELEVATION: 97.0 feet / 5021.006 feet msl	DATE DRILLED: 11/17/2015
CADASTRAL / NAD83 : (A-18-19)23cbd / 1434008.665 N / 659268.051 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish brown [5YR2.5/2]; silt and clay 60%, rounded to angular, fine to coarse sand 30%, gravel 10%. Gravel fraction: subrounded to subangular gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
5.0 - 10.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish brown [5YR2.5/2]; silt and clay 60%, rounded to angular, fine to coarse sand 30%, gravel 10%. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
10.0 - 15.0	**Qal**	**FAT CLAY WITH SAND (CH)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded to angular medium sand 25%. Gravel fraction: subrounded to subangular gravel. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
15.0 - 20.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 70%, rounded to angular medium sand 30%. Gravel fraction: subrounded to subangular gravel. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; rounded to angular fine sand 50%, silt and clay 50%. Gravel fraction: subrounded to subangular gravel. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
25.0 - 30.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; rounded to angular fine sand 50%, silt and clay 50%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
30.0 - 35.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded to angular, fine to medium sand 25%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded to angular, fine to medium sand 25%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SANDY SILT (ML)**: Light reddish brown [5YR6/3]; silt and clay 55%, rounded to angular, fine to medium sand 45%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-12. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-62A [*55-918658*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 70%, gravel 20%, silt 10%. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 70%, gravel 20%, silt 10%. Gravel fraction: subrounded to subangular gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, silt 10%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 60%, gravel 30%, silt 10%. Gravel fraction: subrounded to subangular gravel to 0.6 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
70.0 - 75.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 1.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
80.0 - 85.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 1.0 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
85.0 - 90.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-12. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-62A [*55-918658*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
90.0 - 95.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 95%, silt 5%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
95.0 - 97.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 95%, silt 5%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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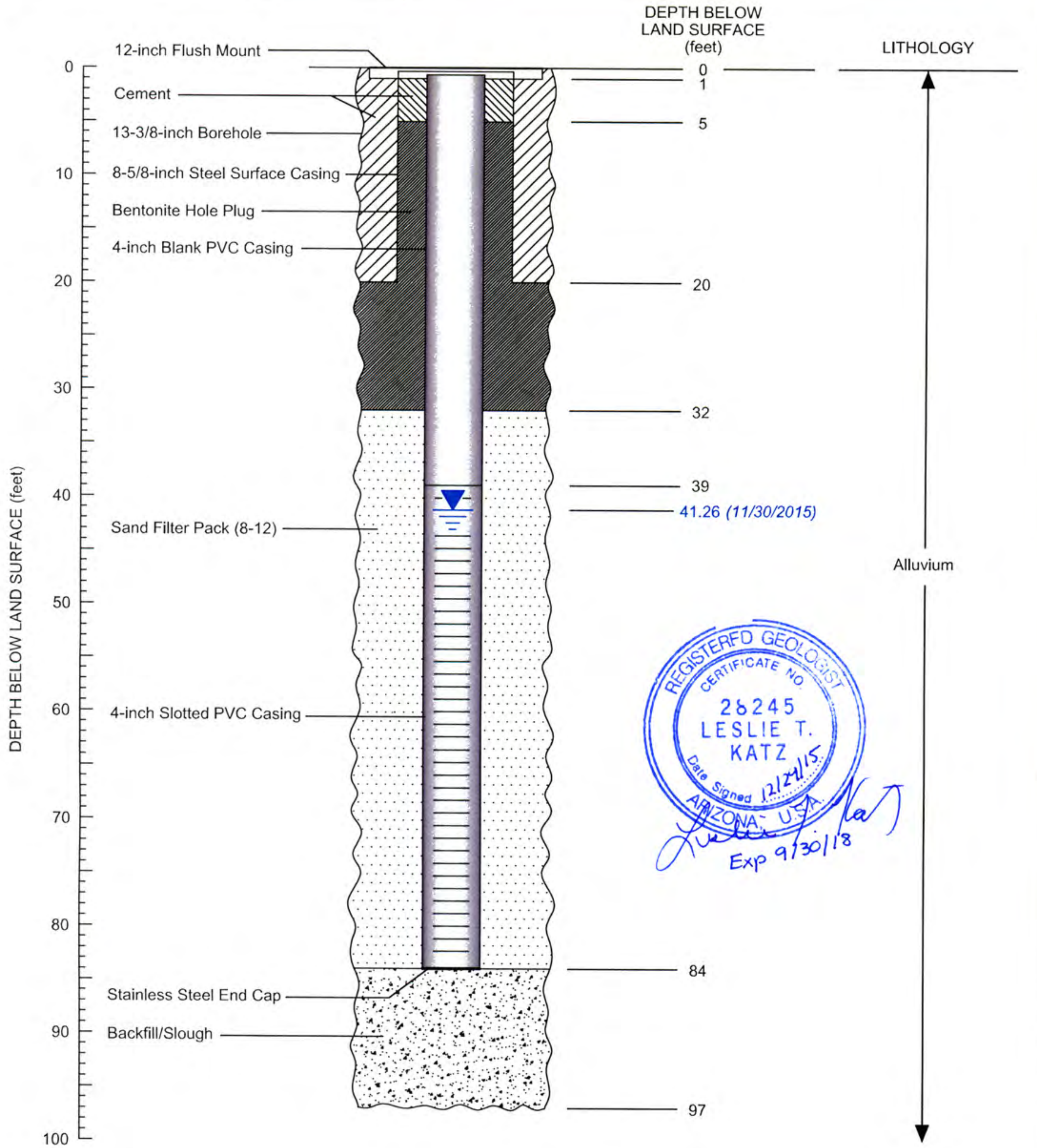


EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-62A (SP-1U)	NORTHING: 1434008.665
REGISTRATION: 55-918658	EASTING: 659268.051
COUNTY: Navajo, Arizona	MP Elevation: 5020.874 feet amsl
DATE COMPLETED: 11/17/15	DATUM: NAD83, State Plane 1983

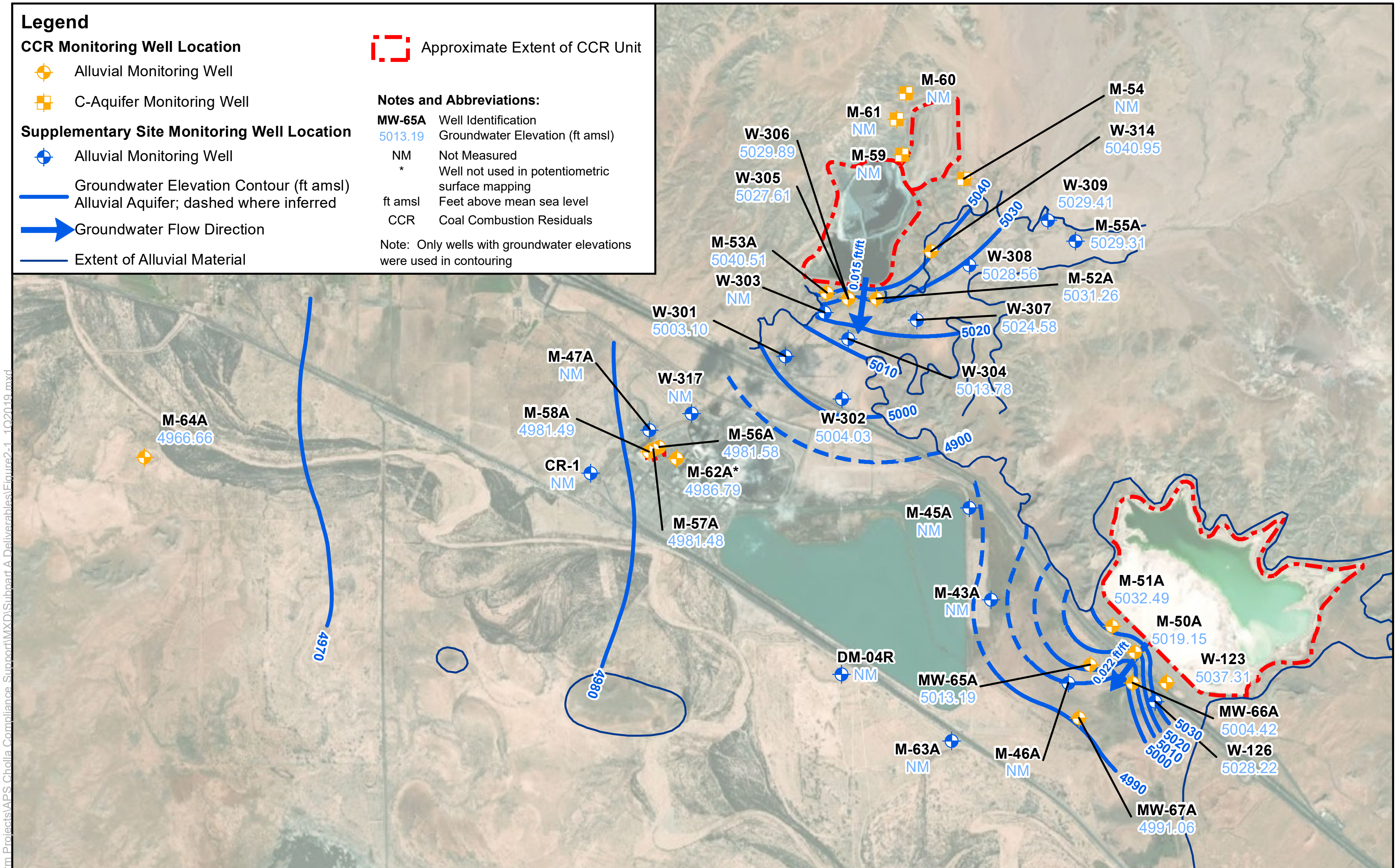
SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-62A APS CHOLLA POWER PLANT

MONTGOMERY & ASSOCIATES

2015

FIGURE A-15

Drafting\897.0702\M62A_ws\29Dec2015



0 1,500 3,000 6,000 Feet

Job No.	14-2018-2040
PM:	MBH
Date:	9/14/2020
Scale:	1" = 3,000'

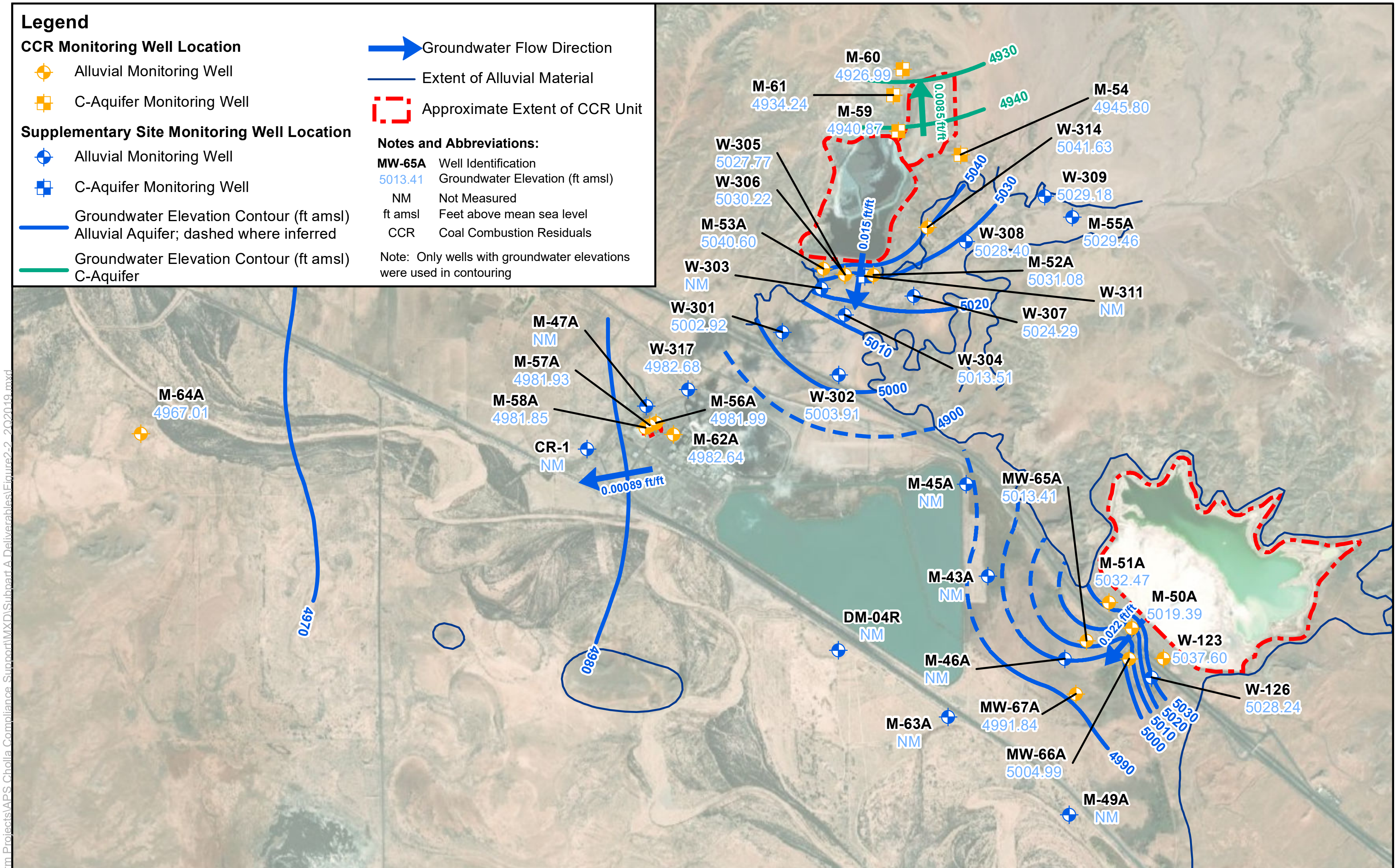
N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Potentiometric Surface Map
February 2019

FIGURE
2-1

wood.



0 1,500 3,000 6,000 Feet

Job No. 14-2018-2040
PM: MBH
Date: 9/14/2020
Scale: 1" = 3,000'

N

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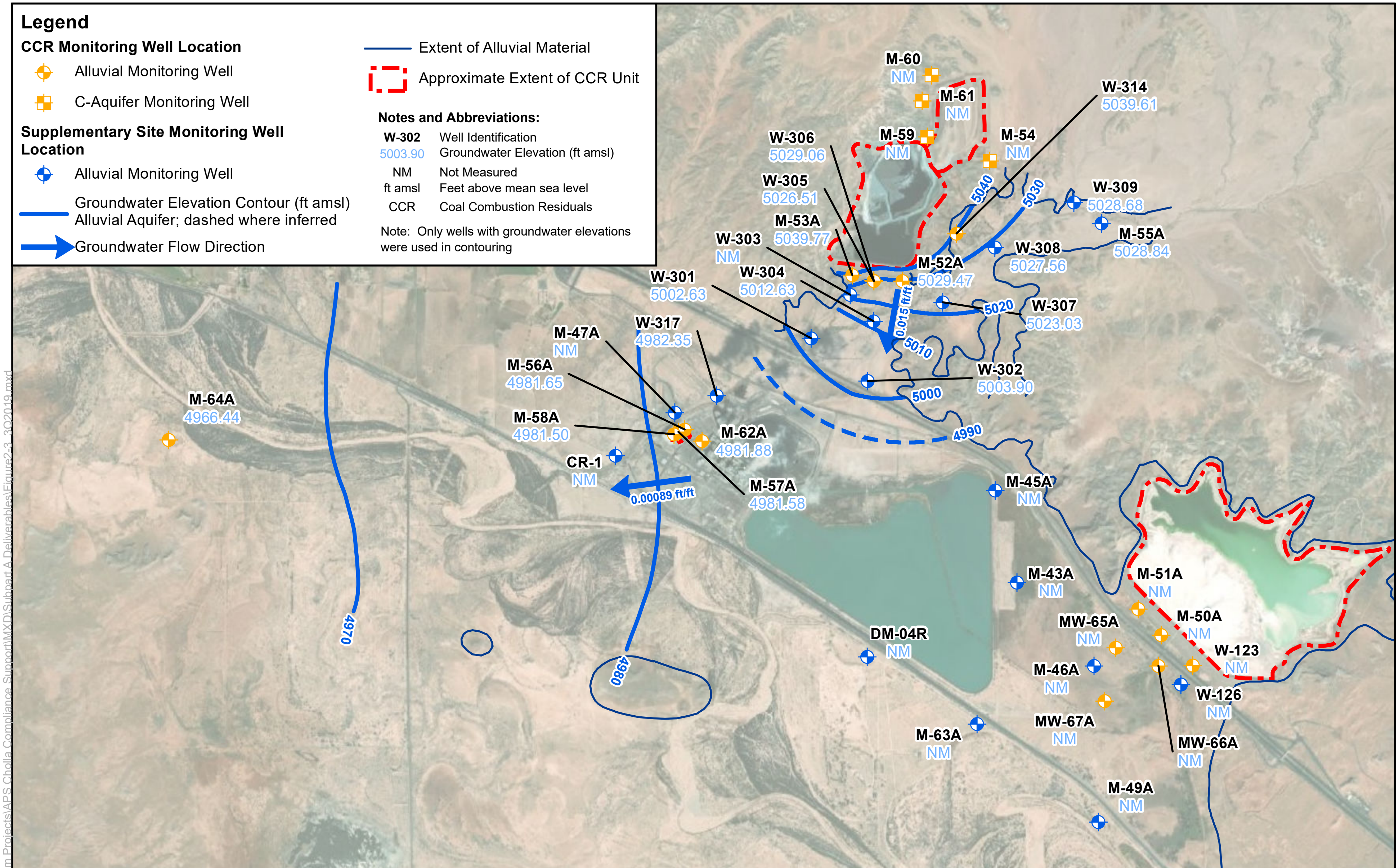
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Potentiometric Surface Map
April 2019

FIGURE
2-2

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\Subpart A Deliverables\Figure2-2_2O2019.mxd



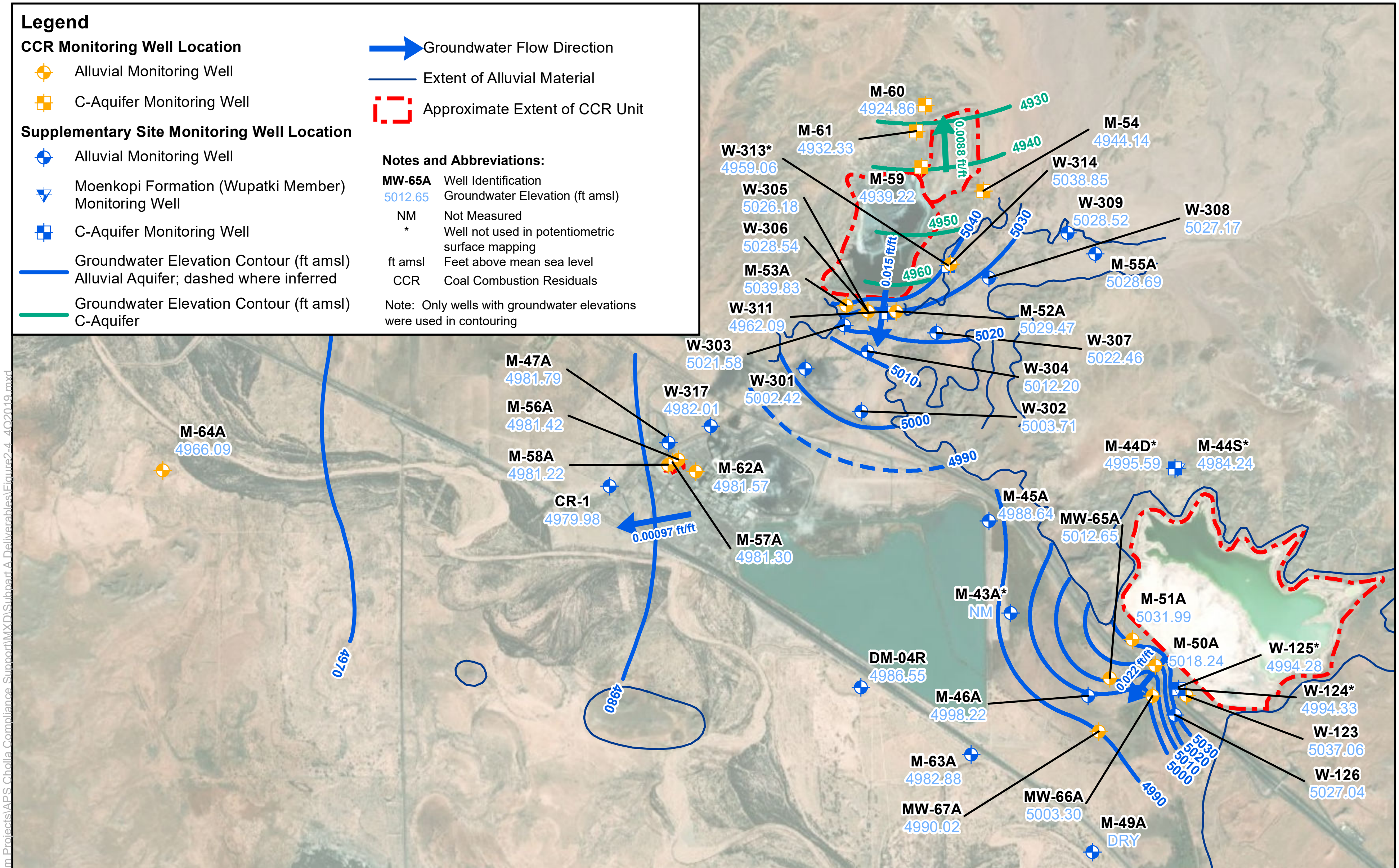
Job No.	14-2018-2040
PM:	MBH
Date:	9/14/2020
Scale:	1" = 3,000'

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Potentiometric Surface Map
August 2019

FIGURE
2-3

wood.



Job No.	14-2018-2040
PM:	MBH
Date:	9/14/2020
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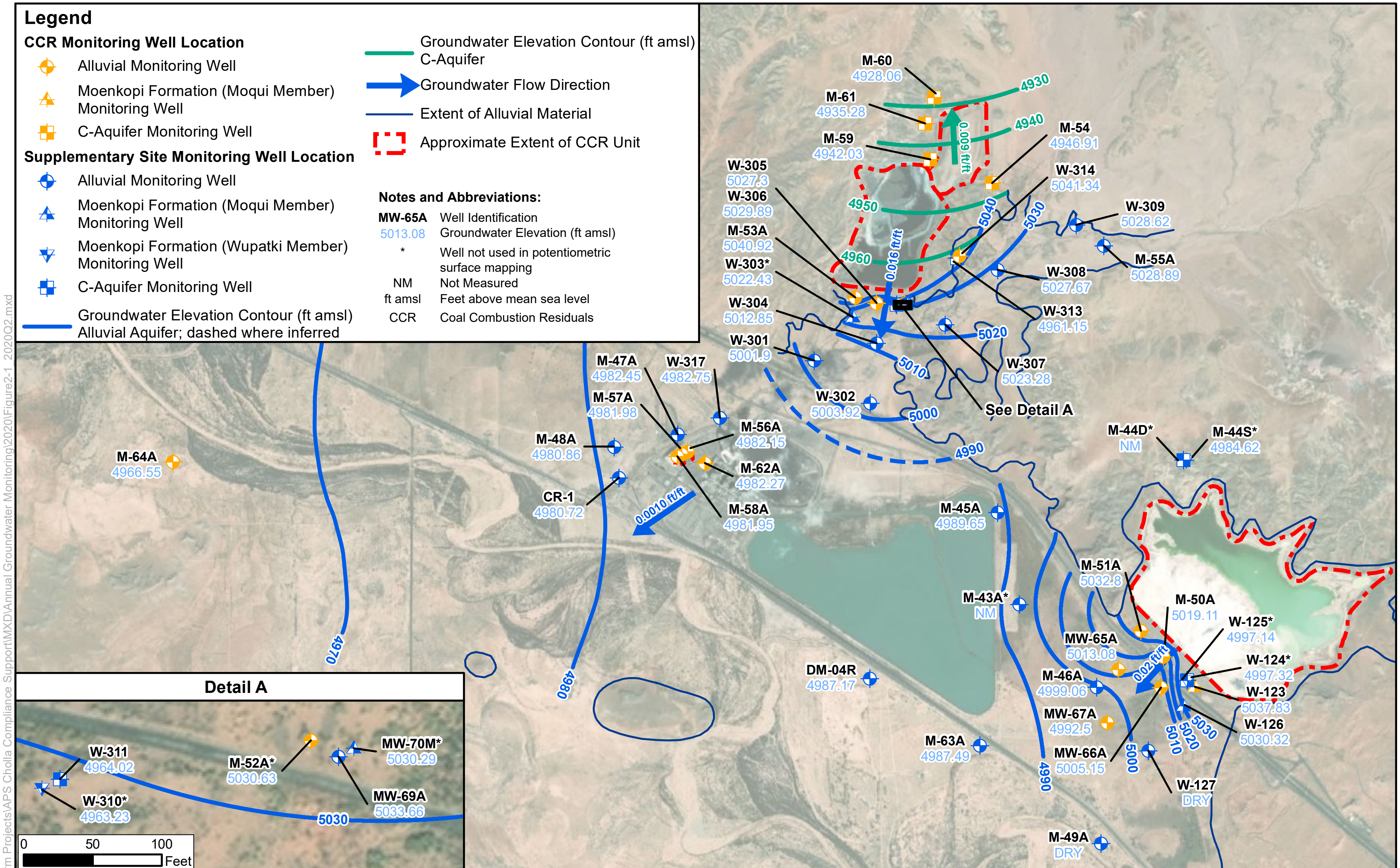
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Potentiometric Surface Map
October 2019

FIGURE
2-4

wood.



Job No. 14-2018-2040
PM: MBH
Date: 10/2/2020
Scale: 1" = 3,000'

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Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Potentiometric Surface Map
April 2020

FIGURE
2-5

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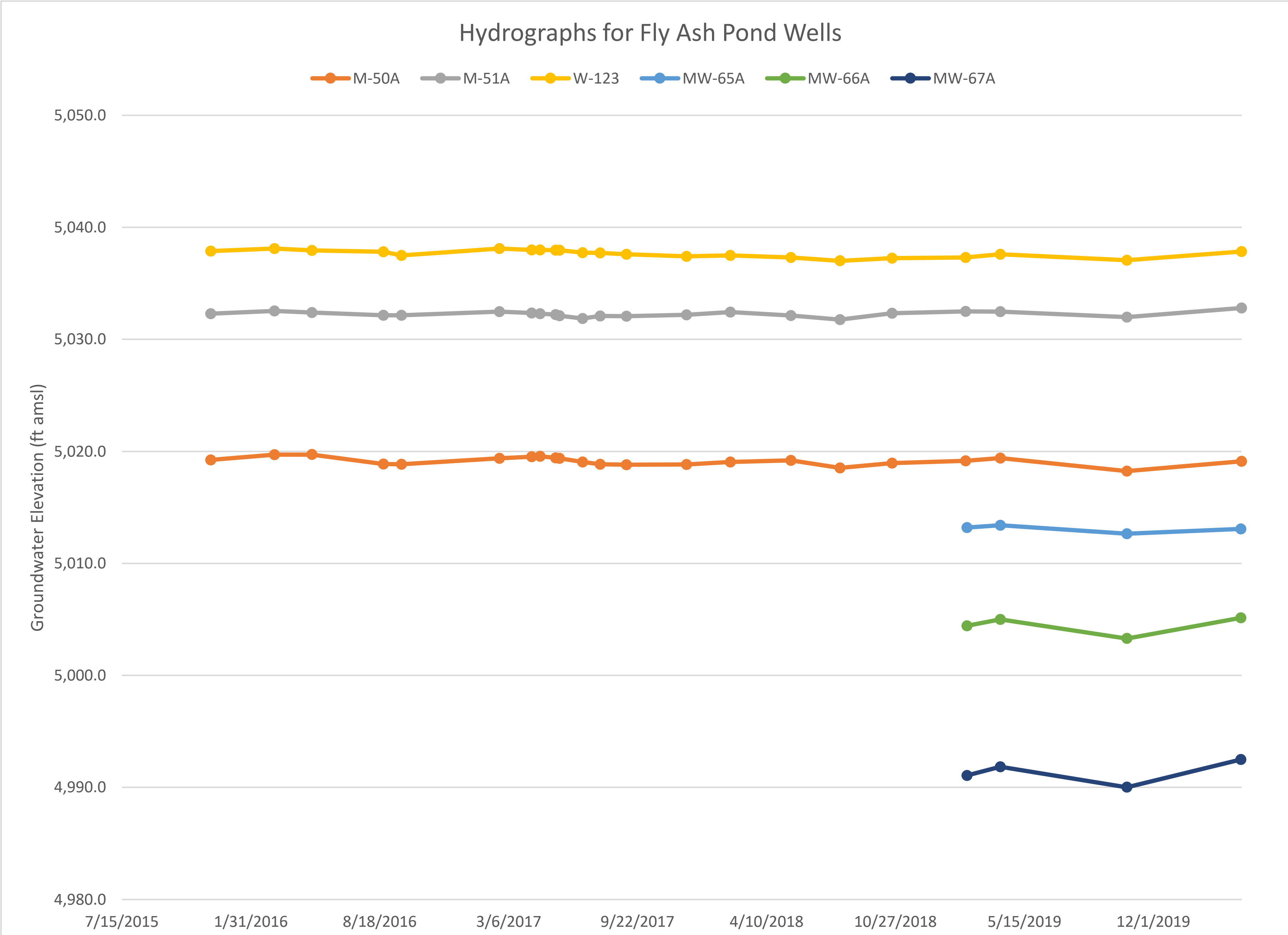
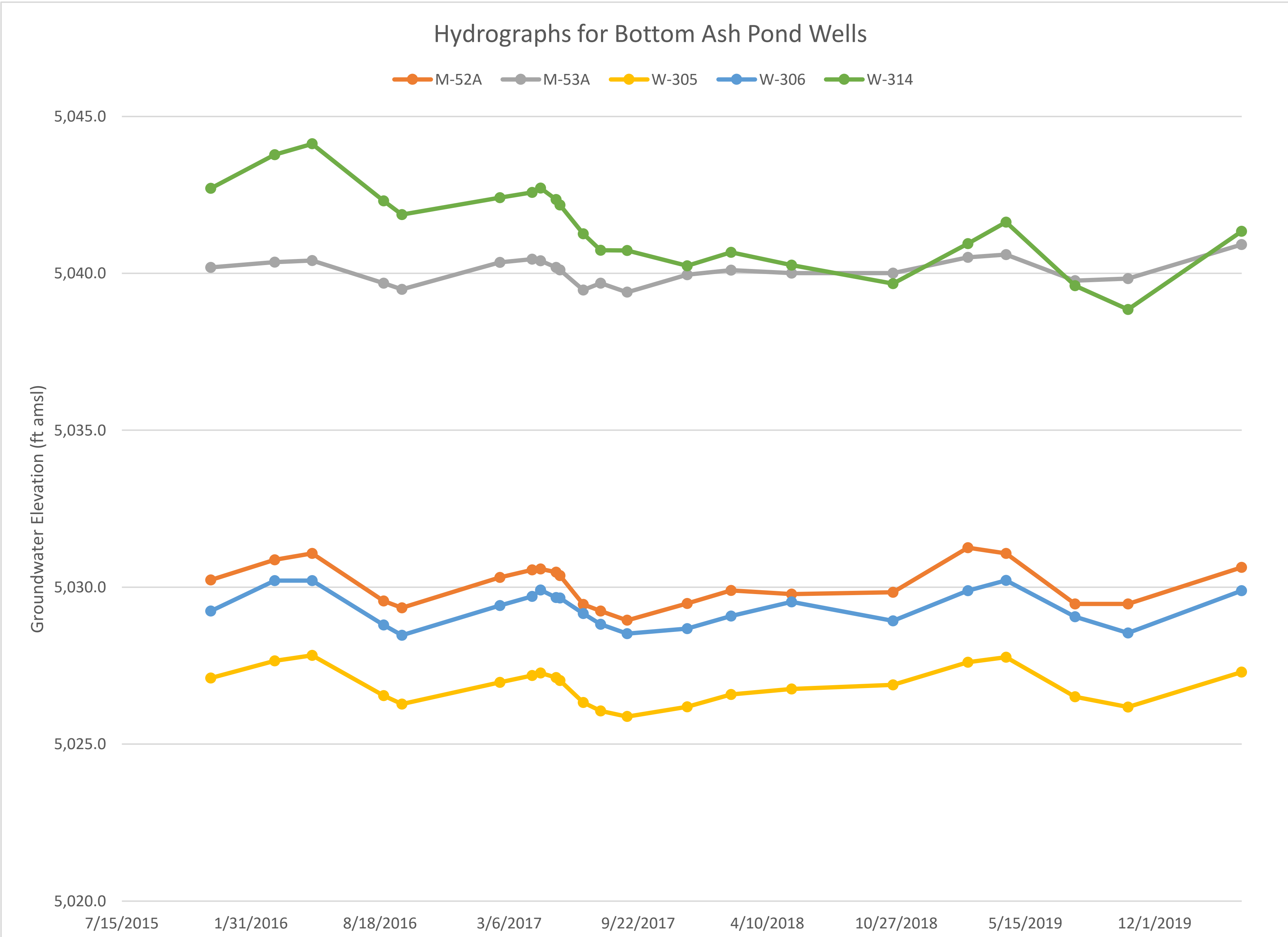
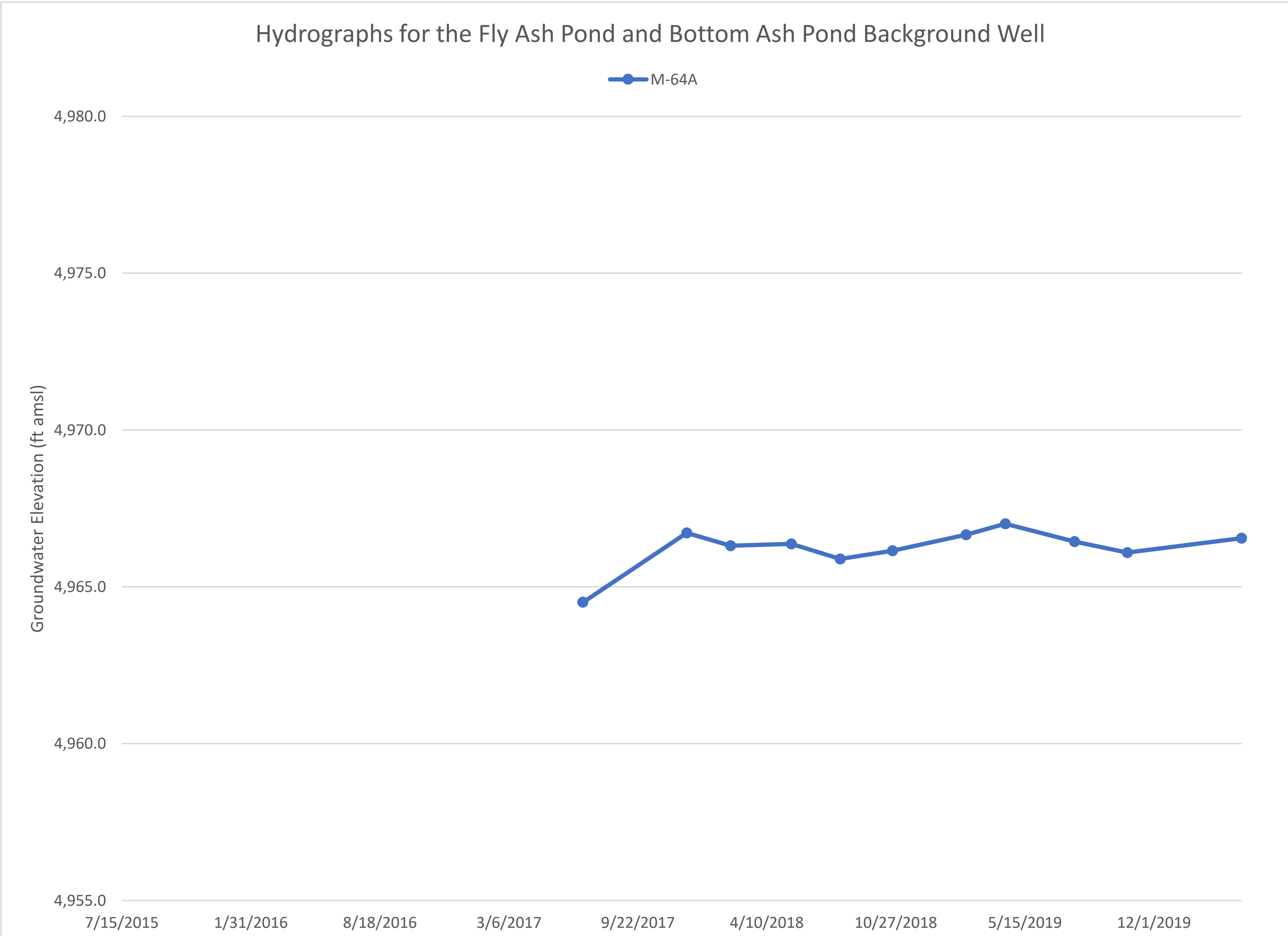
Hydrographs for FAP Wells



Hydrographs for BAP Wells



Hydrograph for M-64A



MONTGOMERY
& ASSOCIATES
Water Resource Consultants

REPORT

September 19, 2017 | Prepared for: aps

Cholla Power Plant Coal Combustion Residuals Program - Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks Navajo County, Arizona

Document # CH_GW_SystemCert_020_20170919

www.elmontgomery.com 520-881-4912 1550 East Prince Road, Tucson AZ 85719

MONTGOMERY & ASSOCIATES
Water Resource Consultants

September 19, 2017

Cholla Power Plant Coal Combustion Residuals Program – Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks

Document # CH_GW_SystemCert_020_20170919

ARIZONA PUBLIC SERVICE, NAVAJO COUNTY, ARIZONA

CERTIFICATION STATEMENT

I, Lyle Davis, P.E., have reviewed Montgomery & Associates' report entitled *Cholla Power Plant Coal Combustion Residuals Program – Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks* (Report), dated September 18, 2017, and certify the following for the Arizona Public Service Cholla Power Plant in relation to requirements for the U.S. Environmental Protection Agency Coal Combustion Residual (CCR) Rule (the Rule):

- Groundwater monitoring systems associated with each of the CCR Units have been designed and constructed to ensure that monitoring data will accurately represent the quality of groundwater that has not been affected by leakage from the CCR unit (background) and the quality of groundwater passing the waste boundary (downgradient), consistent with requirements of § 257.91 of the Rule.
- A sufficient number of monitor wells has been installed at each of the CCR Units to meet the performance standards in § 257.91(a)(1) and (2).
- In cases where the number of downgradient monitor wells installed at a particular CCR Unit is equal to the Rule-required minimum of three (3), the Report provides satisfactory technical justification that the number of downgradient monitor wells installed is sufficient to characterize potential leakage, based on requirements of § 257.91 of the Rule.

Stamp

Registered Professional Engineer (Civil)
CERTIFICATE NO.
18752
LYLE A.
DAVIS
Date Signed 9/19/2017
ARIZONA, U.S.A.
EXPIRES 9/30/2017

Signed: Lyle A Davis

Dated: September 19, 2017

I, Leslie T. Katz, P.G., certify that I provided supervision for design and installation of monitor wells for the Cholla CCR monitoring program, pursuant to requirements of the Rule.

Stamp

Signed: Leslie T. Katz

Dated: September 19, 2017

REGISTERED GEOLOGIST
CERTIFICATE NO.
28245
LESLIE T.
KATZ
Date Signed 9/19/17
ARIZONA, U.S.A.
Expires 9/30/18

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Appendices

Appendix A. Construction Details for New CCR Monitor Wells, September 2015 – February 2017

Appendix B. Construction Details for CCR Monitoring Network Pre-Existing Monitor Wells

1 SITE LOCATION AND PROJECT DESCRIPTION

Montgomery & Associates (M&A) designed monitoring networks and provided field oversight for installation of groundwater monitor wells at the Arizona Public Service (APS) Cholla Power Plant (Cholla) as part of the requirements for the U.S. Environmental Protection Agency (EPA) Coal Combustion Residual (CCR) Rule (the Rule). The Cholla facility is located near Joseph City in Navajo County, Arizona, along the north bank of the Little Colorado River (LCR). This report was prepared to describe monitoring network siting, design, drilling, construction, and development procedures associated with each of four Cholla CCR Units[1] that are subject to the Rule. The CCR Units include: the Fly Ash Pond (FAP), Bottom Ash Pond (BAP), Bottom Ash Monofill (BAM), and Sedimentation Pond (SEDI), as shown on **Figure 1**. The SEDI was the first of the CCR Units placed into service (1976). The FAP and BAP dams were completed in 1978 and the BAM came into operation in the late 1990s. It should be noted that the large pond located just southwest of the power plant, Cholla Reservoir, is used for cooling water recirculation and is not a CCR Unit (**Figure 1**). Significant hydrogeologic and water quality data were reviewed and interpreted in an effort to design comprehensive and responsive monitoring networks for each of the Units. Background information on provisions of the Rule, site hydrogeology, and the Cholla CCR Units is provided as context for siting and design of the new monitor wells. To ensure compliance with the Rule, field procedures and monitoring results for CCR monitor wells are evaluated promptly to ensure that the well networks continue to provide a complete and representative data set for each Unit.

[1] CCR Unit – *All new and existing landfills, surface impoundments, or lateral expansions that contain or manage CCR generated from coal combustion at an electric utility or independent power production facility.*

2 PURPOSE

2.1 Establish CCR Monitoring Networks

The primary purpose of this report is to document installation and provide justification for and certification of the monitoring networks established at each of the Cholla CCR Units relative to requirements of the Rule. The report describes monitoring network well locations, well design, field program planning, and well installation. The report also presents and analyzes hydrogeologic and water level data to justify the adequacy of groundwater monitoring systems for each Unit to meet requirements of the Rule.

Wellfield certification will be based on demonstrating that each groundwater monitoring system consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent: (1) the quality of background groundwater that has not been affected by leakage from each CCR unit, and (2) the quality of groundwater passing the waste boundary[2] of each CCR Unit (Rule, 257.91, a, 1 and 2). CCR monitor well network certification will be conducted by Lyle Davis, P.E. in a certification statement to accompany this report.

[2] Waste Boundary – *The waste boundary comprises a vertical surface located at the hydraulically downgradient limit of the CCR unit. The vertical surface extends down into the uppermost aquifer. Monitoring wells must be located as near as possible to the waste boundary.*

3 KEY COMPONENTS OF CCR RULE

On April 17, 2015, the EPA released the final version of the Rule regarding the disposal of CCR from power production facilities. The Rule defines CCR landfills and surface impoundments and establishes minimum criteria for the following: (1) CCR unit design and operation, (2) groundwater monitoring and corrective action, (3) closure requirements, (4) post-closure care, (5) recordkeeping, (6) notification, and (7) internet posting requirements. Programs in place at the Cholla Power Plant to meet criteria established for CCR unit groundwater monitoring are the focus of this report.

3.1 Monitoring Requirements

The Rule defines a minimum acceptable *groundwater monitoring system*[3] for a *CCR Unit* along with additional factors that should be considered in determining if the minimum system is adequate. Additionally, the Rule specifies the required sampling program for the groundwater monitoring network.

3.1.1 Number and Distribution of Wells

The Rule requires that a monitoring well network be developed for each CCR Unit, with upgradient and downgradient wells to determine background groundwater quality in the *uppermost aquifer*[4] and the quality of groundwater passing the waste boundary of each CCR Unit.

Upgradient / Background Wells

A minimum of one monitor well that is located beyond the upgradient extent of potential contamination is required for each Unit. The purpose of upgradient wells is to determine background water quality. The Rule recognizes that background water quality may be

[3] *Groundwater Monitoring System* – The objective of a groundwater monitoring system is to provide samples of groundwater to accurately represent the quality of background groundwater and groundwater passing the waste boundary of a CCR Unit. A groundwater monitoring system must include a minimum of one upgradient and three downgradient monitoring wells. Justification must be provided to support use of a groundwater monitoring system that includes only the minimum number of wells.

[4] *Uppermost Aquifer* – The uppermost aquifer comprises the geologic formation nearest the natural ground surface that may be considered an aquifer, as well as lower aquifers that are hydraulically connected with this aquifer within the facility's property boundary. The groundwater level used for this determination is the point nearest to the natural ground surface to which the aquifer rises during the wet season. Systems encompassed by this definition include shallow, deep, perched, confined or unconfined aquifers, provided they yield usable water. The term "usable" is not clearly defined in the Rule.

better established in wells that are not located hydraulically upgradient from a CCR Unit in the following circumstances:

1. Flow directions in the uppermost aquifer change seasonally, in response to surface water flows, or in response to pumping
2. Upgradient groundwater quality is contaminated by another source
3. The Unit overlies a groundwater divide
4. Geologic units present at downgradient locations are absent in a direction that would normally be considered to be upgradient from the Unit
5. Groundwater flow is modified by karst terrain or fault zones

Circumstance #4 is present at two of the four Cholla CCR Units, as described in **Section 4.3**.

Downgradient Wells

A minimum of three wells are required at the downgradient perimeter of each Unit, or at the closest practical distance from this location. The purpose of the downgradient wells is to accurately represent the quality of water that may be passing the waste boundary of the CCR Unit.

4 CCR UNIT MONITORING NETWORK DESIGN

4.1 Hydrogeologic and General Water Quality Conditions

The primary hydrogeologic units encountered at Cholla, from shallowest to deepest, include the alluvial sediments associated with the LCR and Tanner Wash, the Moenkopi Formation, which is a regional aquitard, and the regional Coconino Sandstone Aquifer. A general overview regarding geologic, hydrologic, and water quality conditions in these units, as they occur in the vicinity of the Cholla Plant, is provided below.

4.1.1 LCR and Tanner Wash Alluvium

The LCR and Tanner Wash alluvial units are present in localized areas at the Cholla site, as shown on **Figure 2**. The alluvial units range in thickness from non-existent to nearly 200 feet. These alluvial deposits are fairly heterogeneous and include gravels, sands, silts, and clays. While both are unconsolidated, Tanner Wash Alluvium is generally more fine-grained than LCR Alluvium in the Cholla area, due to the nature of source rocks and the depositional environment. Over much of the study area, the LCR and Tanner Wash Alluvium are underlain by the Moenkopi Formation. Contours for thickness of the Moenkopi Formation are shown on **Figure 3**. The Chinle Formation over-lies the Moenkopi north of the Cholla area.

Tanner Wash drains a watershed comprised chiefly of the fine-grained rocks of the Chinle and Moenkopi Formations. Based on permeability testing conducted during design and construction of the BAP, hydraulic conductivity for the Tanner Wash Alluvium is reported to range from 0.06 to 0.44 feet per day (APS, 1984). The FAP was generally constructed on Moenkopi Formation bedrock, covered by a veneer of alluvial sediments within a historical drainage that previously contributed runoff to the LCR. A pumping test conducted at alluvium monitor well W-123, located immediately downgradient from the FAP indicated a hydraulic conductivity of 0.03 feet per day (APS, 1984). This test suggests that alluvial sediments immediately downgradient of the FAP have similar hydraulic properties as those in Tanner Wash.

Apart from areas immediately downstream of current or historical Chinle/Moenkopi drainages, lithologic information from drilling in the LCR Alluvium indicates that below the water table, which occurs at a depth of between about 25 and 45 feet, the unit generally comprises well-graded, gravelly sand. A slug test conducted following installation of background LCR Alluvium well M-64A yielded an average hydraulic conductivity of 66 feet per day. This value is anticipated to be fairly typical for the LCR Alluvium.

Depth to water level in the LCR and Tanner Wash Alluvium ranges from a few feet to more than 40 feet below land surface (bls) in the Cholla area, varying spatially based on proximity to recharge sources and topography as well as seasonally based on rainfall-runoff patterns. Direction of groundwater movement generally parallels the stream channels, flowing chiefly from east to west in the LCR Alluvium and from northeast to southwest in the Tanner Wash Alluvium. Groundwater movement in the LCR Alluvium is influenced by the presence of deeper paleochannels, where alluvium thickness exceeds 100 feet; these paleochannels do not always coincide with the location of the present river channel (**Figure 2**). Contours for water level elevation in the alluvial aquifer for June – July 2017 are shown on **Figure 4**.

Background alluvial water quality is known to vary widely based on geologic factors. With respect to Tanner Wash, there is reason to suspect that background water quality has naturally elevated TDS concentrations. Groundwater in the Tanner Wash alluvial aquifer moves through sediments derived from erosion of the Moenkopi and Chinle Formations, which occur at the surface in the Tanner Wash watershed. Both of these formations are composed of very fine-grained and evaporitic sediments, which would be anticipated to result in groundwater with high total dissolved solids (TDS) concentrations. With respect to the LCR, early data from the site suggests that background water quality in the LCR alluvium is variable and possibly fairly poor. Due to elevated TDS concentrations, limited saturated thickness, and recharge reliability constraints, groundwater in the LCR and Tanner Wash Alluvium is not used to a significant extent for water supplies. Outside of the Cholla area, the alluvium is reported to supply groundwater to stock wells along LCR tributaries and to a few domestic wells along the LCR. The LCR and Tanner Wash Alluvium are considered to be the uppermost aquifer for three of the four CCR units at the Cholla facility, as described in **Section 4.2**.

4.1.2 Moenkopi Formation

The Moenkopi Formation is present at land surface across a large portion of the Cholla area. The thickness of the Moenkopi Formation in the Cholla area ranges from non-existent to over 300 feet thick based on data from APS wells, as shown on **Figure 3**. Where a sufficient thickness is present, the Moenkopi Formation restricts the movement of groundwater from the shallow alluvial aquifers to the underlying Coconino Aquifer. The Moenkopi Formation is composed of three members; not all of these members are present in all locations, since part or all of the Moenkopi has been eroded away in certain areas. The upper Holbrook member is a blocky, well-consolidated sandstone and is relatively permeable. This member of the Moenkopi is not known to be present in the project area. The middle Moqui member is typically 250 to 300 feet thick near Cholla and makes up most of the Moenkopi Formation thickness. Consisting primarily of maroon and greenish mudstone with abundant gypsum, the Moqui Member is the primary confining unit within the Moenkopi Formation. The lower 30 to 50 feet of the Moenkopi Formation is the Wupatki member, comprised of relatively permeable sandstone. Where Moenkopi thickness is less than 50 feet (**Figure 3**), these sediments are assumed to comprise the Wupatki member.

Overall, the Moenkopi Formation has low permeability and poor water quality and is not, therefore, considered an aquifer. There are no reported uses of the Moenkopi for water supply in the region. With the exception of areas influenced by surface leakage, the shallower Moqui member of the Moenkopi Formation is reported to be dry. Only the more permeable lower Wupatki member is reported to be water bearing, and only in areas where the potentiometric surface in the underlying Coconino Aquifer is above the base of the Moenkopi.

4.1.3 Coconino Sandstone

The Coconino Sandstone underlies the Moenkopi Formation or the LCR Alluvium, where the Moenkopi is not present, across the Cholla area. It is a very fine- to fine-grained, cross-bedded, aeolian sandstone that has an average thickness of 375 to 400 feet in the Cholla area. Permeability of the Coconino Sandstone is highly variable and dependent on the degree of fracturing and cementation. Particularly where fractures are present, the Coconino Sandstone can be very permeable and yield significant quantities of water. It provides the water supply for operations at the Cholla facility and comprises the principal regional aquifer in the LCR basin of northern Arizona.

In southern Navajo County, groundwater in the Coconino Sandstone Aquifer generally moves from recharge areas in the higher altitudes along the Mogollon Rim to the north toward the LCR. Locally, however, patterns of groundwater movement have been affected by groundwater pumping in the Cholla wellfield. Pumping of Cholla water supply wells has created a cone of depression south of the LCR that results in localized convergent flow patterns. In the area along and south of the LCR, the direction of groundwater movement is generally westward. North of Cholla, direction of movement in the Coconino Aquifer is generally to the northwest. Contours for water level elevation in the Coconino Aquifer for June – July 2017 are shown on **Figure 5**.

Background water quality in the Coconino Aquifer is variable, and water quality is known to deteriorate significantly north of the LCR (Mann, 1976, and McGavock and others, 1986). Results of decades of Coconino Aquifer monitoring associated with the Cholla water supply wellfield indicate that TDS concentrations can vary over almost an order of magnitude in the Cholla area. Regional studies show that groundwater in the Coconino Aquifer generally contains less than 500 mg/L TDS in the area south of the LCR; however, TDS concentrations as high as 64,000 mg/L have been reported in the area north of the LCR (Mann, 1976, and McGavock and others, 1986). Background water quality in the Coconino Aquifer is also brackish in some areas south of the LCR due to upward leakage of saline groundwater from the underlying Supai Formation. The Holbrook anticline, located south of the Cholla water supply wellfield, represents an area of upward leakage from the Supai, which contains halite and gypsum beds (Mann, 1976). Other areas of suspected upward leakage occur along an inferred graben or syncline structure in the Coconino that coincides with the deeper, ancestral channel of the LCR (**Figure 2**). This structural feature likely provides an avenue for poor quality Supai Formation water to migrate upward into the Coconino and is interpreted to be responsible for poor quality water in several Coconino production and monitor wells near the current and ancestral channel of the LCR. Since the Coconino Aquifer historically discharged to the LCR and continues be a source of water to the LCR Alluvium in some areas, upward leakage from the Supai may also be a source of high TDS reported for groundwater samples from the LCR Alluvium.

4.2 Description of CCR Units

4.2.1 Fly Ash Pond

The FAP is the largest CCR surface impoundment at the site, with a surface area of 430 acres (**Figure 1**). The FAP was largely constructed on Moenkopi bedrock, with a veneer of alluvial sediments from the historic drainage. These alluvial sediments are up to 44 feet thick at the toe of the impoundment, where they merge with sediments of the LCR Alluvium aquifer, and are thin to absent near the edges of the current pond (**Figure 2**). The LCR alluvial aquifer is the uppermost aquifer for the FAP. Groundwater near the FAP waste boundary flows west-southwest through the shallow alluvial system adjacent to the dam and then to the west in the LCR Alluvium (**Figure 4**).

The Moenkopi Formation underlies the LCR Alluvium beneath the FAP. The Moenkopi has a thickness of 64 feet at well W-125, southwest of the FAP, and thickens to the north and east, where a thickness of 308 feet was encountered at well M-44D (**Figure 3**). The

Moenkopi is a confining unit and provides a barrier to vertical flow from the FAP into the Coconino Aquifer.

4.2.2 Sedimentation Pond

The SEDI is a small CCR surface impoundment comprising roughly 1.3 acres (**Figure 1**). The SEDI is constructed on LCR Alluvium and the LCR alluvial aquifer is considered the uppermost aquifer for this Unit. Groundwater in the LCR Alluvium beneath the SEDI flows from southeast to northwest approximately parallel to the direction of LCR surface water flows (**Figure 4**).

The LCR Alluvium rests on over 100 feet of Moenkopi in this area and is not anticipated to thin downgradient from the SEDI (**Figure 3**). The thick layer of Moenkopi in this area inhibits hydraulic communication between the LCR Alluvium and the Coconino Aquifer. The SEDI is located west and hydraulically downgradient from the FAP, BAP, and BAM (**Figure 1**).

4.2.3 Bottom Ash Pond

The BAP is a 105 acre CCR surface impoundment located in the Tanner Wash watershed. Tanner Wash is an ephemeral tributary to the LCR (**Figure 1**). The northern and western boundaries of the BAP rest directly on a thick section of Moenkopi Formation (**Figure 3**). The southern boundary of the BAP rests primarily on Tanner Wash Alluvium. The Tanner Wash alluvial aquifer is considered the uppermost aquifer for the BAP. Groundwater in the Tanner Wash alluvial aquifer flows south-southwest along Tanner Wash to its confluence with the LCR alluvial aquifer.

The Moenkopi Formation is more than 200 feet thick at wells south and east of the BAP, and thickens to the north (**Figure 3**). The thick layer of Moenkopi in this area inhibits hydraulic communication between the Tanner Wash Alluvium and the Coconino Aquifer at the BAP.

4.2.4 Bottom Ash Monofill

The BAM is a 41 acre CCR landfill constructed in the Tanner Wash watershed; however, Tanner Wash Alluvium is not present beneath or adjacent to the BAM (**Figure 2**). While lithologic logs for BAM monitor wells, which will be introduced later in the report, describe alluvial sediments at the surface, these sediments are dry, localized, and represent an erosional surface that is not connected with the Tanner Wash Alluvium. The BAM is constructed on rocks of the Moqui member of the Moenkopi Formation, an aquitard that is between about 250 and 350 feet thick and separates the BAM from the Coconino Sandstone Aquifer (**Figure 3**). Water levels indicate that the upper part of the Moenkopi is unsaturated beneath the BAM. As such, the Coconino Aquifer is considered the uppermost aquifer for the BAM.

4.3 Design of Monitoring Networks Using Existing and New Wells

The monitoring network for each CCR Unit was designed to characterize the uppermost aquifer at each Unit, as required by the Rule. Prior to designing the monitoring networks, data from existing wells were reviewed at each Unit to identify the uppermost aquifer and directions of groundwater movement. Based on provisions of the Rule, existing monitor wells were evaluated in relation to their potential use as part of the CCR program and additional proposed monitor well locations were selected to fill gaps in the monitoring networks.

4.3.1 Fly Ash Pond

When design of the FAP monitoring network was initiated, only one existing well, W-123, was located sufficiently close to the FAP's waste boundary in the LCR Alluvium to be considered a downgradient well under the Rule (**Figure 1**). In consideration of the FAP's size, it was initially recommended that three additional monitoring wells be installed in the LCR Alluvium along the FAP's downgradient waste boundary. However, due to limited alluvial thickness in this area, only two additional downgradient FAP monitor wells could be installed (M-50A and M-51A, **Figure 1**). As shown on **Figure 2**, there is only a narrow portion of the FAP waste boundary where alluvium thickness is about 50 feet, and thickness moving either northwest or southeast from this area declines rapidly and significantly. As will be described below, efforts to find a location with adequate alluvial thickness and saturation to install a fourth CCR well along the downgradient FAP waste boundary were not successful.

The upgradient boundary of the FAP rests on a thick section of Moenkopi Formation (**Figure 3**). The FAP was constructed in an historical drainage that used to flow into the LCR Alluvium. While up to 44 feet of alluvium was reported to be present beneath what is now the FAP prior to construction (SHB, 1973), there is no saturated alluvium present in the area upgradient from the current FAP footprint.

The first attempt to install a FAP background well was in the LCR floodplain in the area south of and upstream along the LCR from the FAP. Based on data from existing monitor wells, the LCR Alluvium in this area was known to be relatively thin and to have little to no saturation (**Figure 2**). However, a well site was selected based on the occurrence of vegetation, proximity to the LCR, and distance from surface outcrops of Moenkopi Formation. The monitor well (M-49A, **Figure 4**) that was completed in this area only encountered 20 feet of alluvium and has been dry since installation.

The second attempt to install a FAP background monitor well was in the area southwest from the FAP. Water level data suggested that is area may be cross- rather than down-gradient from the FAP and possibly suitable for characterizing background water quality conditions. The monitor well (M-63A, **Figure 4**) installed in this area encountered 55 feet of alluvium, with about 25 feet of saturation. However, water level data obtained following well construction demonstrated that M-63A was indeed downgradient from the FAP and, thus, cannot be used as a background well.

In a final attempt to install a background well for the FAP, potential downgradient LCR Alluvium well sites were considered. As will be discussed below, similar hydrogeologic conditions also prevented location of a background well hydraulically upgradient from the BAP. Because the Tanner Wash Alluvium discharges to the LCR, a decision was made to construct a combined FAP-BAP background monitor well in the LCR Alluvium at a location that was far enough downgradient to prevent impacts from either of these facilities. Well M-64A (**Figure 1**) is located in the vicinity of Coconino monitor well M-2 and has 65 feet of alluvium, about 40 feet of which is saturated. Travel time calculations conducted to ensure that M-64A is located far enough downgradient to represent groundwater that is not impacted by either the FAP or the BAP are described in **Section 6.1**.

4.3.2 Sedimentation Pond

Due to the small size of the SEDI (1.3 acres), the minimum CCR unit monitoring network of three downgradient wells and one upgradient well was recommended. No downgradient wells were present at the SEDI waste boundary when the monitoring network was designed. Therefore, three new downgradient LCR Alluvium monitor wells were installed immediately adjacent to the downgradient SEDI waste boundary (M-56A, M-57A, and M-58A, **Figure 1**). Additionally, no existing upgradient LCR wells were available to provide a clear indication of the quality of background groundwater flowing beneath the SEDI. Therefore, installation of a new upgradient LCR monitoring well was recommended between any potential upgradient sources and the SEDI (M-62A, **Figure 1**).

4.3.3 Bottom Ash Pond

When the BAP monitoring network was designed, three alluvial monitor wells existed in Tanner Wash that met the requirements of the Rule for downgradient monitor wells. Tanner Wash shallow/deep well pair W-305 and W-306 and Tanner Wash well W-314 are all as close to the downgradient boundary of the BAP as practicably achievable and are considered acceptable downgradient CCR monitoring wells (**Figure 1**). Two additional Tanner Wash Alluvial monitoring wells were installed to fill in gaps and complete the downgradient BAP monitoring network (M-52A and M-53A, **Figure 1**). As a result, there are a total of five downgradient monitoring wells at the BAP.

The Tanner Wash alluvial channel and sediments bend to the east along the eastern boundary of the BAP. Wells W-308 and W-309 are located in Tanner Wash east of the BAP and were initially considered as candidate upgradient wells for the BAP (**Figure 4**). However, further review of water level data showed that both wells are hydraulically down-gradient from the BAP. Therefore, an additional well was installed further upstream along Tanner Wash from well W-309 (M-55A, **Figure 4**). Alluvium thickness (54 feet) and saturation (about 27 feet) at M-55A were initially encouraging. However, while the gradient is very shallow, water level data demonstrated that this well is also downgradient rather that upgradient from the BAP (**Figure 4**).

Because Tanner Wash discharges to and is hydrologically connected to the LCR, and because hydrogeologic conditions prevented location of a background well hydraulically upgradient from the BAP, a decision was made to construct a combined FAP-BAP background monitor well in the LCR Alluvium at a location that was far enough downgradient to be beyond any potential impacts from either of these facilities. Well M-64A (**Figure 1**) is located in the vicinity of Coconino monitor well M-2 and has 65 feet of alluvium, about 40 feet of which is saturated. Travel time calculations conducted to ensure that M-64A is located far enough downgradient to represent groundwater that is not impacted by either the FAP or the BAP are described in **Section 6.1**.

4.3.4 Bottom Ash Monofill

No wells existed in the Coconino Aquifer adjacent to the BAM when the groundwater monitoring system was designed. Therefore, one upgradient well (M-54) and three downgradient wells (M-59, M-60, and M-61) were installed (**Figure 1**), fulfilling the minimum monitor well network requirements of the Rule. Due to the thick section of Moenkopi separating the BAM from the Coconino Aquifer in this area (**Figure 3**), there is little potential for impacts to the Coconino and the minimum monitoring requirements were deemed appropriate to provide an accurate representation of the quality of background groundwater and groundwater passing the waste boundary of the BAM.

5 WELL INSTALLATION FIELD PROGRAM

The installation program for the new CCR monitor wells included pre-construction activities, drilling, construction, and development of the new wells. While general aspects of the field program are summarized below, well-by-well details are provided in **Appendix A**. Available lithologic and well construction information for existing wells that are included in the CCR network are given in **Appendix B**. Locations for all CCR monitor wells are shown on **Figure 1**. Well construction details are summarized in **Table 1**.

5.1 Pre-construction Services

Pre-construction services included field reconnaissance to select locations for the new CCR monitor wells, preparation of technical specifications for drilling and well construction, preparation of site health and safety and emergency response plans, support for well permitting, preparation of a De Minimis Discharge permit application, and preparation of a CCR program sampling and analysis plan (SAP).

5.1.1 Field Reconnaissance and Well Siting

GoogleEarth images, occurrence and thickness maps for geologic units, and geologic cross-sections were examined to identify preliminary locations for the new monitor wells for each of the CCR units. Field reconnaissance was conducted on August 5 and 6, and on September 10, 2015 to finalize and, as appropriate, to modify preliminary well locations. Field reconnaissance for siting of monitor well M-64A, which was installed during a second phase of drilling, was conducted on February 1, 2017. APS personnel accompanied M&A for field reconnaissance tasks. Each CCR Unit was visited and locations for upgradient and downgradient monitor wells were staked and photographed, and GPS coordinates were recorded. Field reconnaissance resulted in changes to several of the well locations initially identified for each CCR Unit. These changes, and the associated rationale, are described below.

FAP

Because hydrogeologic conditions prevented installation of a monitor well upgradient from the FAP (see **Section 4.3.1**), the area between well W-127 and the LCR was initially identified for siting of a background LCR Alluvium well for the FAP. The location (M-49A, **Figure 4**) is on APS property and was believed to be cross- rather than downgradient from the FAP. Since it was known that saturated thickness was small and variable in the area, a secondary FAP background well location was marked near an old LCR Alluvium well, DM-3, which was already planned for replacement (M-63A, **Figure 4**). This location was also believed to be cross- rather than downgradient from the FAP. When well M-49A proved to be dry and well M-63A proved to be downgradient from FAP (**Figure 4**), the focus was shifted toward identifying a FAP background well location that would be far enough downgradient to ensure that the aquifer in the area could not have been impacted by the FAP. The location for the FAP-BAP background well was selected based on travel time analyses, described below, and the fact that data from an adjacent Coconino well, M-2, demonstrated the presence of a significant thickness of alluvium in the area (**Figure 2**).

Initially, three new monitor wells were planned for the downgradient perimeter of the FAP. During final well site selection, the proposed location farthest to the west was determined to be too close to bedrock outcrop, so it was moved slightly eastward. While the proposed location at the east end of the FAP was also acknowledged to be very close to Moenkopi outcrop and unlikely to have a significant thickness of alluvium, a decision was made to stake a site at the eastern location and attempt to install a well. In the end, drilling at this location (FAP-3D, **Figure 2**) confirmed that there was insufficient alluvial thickness (4 feet) and no saturation, so no well was installed at this location. As shown on **Figure 2**, only a relatively small portion of the downgradient waste boundary for the FAP has any significant thickness of LCR Alluvium; therefore, three wells were deemed sufficient to monitor conditions in this narrow area.

SEDI

A separate upgradient LCR alluvial well site was selected for the SEDI to ensure accurate characterization of background water quality passing beneath the Unit. The upgradient well location for the SEDI, M-62A, is shown on **Figure 1**. Three locations downgradient from the SEDI were staked west of the Unit along the access road near the western cooling tower. The final locations for the downgradient SEDI wells were moved approximately 40 feet to the west from those originally planned to prevent damage to the wells from traffic on the access road (M-56A, M-57A, and M-58A, **Figure 1**).

BAP

The areas east and north from the BAP were inspected for a potential location for an upgradient alluvial well in Tanner Wash or its tributaries. The tributary area to the north was ruled out because it was used historically for borrow materials for construction of the dams for the ponds. The land surface in this area was noted as being highly disturbed, with numerous depressions and areas of Moenkopi outcrop. The reconnaissance visit took place following above-average summer rains and many of the depressions were filled with standing water. While a preliminary location was staked, a decision was later made to further investigate the area along the main stem of Tanner Wash between well W-309 and soil boring W-316, where the alluvium was reported to be dry (**Figure 2**). A location for an upgradient BAP well, M-55A, was staked in this area (**Figure 4**). However, when well M-55A indicated potential impact from the BAP (**Figure 4**), the focus was shifted toward identifying a BAP background well location that would be far enough downgradient to ensure that the aquifer in the area could not have been impacted by the BAP. The location for FAP-BAP background well M-64A was selected based on travel time analyses, described below, and the fact that data from an adjacent Coconino well, M-2, demonstrated the presence of a significant thickness of alluvium in the area (**Figure 2**).

During inspection of proposed locations for downgradient alluvial wells along the southern waste boundary of the BAP, the original location farthest to the west was determined to be too close to a bedrock outcrop, so the location was moved eastward. The original location for the downgradient monitor well in the area east of the BAP also had to be reconsidered after the site inspection revealed that this was in an area of Moenkopi outcrop. The area east of the BAP waste boundary was traversed to identify an area of alluvium that might be used as an alternate monitor well location; however, most of the area had Moenkopi outcrop. Therefore, existing well W-314, located slightly farther to the east, was selected as the eastern downgradient well (**Figure 1**).

BAM

The preliminary upgradient well for the BAM was proposed for the same location as the upgradient Tanner Wash alluvial well; however, an alternate location was selected on APS land closer to the BAM and adjacent to an unnamed wash that is tributary to Tanner Wash (M-54, **Figure 1**). Three downgradient BAM wells were initially sited along the access road to the BAM, but due to traffic considerations and on-going construction activities, the downgradient locations were moved to areas outside of the storm water drainage channel to the northwest and west of the BAM (M-59, M-60, and M-61, **Figure 1**).

5.1.2 Technical Specifications and Well Designs

National Exploration Wells and Pumps (National) of Gilbert, Arizona conducted the drilling, well construction, and development program for the CCR wells. M&A developed proposed well designs, prepared technical specifications for the field program, and submitted them to National. Proposed designs included alluvial monitor wells completed to anticipated depths of up to 100 feet deep, drilled using the air rotary casing hammer (ARCH) method. Coconino monitor wells were proposed to be completed to a depth of approximately 60 feet below the Moenkopi/Coconino contact, to anticipated depths of 350 to 400 feet, and drilled using ARCH and air percussion and/or air rotary methods.

5.1.3 Health & Safety Plan

M&A prepared Health & Safety and Emergency Response Plans for the field program to cover activities of M&A on-site personnel. M&A coordinated with APS staff regarding site rules, procedures, and protocols for emergencies and with the National drill crew regarding instructions for working around the drill rig and communicating and interacting with the drilling crew.

5.1.4 Permitting

M&A provided information to National to assist with the well permitting process. National filed Notices of Intent (NOI) to drill forms with the Arizona Department of Water Resources (ADWR) for the new wells. Arizona well registration numbers are given in **Table 1**. Following well installation, National filed well completion reports with ADWR.

An Arizona Pollutant Discharge Elimination System (AZPDES) NOI for a General Permit for De Minimus Discharges to Waters of the United States was prepared and submitted to the Arizona Department of Water Quality (ADEQ) for anticipated discharges of drilling and development water from the Coconino Sandstone monitor wells (M-54, M-59, M-60, and M-61). A Best Management Practices Plan was prepared and submitted along with the De Minimus NOI. Permission to discharge was granted under Authorization Number AZDGP—87417 on September 30, 2015.

Minimal discharges to an unnamed ephemeral stream channel tributary to Tanner Wash occurred during development for the upgradient BAM well (M-54). Similarly, low volume discharges occurred to the storm water channel during development of the downgradient BAM wells (M-59, M-60, and M-61). Discharges occurred during the period November 16 – 23, 2015. A Notice of Termination of discharges was filed with ADEQ on January 14, 2016.

5.2 Well Installation

Most of the new CCR monitor wells were installed by National during the period September 14 – November 19, 2015. A final new CCR monitor well, M-64A, was installed in February 2016. Details for each of the new CCR monitor wells are summarized in **Appendix A**.

5.2.1 Drilling Methods

National drilled and constructed the CCR monitor wells at Cholla using a Speedstar 50K drilling rig (Rig 128). The ARCH drilling method was used for all of the wells completed in alluvium and for the upper 20 feet of the wells completed in the Coconino Sandstone. The lower portion of certain alluvial wells was drilled using the air rotary method without advancing casing, and the lower portion of all Coconino wells was drilled using the air percussion (hammer) method (**Appendix A**).

The ARCH method was used to advance the boreholes through the unconsolidated alluvial deposits. The method utilizes a temporary drive casing to support unconsolidated materials as the borehole is advanced. Following casing installation, the temporary casing is gradually removed from the borehole as the annular materials are installed. The air percussion method was used to drill the Moenkopi Formation and Coconino Sandstone. Minimal water was injected during drilling to assist with lifting drill cuttings and to prevent dust generation.

5.2.2 Installation of the New Wells

National mobilized to the site on September 14, and completed all well installation activities at Cholla on November 19, 2015. Locations for the wells are shown on **Figure1** and construction details are given in **Table 1**. **Appendix A** provides well-by-well summaries of drilling and construction information, along with schematic diagrams and lithologic logs. M&A personnel provided oversight of field activities.

National obtained variances from ADWR to modify surface seal requirements. ADWR requires a minimum 20 feet of surface casing; however, shallow depth to water level and shallow depth to bedrock were anticipated at many of the sites. Because installing deeper surface casing would have prevented well screen installation across the target aquifer zone, most of the wells completed in the alluvium for the Cholla CCR program were constructed with less than the minimum standard of 20 feet of surface casing (**Appendix A**).

At all sites, drilling began with advancement of 13-3/8-inch diameter drive casing to approximately 20 feet bls using the ARCH method. Surface casing was installed during well construction, as detailed below and in **Appendix A**.

At most of the alluvial wells, the 13-3/8-inch diameter drive casing was advanced to total depth or to a depth at which the alluvial deposits were stable and did not cave into the borehole. Where the deposits were more stable (M-50A and M-51A, **Figure 1**), the borehole was advanced to total depth using a 12-1/4-inch diameter rotary bit.

For the wells completed in the Coconino Sandstone, a 12-1/4-inch diameter borehole was advanced to approximately 10 feet below the Moenkopi/Coconino contact using the air percussion method. Then 8-5/8-inch diameter blank steel intermediate casing was installed in the borehole and cemented in place. Following curing of the cement, a 7-7/8-inch diameter borehole was advanced using the air percussion method to total depth, approximately 60 feet below the Moenkopi/Coconino contact.

All alluvium and Coconino monitor wells were constructed using 4-inch diameter blank and factory slotted Schedule 80 PVC casing from the designed depth to land surface. Annular materials, including filter pack, bentonite chips, and grout, were installed using a tremie pipe to ensure bridging did not occur.

5.2.3 Well Development

The new monitor wells were developed by National using a service rig during the period November 16 – 23, 2015. Well M-64A was developed on February 10, 2017. M&A personnel provided oversight of field activities. Development operations began by tagging the bottom of the well and bailing fine sediments that had accumulated during well construction. After bailing was completed, a temporary submersible pump was installed near the bottom of the well screen and pumping was conducted to remove fine suspended sediments from the casing column. Well M-64A was developed using swapping and bailing without use of a submersible pump.

Water quality parameters, including temperature, pH, specific electrical conductance, and oxidation reduction potential, were measured periodically until parameters stabilized and the discharge water was sufficiently free of sediment. After parameters stabilized with the pump installed near the bottom of the well, the pump was raised to the middle of the well screen and pumping and monitoring of water parameters was repeated until parameters stabilized and the discharge water was free of sediment. A water sample was collected at the end of development for screening purposes. Water quality data from the development program is considered qualitative and not included in this report. However, information on parameter stability at the end of development operations is provided in **Appendix A**.

6 DATA ANALYSIS

6.1 Travel Time Analysis

When hydrogeologic conditions prevented installation of background monitor wells upgradient from either the FAP or the BAP, a decision was made to install a background monitor well downgradient along the LCR at a distance that would be sufficient to ensure that alluvial groundwater in the area could not have been impacted by water seeping from either the FAP or the BAP. A travel time analysis was carried out to verify that water from the FAP and BAP could not reach the background monitor well, M-64A, during the time since the two Units began operating. Dams for the FAP and BAP were completed in 1978. Therefore, an estimated travel time of greater than 40 years was deemed to be protective relative to potential impacts at background monitor well M-64A.

It should be noted that potential leakage from either the SEDI or the BAM are not relevant to the travel time analysis. Any seepage from the SEDI would be detected at the downgradient CCR monitor wells associated with that Unit. The upper aquifer for the BAM is the Coconino, which is hydraulically isolated from the alluvium due to a thick sequence of Moenkopi sediments present in the area.

6.1.1 Conceptual Model

Surface geology in the vicinity of the FAP and BAP is comprised of alluvial sediments associated with either the LCR or Tanner Wash (**Figure 2**). Lithologic information from drilling in the LCR Alluvium indicates the unit generally comprises well-graded, gravelly sand. In contrast, Tanner Wash drains a watershed comprised chiefly of the fine-grained rocks of the Chinle and Moenkopi Formations. The lithologic logs from wells in the Tanner Wash area describe sediments that are mostly silt and clay, with some sand and gravel stringers (**Appendices A and B**). Similar to Tanner Wash, the FAP was constructed on Moenkopi Formation bedrock that is overlain by a veneer of alluvial sediments from the historical drainage that previously contributed runoff to the LCR from a Chinle/Moenkopi watershed. Lithologic logs from wells near the FAP indicate that the alluvium in this area is composed mostly of clay and sand, with some silt and gravel (**Appendices A and B**).

Groundwater moving from the BAP to well M-64A would pass through the Tanner Wash Alluvium before reaching the LCR Alluvium. Similarly, water moving from the FAP to well M-64A would pass through the finer-grained alluvial deposits beneath and immediately downgradient from the FAP (FAP alluvium) before entering the main portion of the LCR alluvial system. Water level contours show a steep gradient in the Tanner Wash Alluvium downgradient from the BAP and in the FAP alluvium to the west-southwest of the FAP dam, which is an indication of reduced hydraulic conductivity in the area.

6.1.2 Hydraulic Parameters

Estimates of hydraulic conductivity for the Tanner Wash Alluvium, FAP alluvium, and LCR Alluvium are summarized in **Table 2**.

Testing results indicated hydraulic conductivity values for the Tanner Wash Alluvium that reportedly range from 0.06 to 0.44 feet per day (APS, 1984). Calibration of a numerical groundwater model for the BAP area required hydraulic conductivities ranging between 0.32 and 0.96 feet per day (Woodward-Clyde, 1992). A pumping test conducted at alluvium monitor well W-123, located immediately downgradient from the FAP in the FAP alluvium, indicated a hydraulic conductivity of 0.03 feet per day. For the travel time calculation, a hydraulic conductivity of 1 foot per day was assumed for the FAP alluvium and Tanner Wash alluvium, which is larger (more conservative) than the largest reported estimate of hydraulic conductivity for this unit.

Table 2. Hydraulic Conductivity Estimates for Cholla-Area Alluvium

Unit	Date of Test	Method	Well Name	Hydraulic Conductivity (ft/day)
LCR	13-Feb-17	Slug Test[a]	M-64A	66
Tanner Wash	28-Feb-84	Pumping Test[b]	W-301[b]	3.10E-01
Tanner Wash	28-Feb-84	Pumping Test[c]	W-303[c]	7.50E-02
Tanner Wash	1-Mar-84	Pumping Test[c]	W-304[c]	1.60E-01
Tanner Wash	29-Feb-84	Pumping Test[c]	W-306[c]	6.20E-02
Tanner Wash	2-Mar-84	Pumping Test[b]	W-307[b]	1.50E-01
Tanner Wash	1-Mar-84	Pumping Test[b]	W-308[b]	4.40E-01
Tanner Wash	27-Feb-84	Pumping Test[b]	W-309[b]	3.80E-01
Tanner Wash	N/A	Calibrated Flow Model[d]	N/A	3.2E-01
Tanner Wash	N/A	Calibrated Flow Model[d]	N/A	9.6E-01
FAP	2-Mar-84	Pumping Test[c]	W-123	3.20E-02

a) Average of results of rising- and falling-head slug tests conducted after installation of monitoring well M-64A.
b) Reported in APS (1984). Pumping test analyzed using Jacob straight-line method.
c) Reported in APS (1984). Pumping test analyzed using Bouwer-Rice slug test method; the pumping rate exceeded the well capacity and could not be lowered due to equipment limitations, so these were treated as slug tests.
d) Reported in Woodward-Clyde (1992). Differing values represent the range of cases for the calibrated groundwater flow model.
N/A = Not applicable

A slug test conducted following installation of background LCR alluvium well M-64A, yielded an average hydraulic conductivity of 66 feet per day. This value is anticipated to be fairly typical for the LCR Alluvium and was used for travel time analysis for the portion of the flow path through the LCR Alluvium.

Site-specific effective porosity values are not available for the Cholla alluvial units. An effective porosity of 0.15 is reported in the literature for similar lithologic units (Fetter, 2001). A value of 0.13 was used for the travel time calculations.

6.1.3 Method

The time taken for groundwater to travel a given distance may be estimated by the following equation:

$$Travel\ time = \frac{D\ * n_e}{K * i}$$

where D is the distance traveled, n_e is the effective porosity of the formation, K is the hydraulic conductivity of the formation, and i is the hydraulic head gradient of the groundwater (Fetter, 2001).

Groundwater traveling from the FAP or the BAP to well M-64A would pass through two distinct hydraulic conductivity regimes: the FAP alluvium or Tanner Wash Alluvium, and the LCR Alluvium. Therefore, the travel time calculation for each CCR Unit was divided into two parts. The time to travel through the FAP alluvium or the Tanner Wash Alluvium to the edge of the LCR Alluvium downgradient from each Unit was first calculated, then added to the time to travel through the LCR Alluvium to well M-64A. Travel distances were measured using GIS tools. Straight-line travel was assumed from the CCR Units to the edge of either the Tanner Wash Alluvium (BAP) or the FAP alluvium (FAP), and then for the distance from where these sediments meet the LCR and monitor well M-64A, as these comprised the shortest (most conservative) potential flow paths.

Gradients were computed based on June – July 2017 water level data and associated elevation contours shown on **Figure 4**. For travel time through alluvial sediments immediately downgradient of the CCR Units, gradients were computed using water level elevation contours adjacent to the FAP and BAP dams and water level elevation contours for the areas downgradient from the ponds where the FAP alluvium and Tanner Wash Alluvium transition into the LCR Alluvium. Specifically, the 5,030-foot contour was used for the upgradient water level for the FAP and the 5,040-foot contour was used for the BAP for gradient calculations. On the downgradient side, the 4,990-foot contours downgradient from each of the ponds were used for gradient calculations. For both the FAP and the BAP, the 4,990-foot contours are interpreted to represent the approximate areas where sediments transition from the lower conductivity materials downgradient of the ponds and associated historical drainage areas to the higher conductivity sediments of the principal LCR channel. Water level contours support this interpretation. For travel time for the LCR Alluvium portion of the flow path, gradients were computed using the 4,990-foot contours downgradient from the FAP and BAP and the June – July 2017 water level for M-64A.

Because hydraulic gradients are known to change over time, historical water level data were evaluated for the various sections of the flow path to ensure that gradients used for travel time calculations were conservative relative to the period of operation of the FAP and BAP. Wells used in the historical gradient analysis are shown on **Figures 2 and 4**. Because the FAP and BAP are generally maintained at full to near full levels during routine plant operations, gradients immediately downgradient from these ponds are steeper than they were in the early years when the ponds were filling. Water level data from 1983 through present for the FAP show that levels have been generally increasing over time, with a slight decline over the last 2 years. Water level data for the BAP for the same period show increasing water levels through around 2000, with stable to slightly declining water levels since that time. Review of groundwater level data for well pairs in the area downgradient from the FAP and BAP provides further evidence that current gradients are conservatively high for the area immediately downgradient from these Units. Gradients computed for the well pair W-123 and DM-3/M-63A (M-63A was installed in 2015 to replace DM-3) downgradient from the FAP indicate that a maximum gradient of 0.0112 occurred during the period from 1994 through 2017. The hydraulic gradient used for travel time calculations for the portion of the flow path downgradient from the FAP was 0.0240. Similarly, gradients computed using historical water level data for the well pair W-306 and W-301 downgradient of the BAP indicate that a maximum gradient of 0.0145 occurred during the period from 1984 through 2017. The value used for this portion of the flow path for travel time calculations was 0.0196. Therefore, for both the FAP and BAP, current hydraulic gradients are conservative (high) relative to the entire period of operation of these Units.

With respect to the LCR Alluvium portion of travel time calculations, gradients between monitor wells DM-3/M-63A and DM-5 were evaluated to determine if using gradients based on June – July water level conditions would be conservative. These wells have historical water level data for 1974 and then for the period 1992 through 2017. The maximum gradient in the LCR Alluvium between these wells during the historical period was 0.0016, which is lower (less conservative) than the current gradient between the edge of the Tanner Wash Alluvium and M-64A (0.0019) and higher (more conservative) than the current gradient between the edge of the FAP alluvium and M-64A (0.0013). Therefore, to ensure that travel time estimates are protective, the higher historical gradient of 0.0016 was used instead of the recent gradient of 0.0013 for the portion of the LCR flow path between the edge of the FAP alluvium and background monitor well M-64A.

Table 3. Results of Travel Time Calculation

Description of Travel Path	Distance[a] (feet)	n_e[b]	K[c] (feet/day)	ΔH[d] (feet)	June – July 2017 i[e]	Historical Max i[f]	Travel time (days)	Travel time (years)
FAP to edge of FAP Alluvium	1,667	0.13	1	40	**0.0240**	0.0145	9,033	25
Edge of FAP Alluvium to M-64A	19,581	0.13	66	26	0.0013	**0.0016**	24,106	66
BAP to edge of Tanner Wash Alluvium	2,554	0.13	1	50	**0.0196**	0.0112	16,960	46
Edge of Tanner Wash Alluvium to M-64A	13,662	0.13	66	26	**0.0019**	0.0016	13,992	39
FAP to M-64A							**33,139**	**91**
BAP to M-64A							**30,952**	**85**

a) Straight-line distance
b) Effective porosity
c) Hydraulic conductivity of alluvium on travel path
d) Change in hydraulic head across travel path
e) Hydraulic gradient across travel path
f) Hydraulic gradient from historical maximum
Bold Blue = Gradients used in travel time calculation

6.1.4 Results

Results of conservative travel time analyses indicate that it would take at least 91 years for water seeping from the FAP and 85 years for water seeping from the BAP to reach the location of background monitor well M-64A (**Table 3**). The long travel time presented herein indicates that monitor well M-64A would not be anticipated to have been impacted by seepage from either the FAP or the BAP between pond construction (1978) and sampling to establish background water quality conditions in the LCR Alluvium aquifer (2017).

6.2 Analysis of Groundwater Conditions at CCR Units

6.2.1 Fly Ash Pond

Three CCR alluvial wells monitor groundwater conditions at the downgradient waste boundary of the FAP: M-50A, M-51A, and W-123. Since water was first encountered in the alluvium for all three downgradient wells, the alluvial aquifer is considered the uppermost aquifer for the FAP. Depth to groundwater was at 19.13 bls and 9.91 feet bls, respectively, at M-50A and M-51A during the June 2017 monitoring round. During the monitoring round, water was measured at a depth of 2.11 feet bls at W-123.

Water level elevations along the FAP downgradient waste boundary range from 5,019.05 feet mean sea level (msl) in well M-50A to 5,037.73 feet msl in well W-123 in June 2017 (**Figure 4**). Water levels south and west of the FAP have been measured in well W-126 at 5,026.38 feet mls and in well M-63A at 4,985.62 feet mls. Well M-49A completed in the alluvium in the area further south of the FAP is dry. Water level contours indicate that the FAP creates a mound in the alluvium southwest of the FAP. Water from this mound generally flows southwest from the FAP boundary. Background alluvium monitor well M-64A, located about 4.2 miles (22,197 feet) downgradient from the FAP waste boundary, had a water level elevation of 4,964.51 feet msl in June 2017.

Close to the waste boundary, the gradient away from the FAP is large and towards the west-southwest. As described in the **Section 6.1**, the hydraulic gradient from the 5,030-foot water level elevation contour, adjacent to the FAP, to the 4,990-foot contour, marking the edge of the FAP alluvium, was calculated based on June – July water level data to be to be 0.0240 feet/foot (**Figure 4**).

6.2.2 Sedimentation Pond

Three CCR wells, M-56A, M-57A, and M-58A, were installed on the downgradient waste boundary of the SEDI. Since water was first encountered in the alluvium for all three downgradient wells, the alluvial aquifer is considered the uppermost aquifer for the SEDI. Depth to water at the three downgradient wells was 42.09 feet bls, 42.86 feet bls, and 42.88 feet bls, respectively, during the June – July 2017 monitoring round. Well M-62A was drilled upgradient from the SEDI. Water was encountered in the alluvial aquifer at this well at a depth of 39.61 feet bls during the June – July 2017 monitoring round.

Water level elevations along the SEDI downgradient waste boundary ranged from 4,980.96 feet msl in well M-57A to 4,981.07 feet msl in well M-56A during the June – July 2017 monitoring round (**Figure 4**). Water level in upgradient well M-62A was slightly higher than at the downgradient wells, at 4,981.26 feet msl. Water level contours based on the June – July 2017 monitoring round data, along with other available alluvial water level data for July 2017, show that water flows from east to west beneath the SEDI and that M-62A is upgradient of the SEDI. This is consistent with both historical data and expectations that groundwater flow in alluvial systems is generally parallel to streamflow beneath active streams. The gradient beneath the SEDI is small and towards the west. The hydraulic gradient calculated from the 4,980 and 4,975-foot water level elevation contours downgradient from the SEDI waste boundary for the June – July 2017 data set is 0.0015 feet/foot (**Figure 4**).

6.2.3 Bottom Ash Pond

Two new wells, M-52A and M-53A, and three existing wells W-305, W-306, and W-314, comprise the CCR monitoring network along the downgradient waste boundary of the BAP. Since water was first encountered in the alluvium for all five downgradient wells, the alluvial aquifer is considered the uppermost aquifer for the BAP. Depth to water at new CCR wells M-52A and M-53A was 19.13 feet bls and 5.21 feet bls, respectively, during the June – July 2017 monitoring round. Depth to water at existing wells W-305, W-306, and W-314 during the June – July 2017 monitoring round was 20.47 feet bls, 17.58 feet bls, and 9.84 feet bls respectively.

Water level elevations along the BAP downgradient waste boundary range from 5,026.33 feet msl in well W-305 to 5,041.26 feet msl in well W-314 (**Figure 4**). Background alluvium monitor well M-64A, located about 3.14 miles (16,585 feet) downgradient from the BAP waste boundary, had a water level elevation of 4,964.51 feet msl in June 2017.

Water level contours based on the June – July 2017 monitoring round data, along with other available alluvial water level data from the same time period, indicate that the BAP creates a mound in the alluvium south and southeast of the Unit. Water from this mound generally flows south and southeast from the BAP boundary in the Tanner Wash Alluvium. The gradient away from the BAP is relatively large and ranges from south to southeast. Tanner Wash flows into the LCR, where the gradient is more shallow. Hydraulic gradient calculated from the 5,040- and 4,990-foot water level elevation contours downgradient from the BAP waste unit boundary for the June – July data set is 0.0196 feet/foot.

6.2.4 Bottom Ash Monofill

Three wells, M-59, M-60, and M-61, were installed to provide the CCR monitoring network along the downgradient waste boundary of the BAM. Since water was first encountered in the Coconino Aquifer for all three downgradient wells, the Coconino Aquifer is considered the uppermost aquifer for the BAM. Depth to water level at M-59, M-60, and M-61 was measured at 196.72 feet bls, 225.73 feet bls, and 194.89 feet bls, respectively, during the June – July 2017 monitoring round. Background Coconino well, M-54, was drilled upgradient from the BAM. Water was encountered in the Coconino Aquifer at a depth of 126.42 feet bls at M-54 during the June – July 2017 monitoring round.

Water level elevations along the BAM downgradient waste boundary ranged from 4,925.45 feet msl in well M-60 to 4,939.28 feet msl in well M-59 (**Figure 5**). Water level in upgradient well M-54, at 4,944.29 feet msl, is higher than at downgradient wells. Water level contours based on the June – July 2017 monitoring round data, along with other available Coconino water level data for the same time period, show that water flows from southeast to northwest beneath the BAM. This is consistent with both historical data and expectations for the flow of groundwater in this region of the Coconino Aquifer.

The hydraulic gradient beneath the BAM is moderate. Water levels drop about 19 feet between upgradient well M-54 and downgradient well M-60. The gradient beneath the BAM is toward the northwest. Hydraulic gradient calculated from the 4,940- and 4,930-foot water level elevation contour intervals adjacent to the BAM for the June – July 2017 data set was 0.0115 feet/foot.

7 SUMMARY EVALUATION OF CCR MONITORING NETWORKS

7.1 Fly Ash Pond

The uppermost aquifer for the FAP is the LCR Alluvial aquifer. The FAP monitoring network includes four wells completed in the LCR Alluvium. The FAP monitoring network meets requirements of the Rule and is believed to be sufficient for characterization of background water quality and monitoring groundwater passing the downgradient FAP waste boundary. With respect to monitoring in the uppermost aquifer, the LCR Alluvium, downgradient wells M-50A, M-51A, and W-123 are well positioned to monitor water quality at the FAP downgradient waste boundary. While efforts were made to find a location where alluvial thickness and saturation were adequate to install a fourth CCR well, this was not possible. As shown on **Figure 2**, there is only a narrow portion of the FAP waste boundary where alluvium thickness is about 50 feet, and thickness moving either northwest or southeast from this area declines rapidly and significantly. Because of the narrow extent of saturated alluvium at the downgradient waste boundary of the FAP, the three downgradient wells, M-50A, M-51A, and W-123, are deemed to be sufficient to monitor groundwater passing the FAP boundary.

The location for background alluvial well M-64A was selected for several reasons: (1) the FAP is constructed on Moenkopi bedrock, covered by a veneer of alluvium, and alluvial sediments are generally absent and, where present, anticipated to be unsaturated, in the area hydraulically upgradient from the FAP; (2) saturated thickness is limited and there are alluvial wells that are dry in the LCR Alluvium upstream from the FAP; and, (3) conservative travel time estimates indicate that it would take at least 91 years for FAP seepage to reach the vicinity of M-64A in the alluvium, which greatly exceeds the 40 year timeframe since FAP construction. Monitor well M-64A is interpreted to be located in an area that may be used to characterize and monitor groundwater quality that has not been affected by leakage from a CCR Unit.

7.2 Sedimentation Pond

The uppermost aquifer for the SEDI is the LCR alluvial aquifer. The SEDI CCR monitoring network includes four alluvial wells, which meets the Rule's minimum requirement. Given the small size of the SEDI (1.3 acres), the minimum number of wells is believed to be appropriate. The SEDI monitoring network meets all requirements of the Rule and is believed to be sufficient for characterization of background water quality and for monitoring the quality of groundwater passing the SEDI waste boundary.

LCR alluvial wells M-56A, M-57A, and M-58A are distributed along the downgradient waste boundary and are well positioned to monitor constituents in groundwater that might be passing the SEDI boundary. The upgradient well for the SEDI is alluvial well M-62A. M-62A is well situated to determine background groundwater quality in the LCR Alluvium that has not been affected by leakage from the SEDI.

7.3 Bottom Ash Pond

The uppermost aquifer for the BAP is the Tanner Wash alluvial aquifer, which flows into the LCR Alluvium to the southeast. The BAP monitoring network includes six wells. The five downgradient wells that are part of the BAP CCR monitoring network exceed requirements of the Rule and are believed to be sufficient for monitoring the quality of groundwater passing the BAP waste boundary.

Tanner Wash alluvial wells M-52A, M-53A, W-305, W-306, and W-314 are distributed along the downgradient waste boundary. This well configuration is both sufficient and protective. The location for background alluvial well M-64A was selected for several reasons: (1) the BAP is constructed principally on Moenkopi bedrock and alluvial sediments are absent in the area hydraulically upgradient from the BAP; (2) data from monitor wells in the Tanner Wash Alluvium upstream from the BAP indicate that saturated thickness is limited and that hydraulic gradients are influenced by the pond, making this area unsuitable for determining background water quality; and, (3) conservative travel time estimates indicate that it would take at least 85 years for BAP seepage to reach the vicinity of M-64A in the alluvium, which greatly exceeds the 40-year timeframe from BAP construction.

7.4 Bottom Ash Monofill

The uppermost aquifer for the BAM is the Coconino Aquifer. The BAM monitoring network includes four wells, which meets the Rule’s minimum requirement. Given the thick layer of fine grained Moenkopi Formation between the BAM and the Coconino Aquifer, the confined conditions in the Coconino aquifer, and the fact that the BAM is used to store de-watered bottom ash removed from the BAP rather than liquids, the minimum number wells is believed to be appropriate. The BAM monitoring network meets all requirements of the Rule and is believed to be sufficient for characterization of upgradient groundwater quality and for monitoring groundwater passing the BAM waste boundary. Coconino Aquifer wells M-59, M-60, and M-61 are distributed along the downgradient waste boundary. The upgradient well for the BAM is Coconino well M-54.

8 REFERENCES CITED

Arizona Public Service Co., 1984, Cholla Ash Ponds Groundwater Interpretative Report No. 1. Prepared for the Arizona Department of Water Resources, June 1984.

Fetter, C.W., 2001, Applied Hydrogeology (4th ed.), Prentice-Hall, Upper Saddle River, New Jersey, 598p.

Guyton, William, F. and Associates, 1957, Memorandum on Ground-Water Conditions in the Area Along Little Colorado River Between Holbrook and Winslow, Arizona.

Mann, L.J., 1976, Ground-water resources and water use in southern Navajo County, Arizona: Arizona Water Commission Bulletin 10.

McGavock, E.H. and others, 1986, Water resources of southern Coconino County: Arizona Department of Water Resources Bulletin 4.

Montgomery & Associates, 2015, Groundwater Sampling and Analysis Program, Cholla Power Plant, Joseph City, Arizona, Document #CH_GW_SAP_11-30-15.

Sargent, Hauskins & Beckwith (SHB), 1973, Preliminary Soil and Geology Study of Proposed Ash Disposal Areas: Prepared for Arizona Public Service Company.

Woodward-Clyde, 1992, Evaluation of Hydrogeologic Conditions, Bottom Ash Pond, Cholla Steam Generating Station, Reference No. 914X236: Prepared for Arizona Public Service Co., Phoenix, Arizona, May 22, 1992.

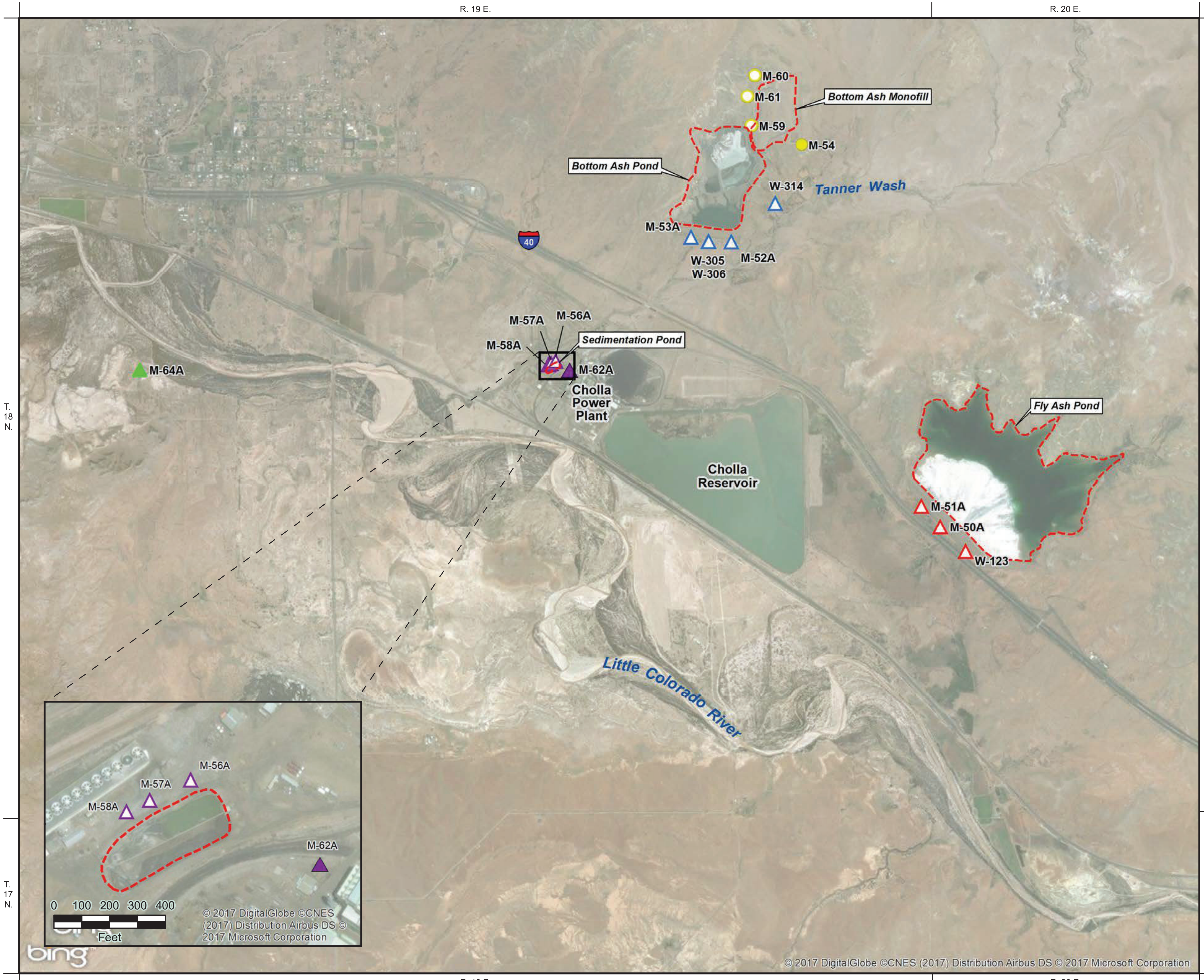
U.S. Environmental Protection Agency, 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures: EPA/540/S-95/504, April 1996.

_____, 2009, Statistical Analysis of groundwater monitoring data at RCRA facilities, Unified guidance; EPA/530/R-09/007, March 2009.

TABLE 1. SUMMARY OF WELL CONSTRUCTION DETAILS
FOR CCR MONITORING NETWORK WELLS, APS CHOLLA POWER PLANT, NAVAJO COUNTY, ARIZONA

CCR Pond	Well Identifier	Hydrogeologic Unit	Cadastral Location	ADWR ID	Date Completed	Borehole Depth (feet, bls[a])	Total Cased Depth (feet, bls)	Screened Interval (feet, bls)	Depth to Top of Gravel Pack (feet, bls)	Well Location Data[b]				Depth to Groundwater Level (feet, bmp[d])	Groundwater Level Elevation (feet, msl)	Date Measured	Hydrogeologic Contacts	
										Northing	Easting	Land Surface Elevation (feet, amsl[c])	Measurement Point Elevation (feet, amsl)				Moenkopi Contact (feet, bls)	Coconino Contact (feet, bls)
Bottom Ash Monofill	M-54	Coconino	(A-18-19)13cab	918646	10/2/2015	370	365	315-365	312	1440088.61	665508.13	5068.21	5070.71	126.42	4944.29	6/26/2017	19	302
Bottom Ash Monofill	M-59	Coconino	(A-18-19)13cbb	918647	10/21/2015	425	423	373-423	365	1440604.73	664161.36	5133.86	5136.00	196.72	4939.28	6/26/2017	13	360
Bottom Ash Monofill	M-60	Coconino	(A-18-19)13bac	918649	11/1/2015	450	445	395-445	384	1441947.89	664249.99	5148.69	5151.18	225.73	4925.45	6/26/2017	14	380
Bottom Ash Monofill	M-61	Coconino	(A-18-19)13bca	918648	11/13/2015	420	415	365-415	354	1441383.55	664047.00	5124.95	5127.58	194.89	4932.69	6/26/2017	5	355
Bottom Ash Pond	M-52A	Alluvium	(A-18-19)24bbc	918657	9/22/2015	83	70	20 - 70	16	1437475.71	663614.27	5047.08	5049.36	19.91	5029.45	6/26/2017	79	N/A
Bottom Ash Pond	M-53A	Alluvium	(A-18-19)23aab	918651	9/22/2015	38	35	10-35	8	1437605.11	662529.37	5042.09	5044.68	5.21	5039.47	6/26/2017	34	N/A
Bottom Ash Pond	W-305	Alluvium	(A-18-19)23aaa	506364	10/7/1983	108	102	80-100	N/A	1437484.17	662998.76	5044.65	5046.80	20.47	5026.33	6/26/2017	>110	N/A
Bottom Ash Pond	W-306	Alluvium	(A-18-19)23aaa	506365	10/11/1983	54	52	30-50	N/A	1437482.84	663008.29	5044.78	5046.74	17.58	5029.16	6/26/2017	>55	N/A
Bottom Ash Pond	W-314	Alluvium	(A-18-19)13ccd	533814	1/27/1992	63	62	41-61	44	1438507.58	664796.73	5051.32	5051.10	9.84	5041.26	6/26/2017	>63	N/A
Fly Ash Pond	M-50A	Alluvium	(A-18-20)30bbc	918641	9/18/2015	32	29	9-29	7	1429799.42	669243.76	5035.65	5038.18	19.13	5019.05	6/26/2017	28	N/A
Fly Ash Pond	M-51A	Alluvium	(A-18-19)25add	918640	9/19/2015	14	12	7-12	6	1430360.14	668733.14	5039.10	5041.77	9.91	5031.86	6/26/2017	9	N/A
Fly Ash Pond	W-123	Alluvium	(A-18-20)30cbd	506587	11/4/1983	40	35	14-29	N/A	1429140.92	669925.02	5038.14	5039.84	2.11	5037.73	6/26/2017	>40	N/A
Fly Ash Pond & Bottom Ash Pond	M-64A	Alluvium	(A-18-19)21ccb	920353	2/9/2017	69	60	30-60	18	1434030.01	647702.04	4988.90	4991.90	24.39	4967.51	6/26/2017	63	N/A
Sedimentation Pond	M-56A	Alluvium	(A-18-19)23cbc	918661	10/7/2015	100	85	40-85	37	1434257.73	658887.35	5020.63	5023.17	42.09	4981.08	6/26/2017	>100	N/A
Sedimentation Pond	M-57A	Alluvium	(A-18-19)23cbc	918660	10/8/2015	100	85	40-85	37	1434198.68	658767.25	5021.16	5023.82	42.86	4980.96	6/26/2017	>100	N/A
Sedimentation Pond	M-58A	Alluvium	(A-18-19)23cbc	918659	10/13/2015	100	84	39-84	36	1434165.11	658698.92	5021.24	5023.84	42.88	4980.96	6/26/2017	>100	N/A
Sedimentation Pond	M-62A	Alluvium	(A-18-19)23cbd	918658	11/17/2015	97	84	39-84	32	1434008.67	659268.05	5021.01	5020.87	39.61	4981.26	6/26/2017	97	N/A

[a] bls = below land surface
[b] Well coordinates are in Arizona State Plane, Central zone, NAD83, Int. Feet; vertical NAVD88, Int. Feet
[c] amsl = above mean sea level
[d] bmp = below measuring point
N/A = data not available



EXPLANATION

Approximate Extent of Coal Combustion Residual Unit

M-51A Monitor Well Location and Identifier

CCR WELLS:

- Alluvium, Background, Fly Ash Pond and Bottom Ash Pond
- Alluvium, Downgradient, Bottom Ash Pond
- Alluvium, Downgradient, Fly Ash Pond
- Alluvium, Upgradient, Sedimentation Pond
- Alluvium, Downgradient, Sedimentation Pond
- Coconino, Upgradient, Bottom Ash Monofill
- Coconino, Downgradient, Bottom Ash Monofill

0 1,000 2,000 3,000 4,000
Feet

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CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

CCR MONITORING NETWORK LOCATIONS

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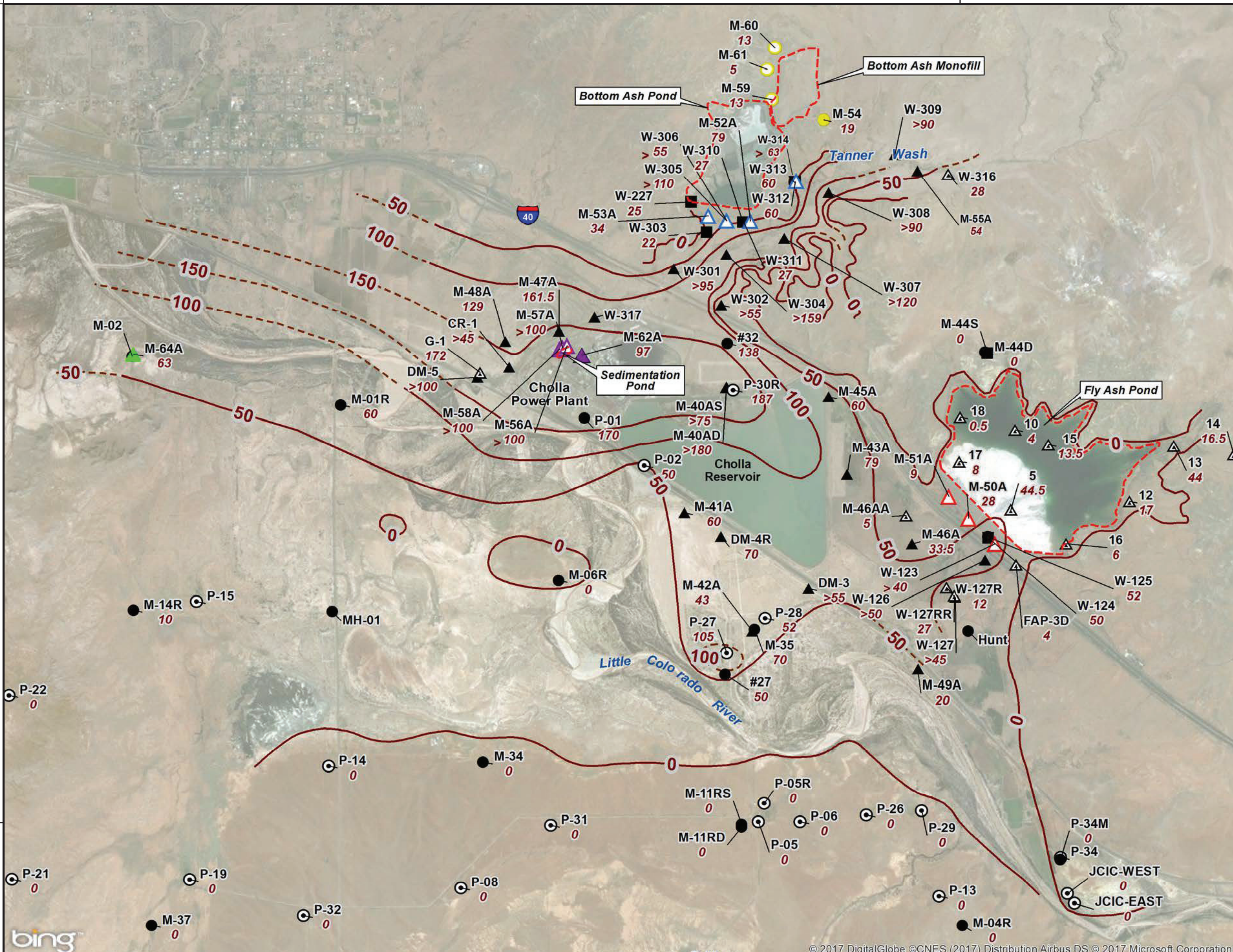
2017

FIGURE 1

GIS-TUC\897.0704\CCR_MonWellProgram_RevAug2017.mxd\19Sept2017 StatePlane Nad83_ft



EXPLANATION

Approximate Extent of Coal Combustion Residual Unit

50 — Contour of Alluvium Thickness, in feet (dashed where inferred)

M-51A 9 — Well Location and Identifier; Thickness of Alluvium, in feet

CCR WELLS:

- Alluvium, Background, Fly Ash Pond and Bottom Ash Pond
- Alluvium, Downgradient, Bottom Ash Pond
- Alluvium, Downgradient, Fly Ash Pond
- Alluvium, Downgradient, Sedimentation Pond
- Alluvium, Upgradient, Sedimentation Pond
- Coconino, Downgradient, Bottom Ash Monofill
- Coconino, Upgradient, Bottom Ash Monofill

OTHER WELLS:

- Alluvium, Boring
- Alluvium, Monitor
- Moenkopi, Monitor
- Coconino, Monitor
- Coconino, Production

0 1,000 2,000 3,000 4,000
Feet

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NAVAJO COUNTY, ARIZONA

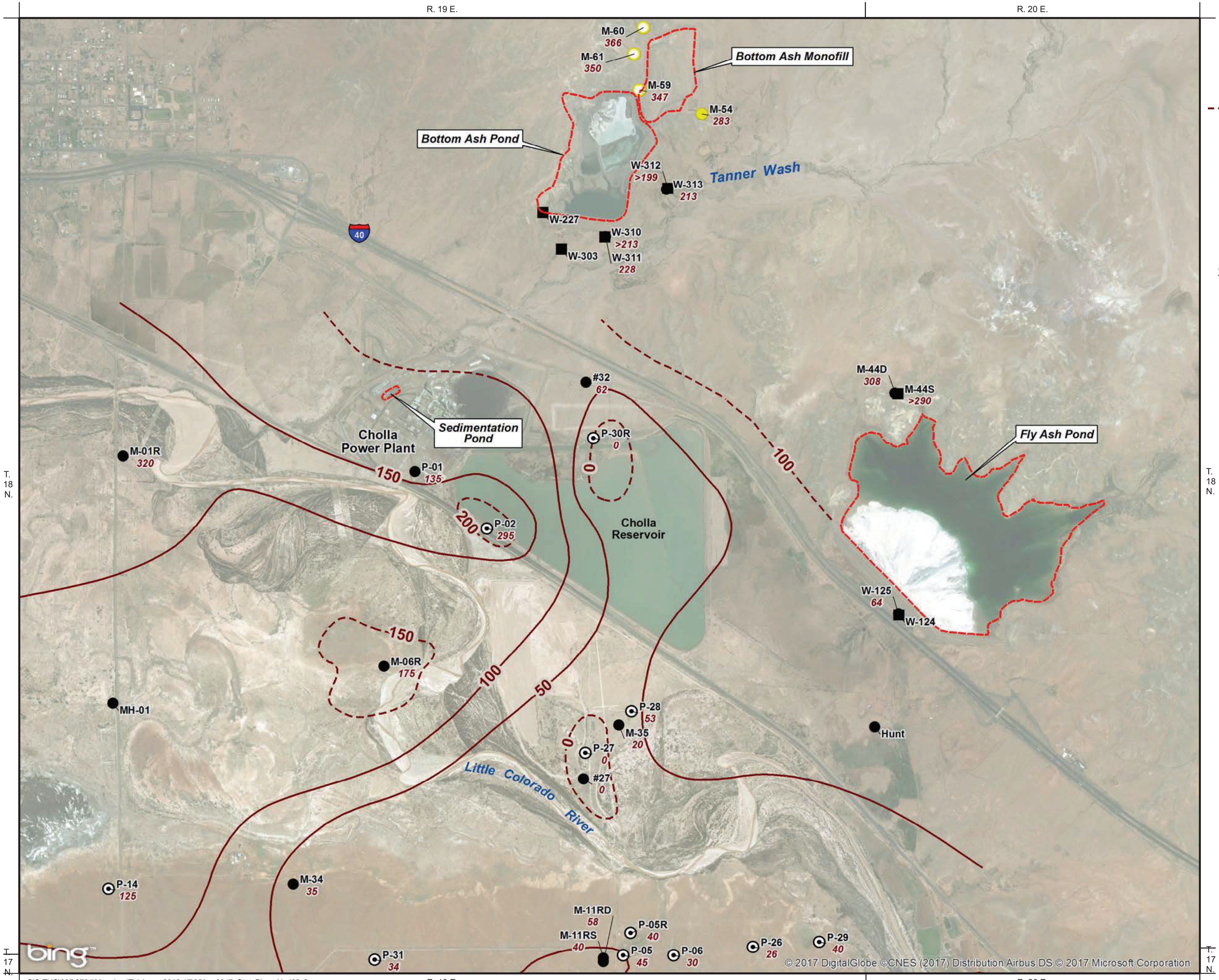
LCR AND TANNER WASH ALLUVIUM THICKNESS

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2017

FIGURE 2

GIS-TUC\897.0704\\AlluvThickCont2017\19Sept2017 StatePlane Nad83_ft



EXPLANATION

Approximate Extent of Coal Combustion Residual Unit

50 — Contour of Moenkopi Thickness, in feet (dashed where inferred)

M-59 347 — Well Location and Identifier; Thickness of Moenkopi, in feet

CCR WELLS:

- Coconino, Downgradient, Bottom Ash Monofill
- Coconino, Upgradient, Bottom Ash Monofill

OTHER WELLS:

- Moenkopi, Monitor
- Coconino, Monitor
- Coconino, Production

0 1,000 2,000 3,000 4,000
Feet

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CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

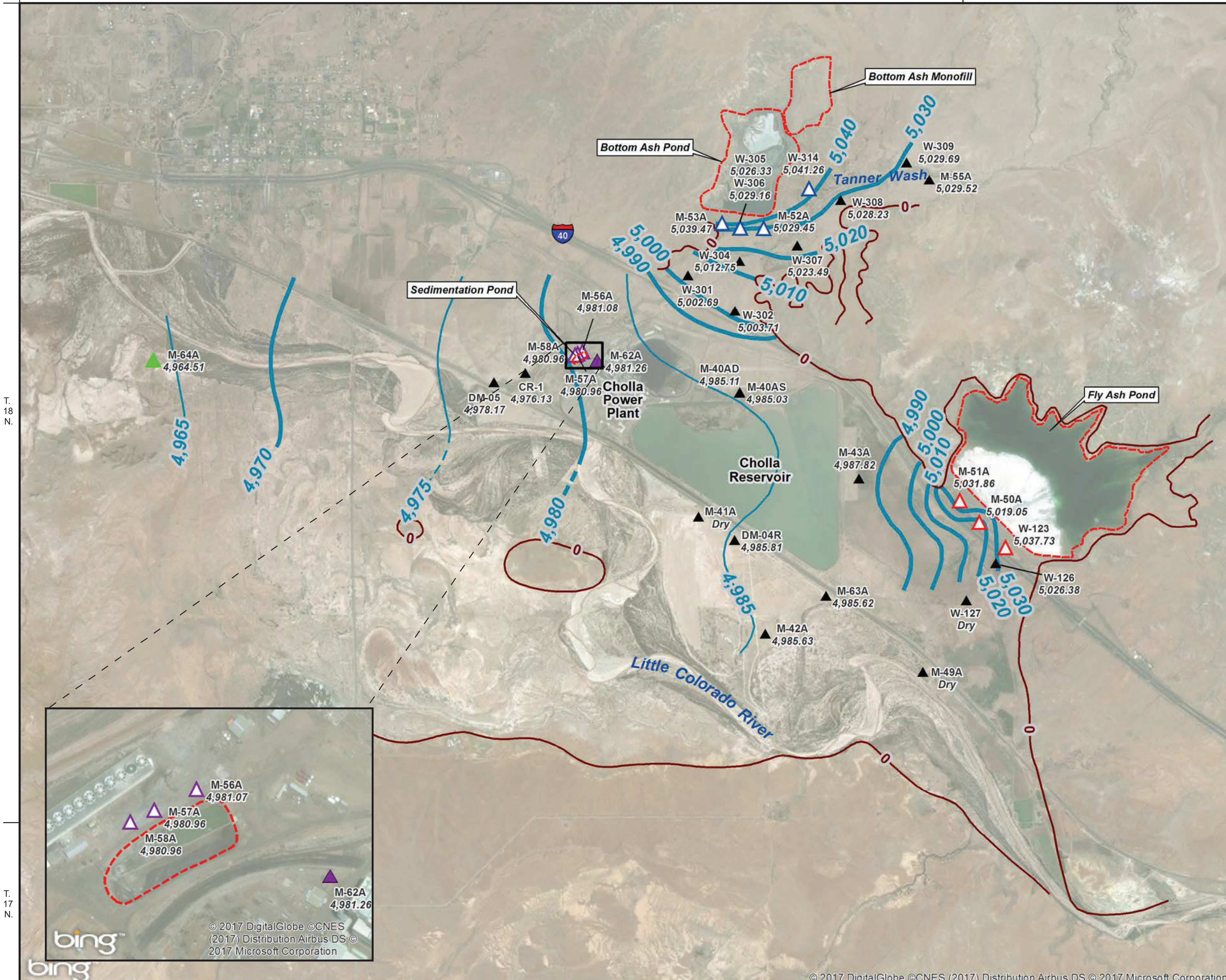
MOENKOPI FORMATION THICKNESS

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2017

FIGURE 3

R. 19 E. R. 20 E.



T. 18 N.

T. 17 N.

EXPLANATION

Approximate Extent of Coal Combustion Residual Unit

Estimated Extent of Alluvium

5,030 — 10-Foot Contour of Water Level Elevation in Alluvial Aquifer, in feet above mean sea level (dashed where inferred)

4,985 — 5-Foot Contour of Water Level Elevation in Alluvial Aquifer, in feet above mean sea level (dashed where inferred)

M-51A — Alluvium Monitor Well Location and Identifier

5,031.85 — Elevation of Water Level, June - July 2017, in feet above mean sea level

CCR WELLS:

- Background, Fly Ash Pond and Bottom Ash Pond Well
- Downgradient, Bottom Ash Pond
- Downgradient, Fly Ash Pond
- Upgradient, Sedimentation Pond
- Downgradient, Sedimentation Pond

OTHER WELLS:

- Monitor Well

0 1,000 2,000 3,000 4,000

Feet

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ALLUVIAL AQUIFER WATER LEVEL ELEVATION JUNE - JULY 2017

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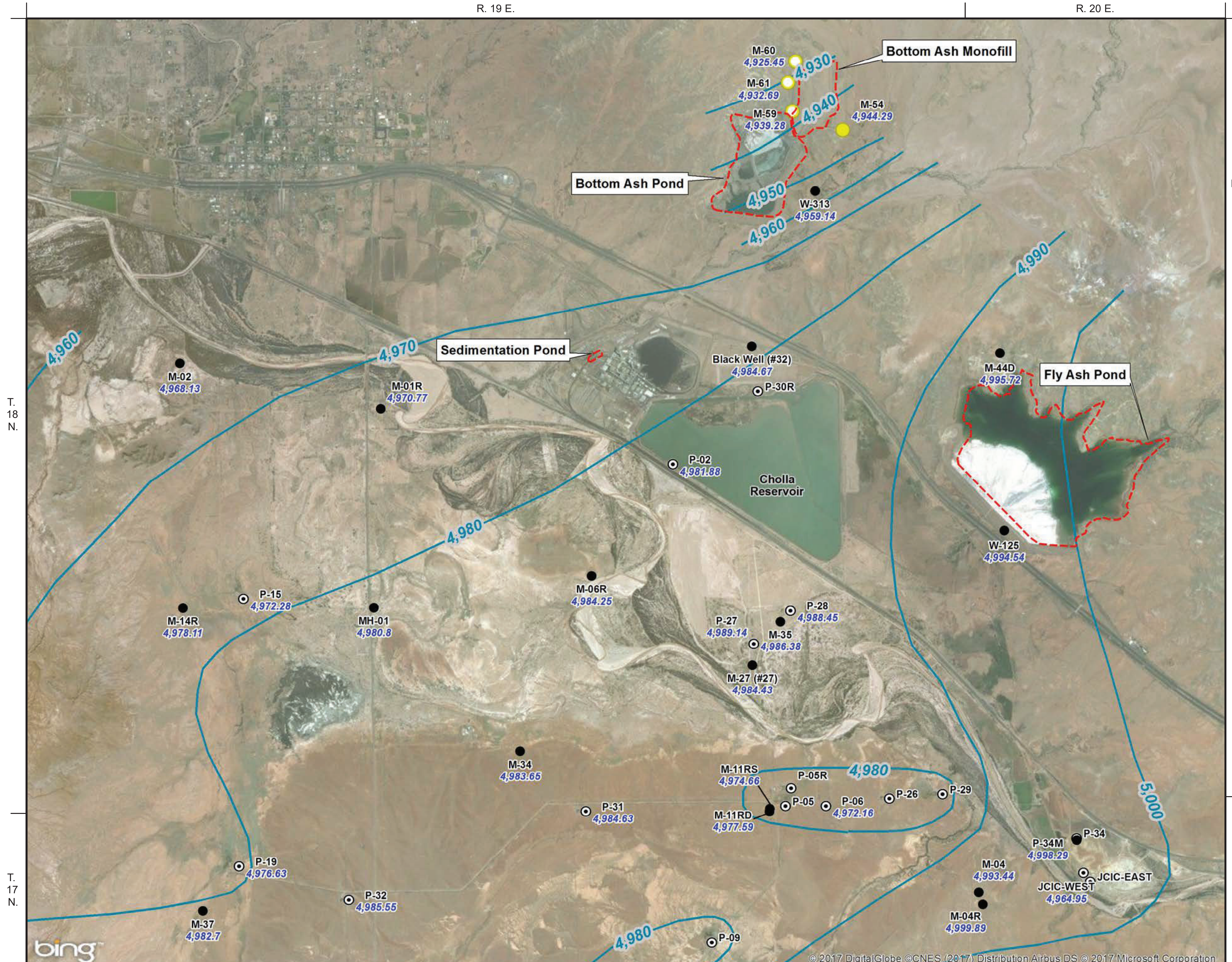
2017

FIGURE 4

GIS-TUC\897.0704\AlluvThickness_GWelevation_June-July2017 \12Sept2017 StatePlane Nad83_ft

R. 19 E. R. 20 E.



EXPLANATION

- Approximate Extent of Coal Combustion Residual Unit
- 5,000 — 10-Foot Contour of Water Level Elevation in Coconino Sandstone Aquifer, in feet above mean sea level
- M-44D 4,995.72 — Coconino Monitor Well Location and Identifier; Elevation of Water Level, June - July 2017, in feet above mean sea level

CCR WELLS:

- Downgradient, Bottom Ash Monofill
- Upgradient, Bottom Ash Monofill

OTHER WELLS:

- Monitor
- Production

N

0 4,000

Feet

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COCONINO AQUIFER WATER LEVEL ELEVATION JUNE - JULY 2017

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2017

FIGURE 5

GIS\897.0704\Coco_WaterLevelAlt_June-July2017\19Sept2017 UTM NAD27

APPENDIX A
CONSTRUCTION DETAILS FOR CCR NEW MONITOR WELLS
SEPTEMBER 2015 – February 2017

A total of 13 new wells were installed as part of the CCR monitoring network at Cholla Power Plant in two field programs implemented during the period September 2015 through February 2017. Detailed information regarding the construction for these wells is presented in the following sections. Locations for the new wells are shown on **Figure 1** in the main document. Schematic diagrams of well construction for the new CCR monitor wells are shown on **Figures A-1 through A-13** and lithologic logs are provided in **Tables A-1 through A-13**. **Table A-14** summarizes well development parameter stability measurements prior to collection of development samples. Wells are sequenced below and in associated figures and tables in order of well identification number, which coincides with the order in which the wells were drilled.

Monitor Well M-50A

- Location: Monitor well M-50A (55-918641) is located on land owned by Arizona Public Service (APS) in T18N, R20E, in the NW 1/4 of the NW 1/4 of the SW 1/4 of Section 30 (A-18-20)30bbc, at the base of the Fly Ash Pond (FAP) (**Figure 1**).
- Installation Dates: M-50A was drilled and constructed during the period September 17-18, 2015.
- Depth: Total drilled depth for M-50A is 32 feet below land surface (bls).
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary Alluvium (0 to 28 feet) and Moenkopi Formation (28 to 32 feet). Lithologic descriptions of drill cuttings for M-50A are presented in **Table A-1**.
- Screened Interval: M-50A was completed within the alluvium with a screened interval from 9 to 29 feet; non-pumping water level was 18.95 feet below measuring point (bmp) on November 30, 2015 (**Figure A-1**).
- Development: M-50A was developed by bailing and pumping on November 22, 2015 for a period of about 1 hour and 12 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-51A

- Location: Monitor well M-51A (55-918640) is located on land owned by APS in T18N, R19E, in the SE 1/4 of the SE 1/4 of the NE 1/4 of Section 25 (A-18-19)25add, at the base of the FAP (**Figure 1**).

- Installation Dates: M-51A was drilled and constructed during the period September 18-19, 2015.
- Depth: Total drilled depth for M-51A is 14 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 9 feet) and Moenkopi Formation (9 to 14 feet). Lithologic descriptions of drill cuttings for M-51A are presented in **Table A-2**.
- Screened Interval: M-51A was completed within the alluvium with a screened interval from 7 to 12 feet; non-pumping water level was 9.47 feet bmp on November 30, 2015 (**Figure A-2**).
- Development: M-51A was developed by bailing and pumping on November 22, 2015 for a period of about 1 hour and 42 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-52A

- Location: Monitor well M-52A (55-918657) is located on land owned by APS, in T18N, R19E, in the SW 1/4 of the NW 1/4 of the NW 1/4 of Section 24 (A-18-19)24bbc, north of the Little Colorado River (LCR) and U.S Highway 40 at the base of the Bottom Ash Pond (BAP) impoundment (**Figure 1**).
- Installation Dates: M-52A was drilled and constructed during the period September 21-22, 2015.
- Depth: Total drilled depth for M-52A is 83 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 79 feet) and Moenkopi Formation (79 to 83 feet). Lithologic descriptions of drill cuttings for M-52A are presented in **Table A-3**.
- Screened Interval: M-52A was completed within the alluvium with a screened interval from 20 to 70 feet; non-pumping water level was 19.13 feet bmp on December 1, 2015 (**Figure A-3**).
- Development: M-52A was developed by bailing and pumping on November 17, 2015 for a period of about 6 hour and 55 minutes; field parameters stabilized and water was described as slightly brown/reddish with no sand prior to sample collection (**Table A-14**).

Monitor Well M-53A

- Location: Monitor well M-53A (55-918651) is located on land owned by APS, in T18N, R19E, in the SW 1/4 of the SW 1/4 of the NW 1/4 of the NW 1/4 of Section 24 (A-18-19)23aab, north of the LCR and U.S Highway 40 at the base of the BAP impoundment (**Figure 1**).
- Installation Dates: M-53A was drilled and constructed during the period September 21-22, 2015.
- Depth: Total drilled depth for M-53A is 38 feet bls.

- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 34 feet) and Moenkopi Formation (34 to 38 feet). Lithologic descriptions of drill cuttings for M-53A are presented in **Table A-4**.
- Screened Interval: M-53A was completed within the alluvium with a screened interval from 10 to 35 feet; non-pumping water level was 4.49 feet bmp on December 1, 2015 (**Figure A-4**).
- Development: M-53A was developed by bailing and pumping on November 17, 2015 for a period of about 3 hours and 17 minutes; field parameters stabilized and water was described as clear with no sand prior to sample collection (**Table A-14**).

Monitor Well M-54

- Location: Monitor well M-54 (55-918646) is located on land owned by APS, in T18N, R19E, in the NW 1/4 of the NE 1/4 of the SW 1/4 of Section 13 (A-18-19)13cab, north of the LCR and U.S Highway 40 and east of the Bottom Ash Monofill (BAM) adjacent to an unnamed ephemeral wash that is tributary to Tanner Wash (**Figure 1**).
- Installation Dates: M-54 was drilled and constructed during the period September 23-October 2, 2015.
- Depth: Total drilled depth for M-54 is 370 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 19 feet), Moenkopi Formation (19 to 302 feet), and Permian Coconino Sandstone (302 to 370 feet). Lithologic descriptions of drill cuttings for M-54 are presented in **Table A-5**.
- Screened Interval: M-54 was completed within the Coconino Sandstone with a screened interval from 315 to 365 feet; non-pumping water level was 127.99 feet bmp on December 2, 2015 (**Figure A-5**).
- Development: M-54 was developed by bailing and pumping on November 18, 2015 for a period of about 4 hours; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-56A

- Location: Monitor well M-56A (55-918661) is located on land owned by APS, in T18N, R19E, in the SW 1/4 of the NW 1/4 of the SW 1/4 of Section 23 (A-18-19)23cbc, within the plant site adjacent to the western cooling towers and the Sedimentation Pond (SEDI) (**Figure 1**).
- Installation Dates: M-56A was drilled and constructed during the period October 4-7, 2015.
- Depth: Total drilled depth for M-56A is 100 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 100 feet). Lithologic descriptions of drill cuttings for M-56A are presented in **Table A-6**.

- Screened Interval: M-56A was completed within the alluvium with a screened interval from 40 to 85 feet; non-pumping water level was 43.52 feet bmp on November 30, 2015 (**Figure A-6**).
- Development: M-56A was developed by bailing and pumping on November 21, 2015 for a period of about 2 hours and 45 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-57A

- Location: Monitor well M-57A (55-918660) is located on land owned by APS, in T18N, R19E, in the SW 1/4 of the NW 1/4 of the SW 1/4 of Section 23 (A-18-19)23cbc, within the plant site adjacent to the western cooling towers and the SEDI (**Figure 1**).
- Installation Dates: M-57A was drilled and constructed during the period October 7-8, 2015.
- Depth: Total drilled depth for M-57A is 100 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 100 feet). Lithologic descriptions of drill cuttings for M-57A are presented in **Table A-7**.
- Screened Interval: M-57A was completed within the alluvium with a screened interval from 40 to 85 feet; non-pumping water level was 44.25 feet bmp on November 30, 2015 (**Figure A-7**).
- Development: M-57A was developed by bailing and pumping on November 21, 2015 for a period of about 3 hours and 4 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-58A

- Location: Monitor well M-58A (55-918659) is located on land owned by APS, in T18N, R19E, in the SW 1/4 of the NW 1/4 of the SW 1/4 of Section 23 (A-18-19)23cbc, within the plant site adjacent to the western cooling towers and the SEDI (**Figure 1**).
- Installation Dates: M-58A was drilled and constructed during the period of October 8 through October 13, 2015.
- Depth: Total drilled depth for M-58A is 100 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 100 feet). Lithologic descriptions of drill cuttings for M-58A are presented in **Table A-8**.
- Screened Interval: M-58A was completed within the alluvium with a screened interval from 39 to 84 feet; non-pumping water level was 44.25 feet bmp on November 30, 2015 (**Figure A-8**).

- Development: M-58A was developed by bailing and pumping on November 21, 2015 for a period of about 2 hours and 10 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-59

- Location: Monitor well M-59 (55-918647) is located on land owned by APS, in T18N, R19E, in the NW 1/4 of the NW 1/4 of the NW 1/4 of the SW 1/4 of Section 13 (A-18-19)13cbb, north of the LCR and U.S Highway 40 and northwest of the BAM (**Figure 1**).
- Installation Dates: M-59 was drilled and constructed during the period October 14-21, 2015.
- Depth: Total drilled depth for M-59 is 425 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 13 feet), Moenkopi Formation (13 to 360 feet), and Coconino Sandstone (360 to 425 feet). Lithologic descriptions of drill cuttings for M-59 are presented in **Table A-9**.
- Screened Interval: M-59 was completed within the Coconino Sandstone with a screened interval from 373 to 423 feet; non-pumping water level was 197.78 feet bmp on December 2, 2015 (**Figure A-9**).
- Development: M-59 was developed by bailing and pumping on November 20, 2015 for a period of about 2 hours and 25 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-60

- Location: Monitor well M-60 (55-918649) is located on land owned by APS, in T18N, R19E, in the SW 1/4 of the SW 1/4 of the NE 1/4 of the NW 1/4 of Section 13 (A-18-19)13bac, north of the LCR and U.S Highway 40 and west of the BAM (**Figure 1**).
- Installation Dates: M-60 was drilled and constructed during the period October 21-November 1, 2015.
- Depth: Total drilled depth for M-60 is 450 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 14 feet), Moenkopi Formation (14 to 380 feet), and Coconino Sandstone (380 to 450 feet). Lithologic descriptions of drill cuttings for M-60 are presented in **Table A-10**.
- Screened Interval: M-60 was completed within the Coconino Sandstone with a screened interval from 395 to 445 feet; non-pumping water level was 226.92 feet bmp on December 2, 2015 (**Figure A-10**).
- Development: M-60 was developed by bailing and pumping on November 20, 2015 for a period of about 3 hours and 24 minutes; field parameters generally stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-61

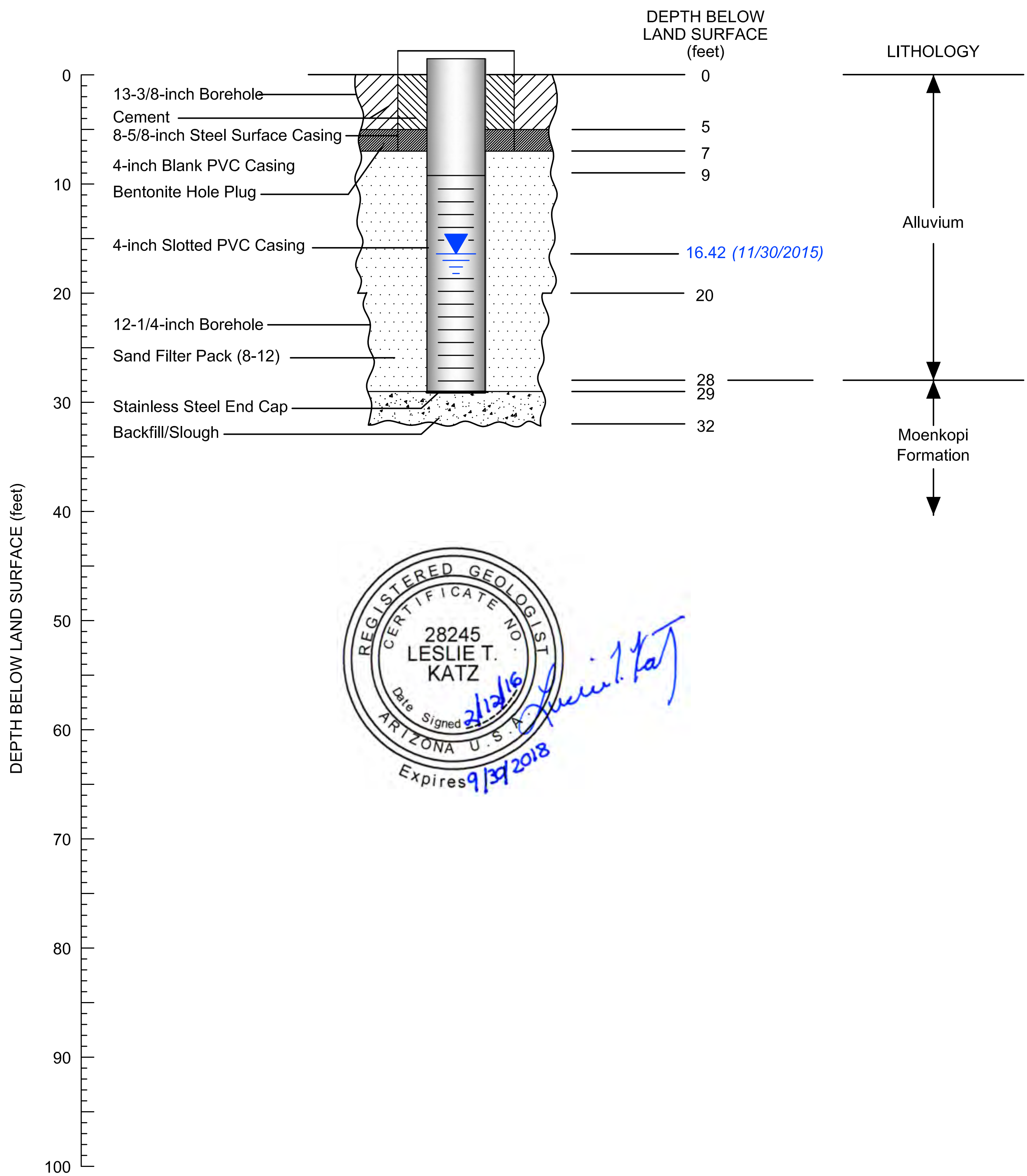
- Location: Monitor well M-61 (55-918648) is located on land owned by APS, in T18N, R19E, in the NE 1/4 of the SW 1/4 of the NW 1/4 of Section 13 (A-18-19)13bca, north of the LCR and U.S. Highway 40 and west of the BAM (**Figure 1**).
- Installation Dates: M-61 was drilled and constructed during the period November 2-13, 2015.
- Depth: Total drilled depth for M-61 is 420 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 5 feet), Moenkopi Formation (5 to 350 feet), and Coconino Sandstone (350 to 420 feet). Lithologic descriptions of drill cuttings for M-61 are presented in **Table A-11**.
- Screened Interval: M-61 was completed within the Coconino Sandstone with a screened interval from 365 to 415 feet; non-pumping water level was 195.93 feet bmp on December 2, 2015 (**Figure A-11**).
- Development: M-61 was developed by bailing and pumping on November 19, 2015 for a period of about 2 hours and 45 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).

Monitor Well M-62A

- Location: Monitor well M-62A (55-918658) is located on land owned by APS, in T18N, R19E, in the SE 1/4 of the NW 1/4 of the SW 1/4 of Section 23 (A-18-19)23cbd, within the plant site adjacent to the western cooling towers and the SEDI (**Figure 1**).
- Installation Dates: M-62A was drilled and constructed during the period November 14-17, 2015.
- Depth: Total drilled depth for M-62A is 97 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 97 feet). Lithologic descriptions of drill cuttings for M-62A are presented in **Table A-12**.
- Screened Interval: M-62A was completed within the alluvium with a screened interval from 39 to 84 feet; non-pumping water level was 41.13 feet bmp on November 30, 2015 (**Figure A-12**).
- Development: M-62A was developed by bailing and pumping on November 22, 2015 for a period of about 3 hours and 5 minutes; field parameters stabilized and water was described as clear prior to sample collection (**Table A-14**).
- Well M-62A was installed as a dual purpose well for both the CCR program and Voluntary Remediation Program (VRP). Split spoon samples were collected during drilling. Details of the split spoon sampling program and results were presented to the APS VRP group under a separate communication.

Monitor Well M-64A

- Location: Monitor well M-64A (55-920353) is located on land owned by APS in T18N, R19E, in the SW 1/4 of the SW 1/4 of the NW 1/4 of Section 21 (A-18-19)21ccb, south of the LCR and U.S. Highway 40 and west of the Cholla Power Plant (**Figure 1**).
- Installation Dates: M-64A was drilled and constructed during the period February 7-8, 2017.
- Depth: Total drilled depth for M-64A is 69 feet bls.
- Geology: Geologic units encountered during drilling from land surface to total depth include Quaternary alluvium (0 to 63 feet) and Moenkopi Formation (63 to 69 feet). Lithologic descriptions of drill cuttings for M-64A are presented in **Table A-13**.
- Screened Interval: M-64A was completed within the alluvium with a screened interval from 30 to 60 feet; non-pumping water level was 25.18 feet bmp on February 20, 2017 (**Figure A-13**).
- Development: M-64A was developed by swabbing and bailing on February 10, 2017 for a period of about 4 hours and 3 minutes; field parameters generally stabilized and water was described to have minimal sand prior to sample collection (**Table A-14**).



WELL: M-50A (FAP-2D)	NORTHING: 1429799.42
REGISTRATION: 55-918641	EASTING: 669243.76
COUNTY: Navajo, Arizona	MP Elevation: 5038.179 feet amsl
DATE COMPLETED: 09/18/15	DATUM: NAD83, State Plane 1983

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-50A APS CHOLLA POWER PLANT

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2016

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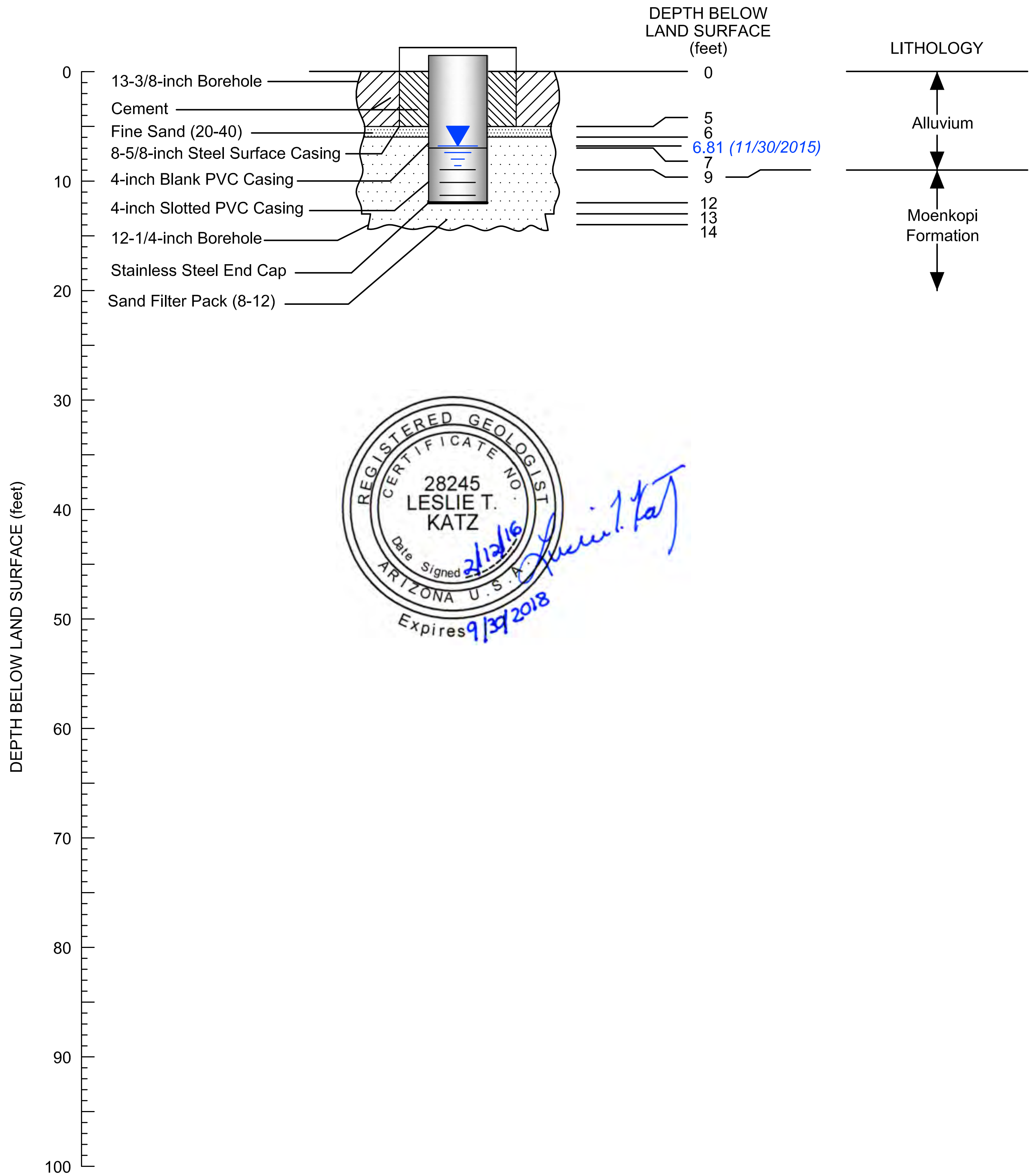

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-51A (FAP-1D)	NORTHING: 1430360.14
REGISTRATION: 55-918640	EASTING: 668733.14
COUNTY: Navajo, Arizona	MP Elevation: 5041.765 feet amsl
DATE COMPLETED: 9/19/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-51A APS CHOLLA POWER PLANT

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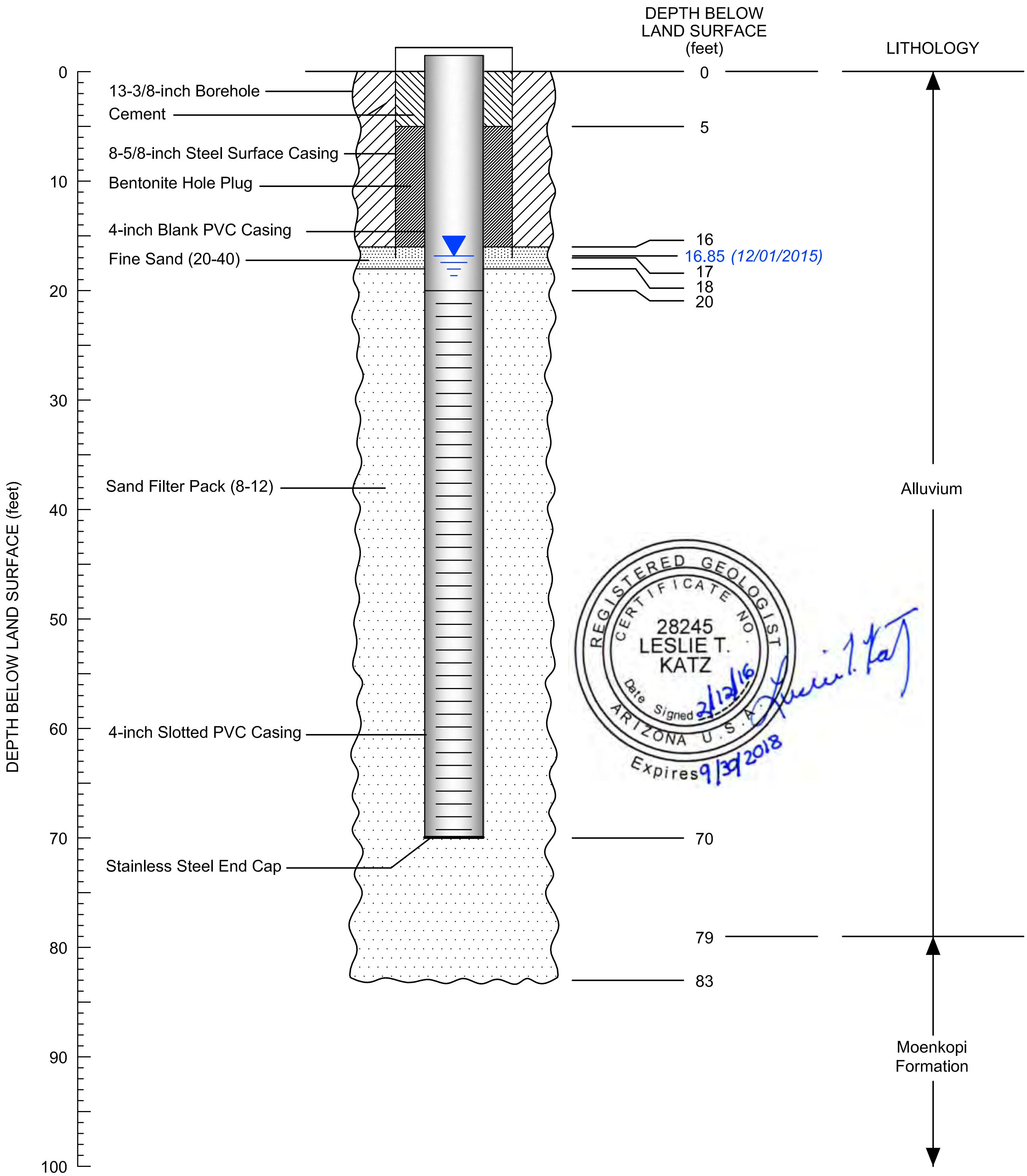

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-52A (BAP-2D)	NORTHING: 1437475.71
REGISTRATION: 55-918657	EASTING: 663614.28
COUNTY: Navajo, Arizona	MP Elevation: 5049.363 feet amsl
DATE COMPLETED: 09/21/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-52A APS CHOLLA POWER PLANT

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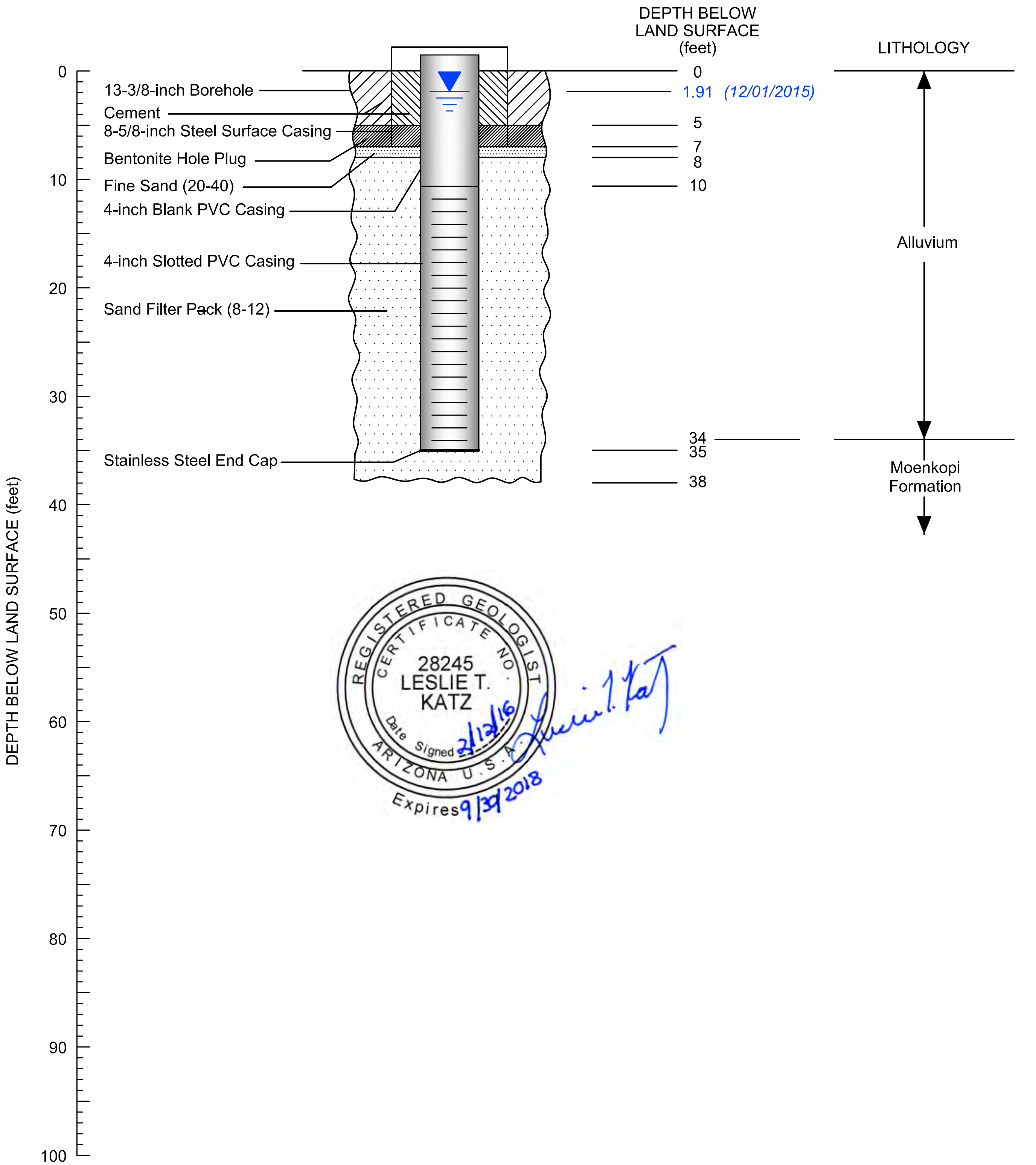

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-53A (BAP-1D)	NORTHING: 1437605.11
REGISTRATION: 55-918651	EASTING: 662529.37
COUNTY: Navajo, Arizona	MP Elevation: 5044.677 feet amsl
DATE COMPLETED: 09/22/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-53A APS CHOLLA POWER PLANT

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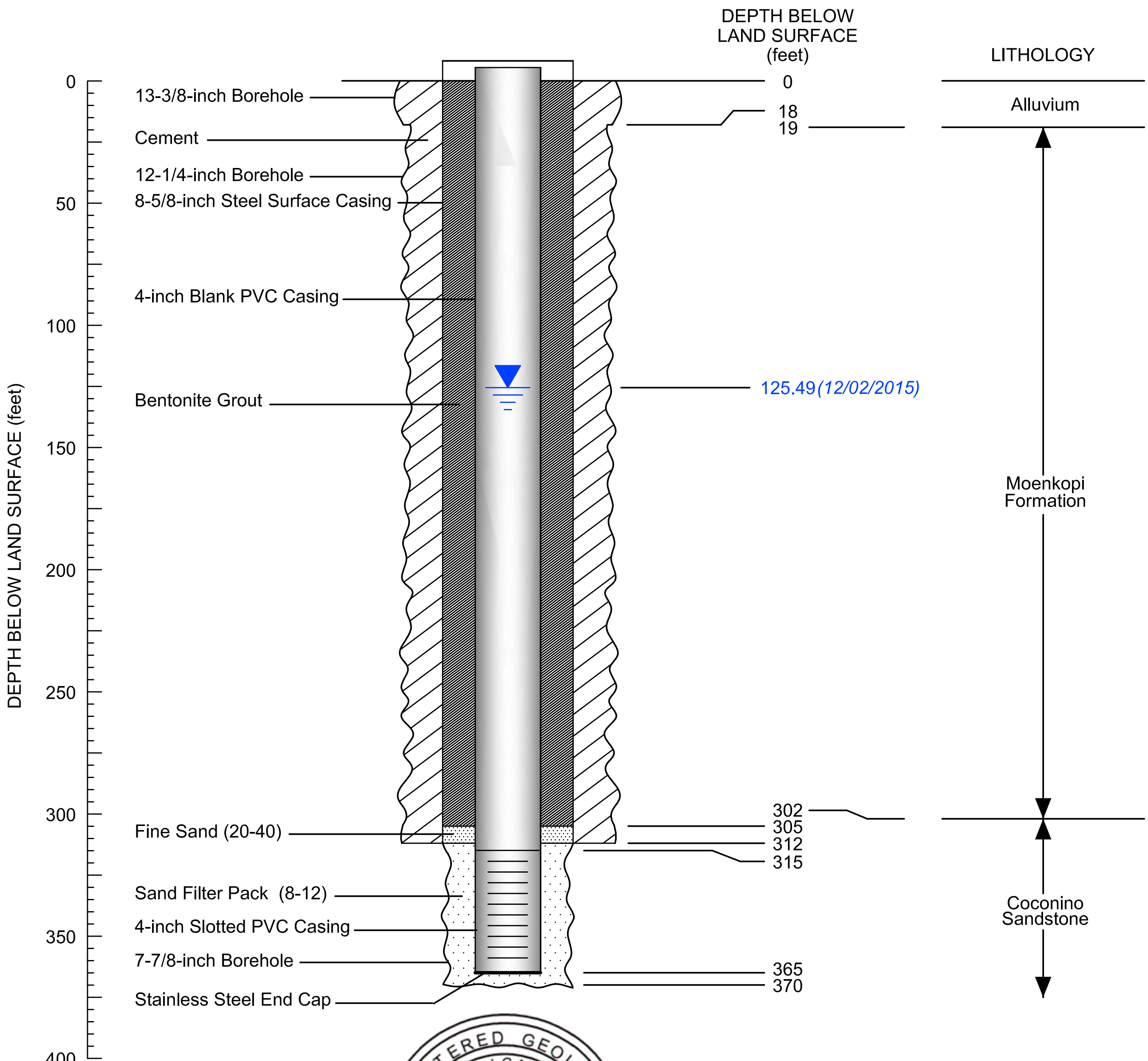

REGISTERED GEOLOGIST
CERTIFICATE NO. 28245
LESLIE T. KATZ
Date Signed 2/12/16
ARIZONA U.S.A.
Expires 9/30/2018

EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-54 (BAM-1U)	NORTHING: 1440088.61
REGISTRATION: 55-918646	EASTING: 665508.13
COUNTY: Navajo, Arizona	MP Elevation: 5070.71 feet amsl
DATE COMPLETED: 10/02/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-54 APS CHOLLA POWER PLANT

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2016

FIGURE A-5

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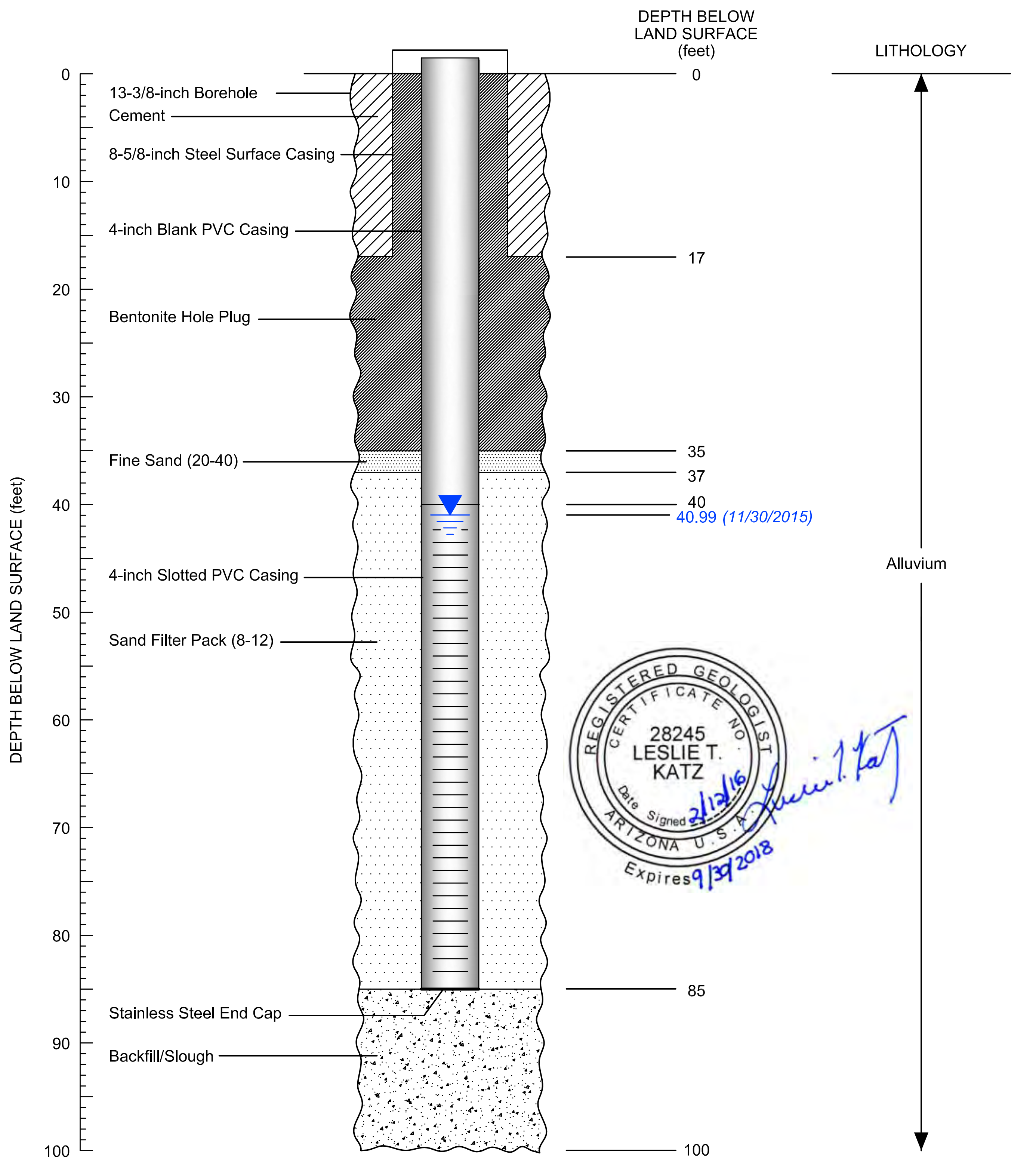

WELL: M-56A (SP-3D)	NORTHING: 1434257.73
REGISTRATION: 55-918661	EASTING: 658887.35
COUNTY: Navajo, Arizona	MP Elevation: 5023.165 feet amsl
DATE COMPLETED: 10/07/15	DATUM: NAD83, State Plane 1983

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-56A APS CHOLLA POWER PLANT

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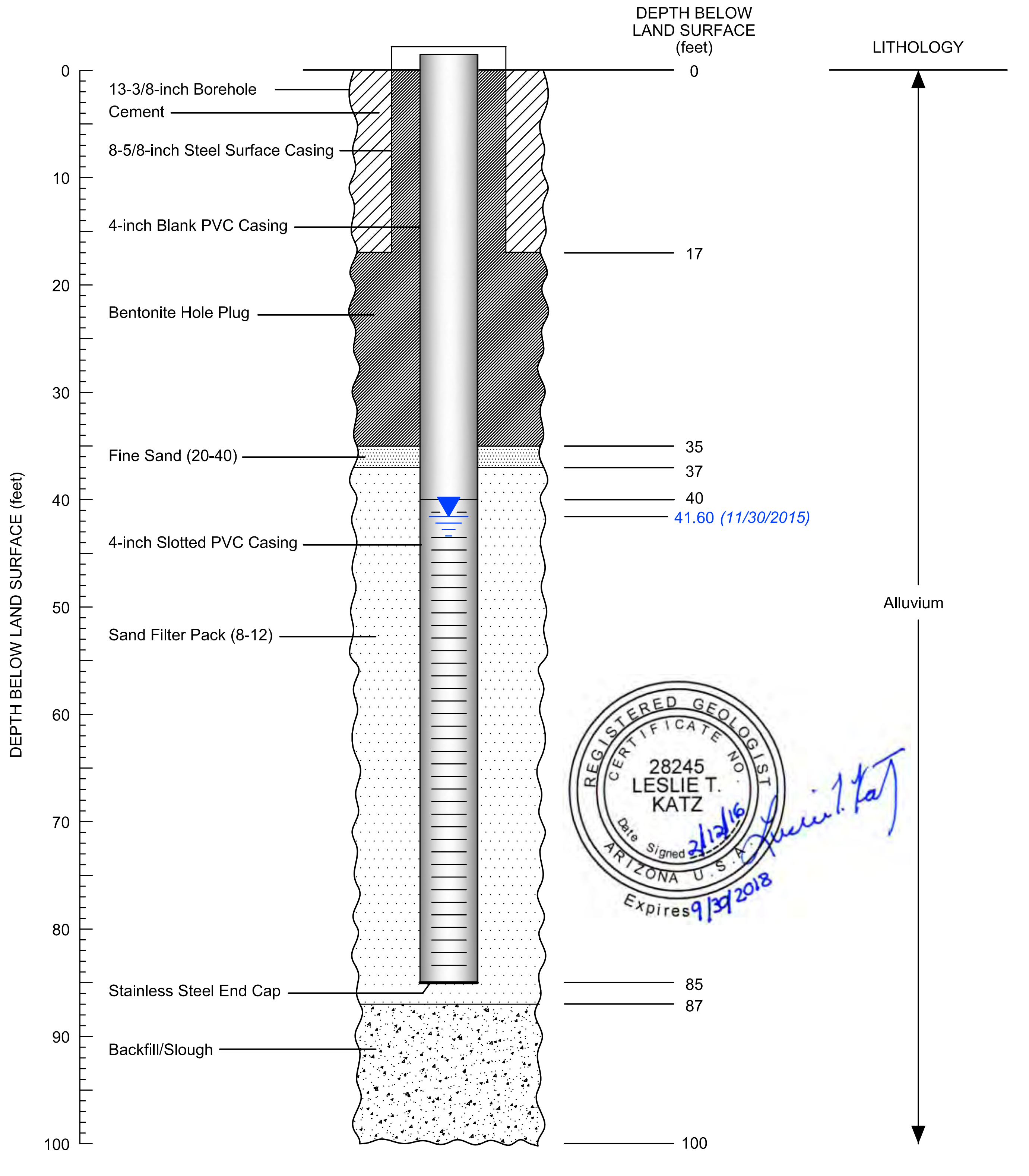

EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-57A (SP-2D)	NORTHING: 1434198.68
REGISTRATION: 55-918660	EASTING: 658767.25
COUNTY: Navajo, Arizona	MP Elevation: 5023.816 feet amsl
DATE COMPLETED: 10/08/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-57A APS CHOLLA POWER PLANT

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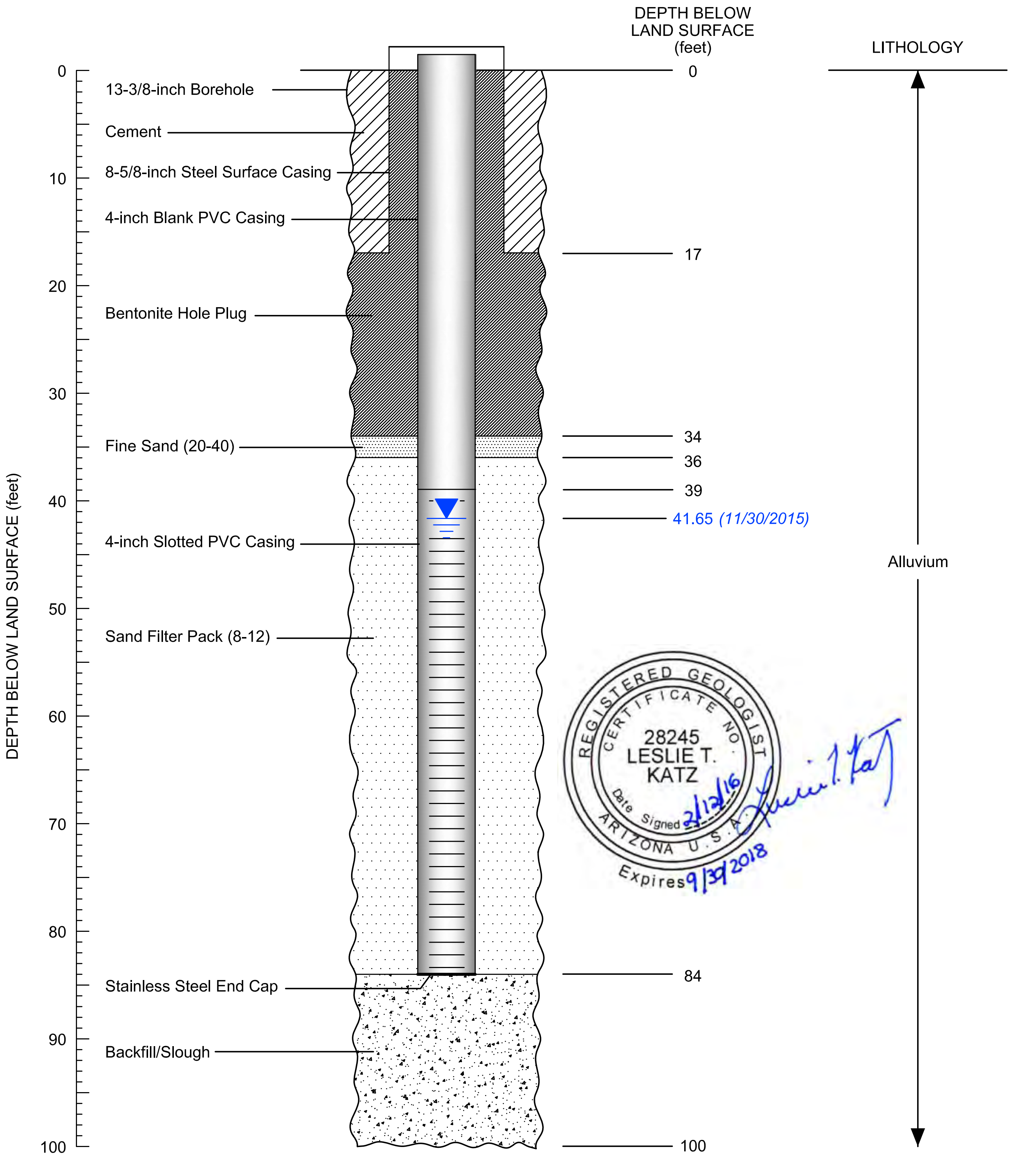

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-58A (SP-1D)	NORTHING: 1434165.11
REGISTRATION: 55-918659	EASTING: 658698.92
COUNTY: Navajo, Arizona	MP Elevation: 5023.841 feet amsl
DATE COMPLETED: 10/13/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-58A APS CHOLLA POWER PLANT

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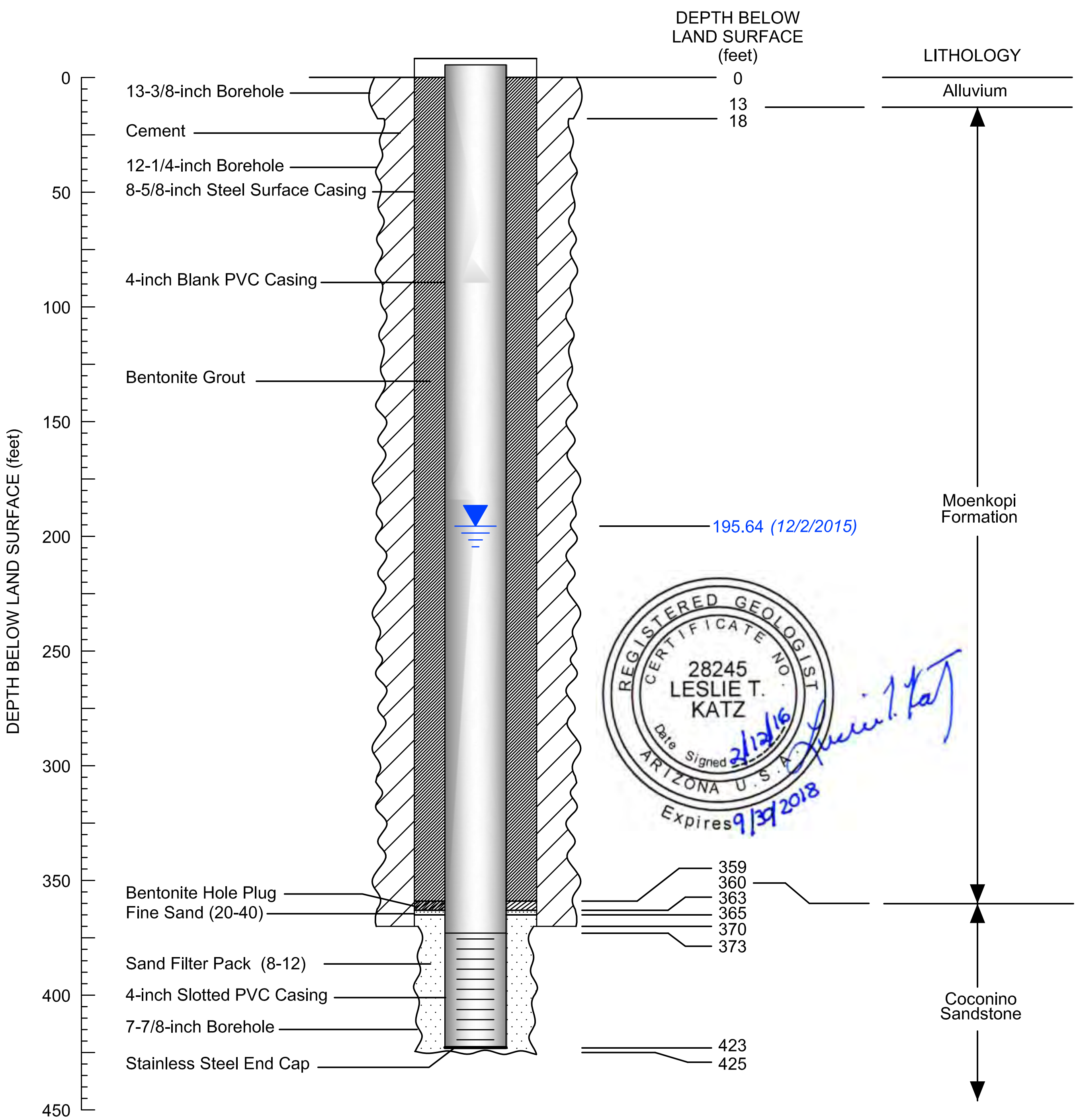

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-59 (BAM-1D)	NORTHING: 1440604.73
REGISTRATION: 55-918647	EASTING: 664161.36
COUNTY: Navajo, Arizona	MP Elevation: 5136.002 feet amsl
DATE COMPLETED: 10/21/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-59 APS CHOLLA POWER PLANT

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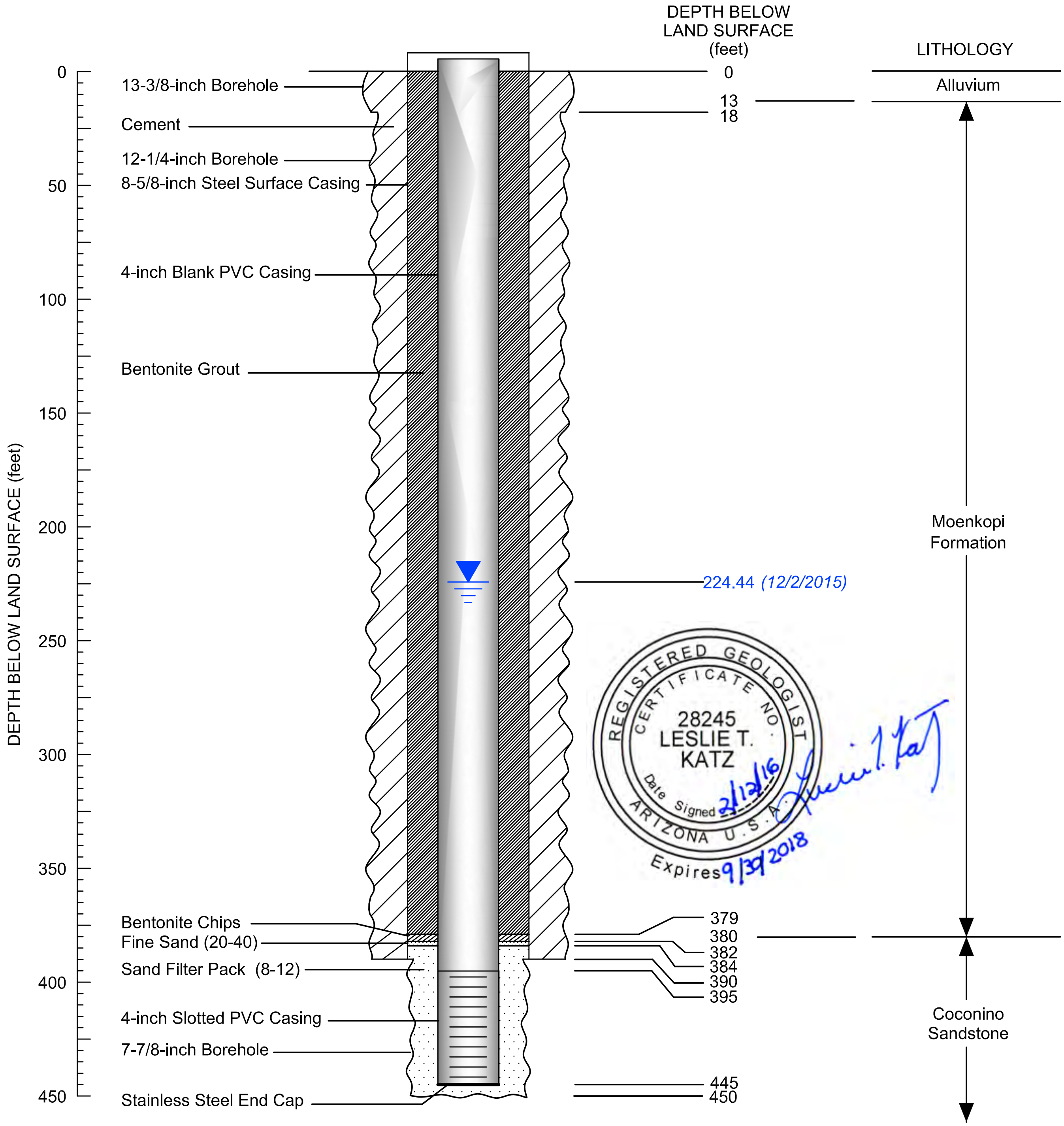

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-60 (BAM-3D)	NORTHING: 1441947.89
REGISTRATION: 55-918649	EASTING: 664249.99
COUNTY: Navajo, Arizona	MP Elevation: 5151.175 feet amsl
DATE COMPLETED: 11/1/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-60 APS CHOLLA POWER PLANT

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2016

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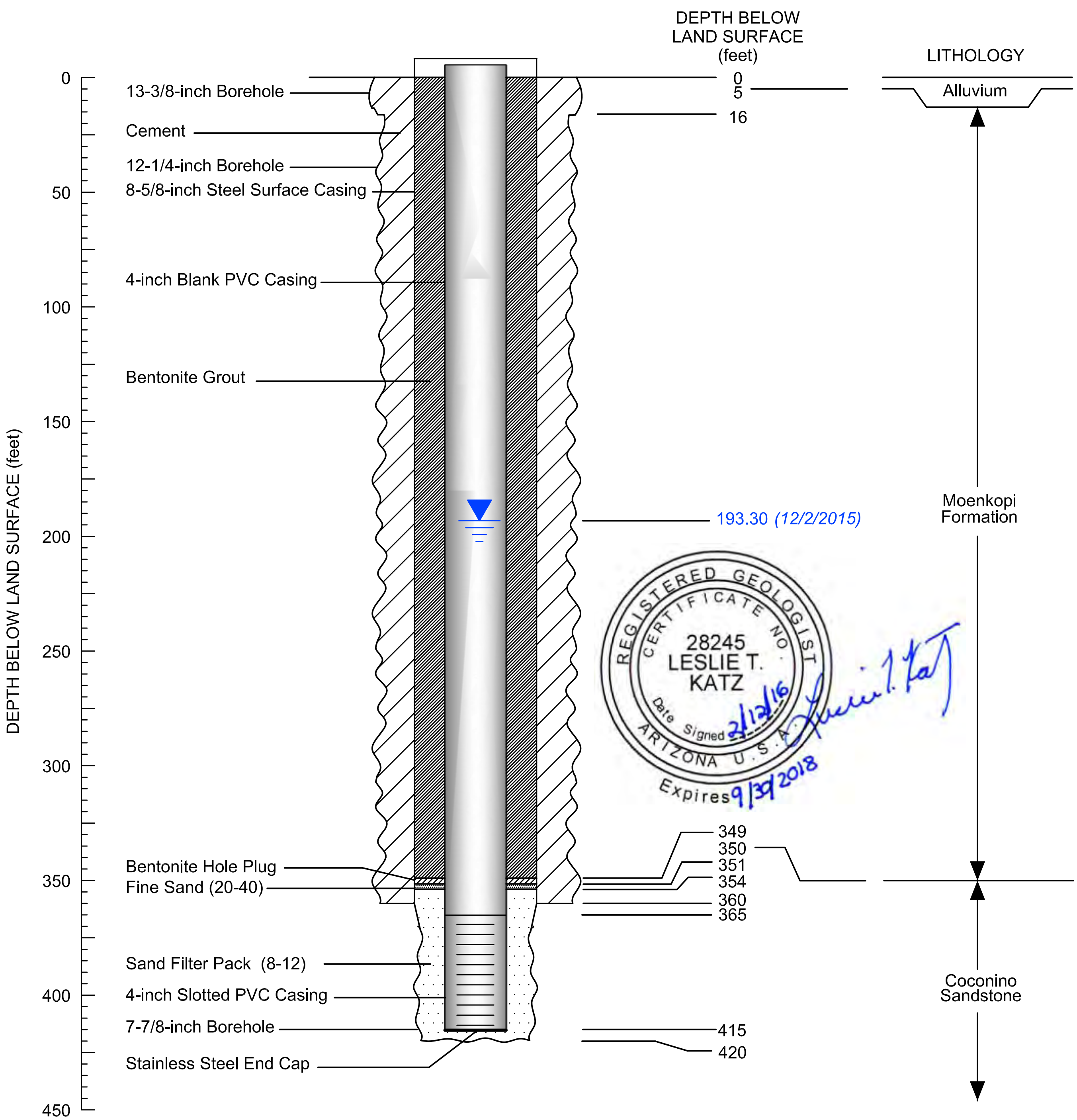

EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-61 (BAM-2D)	NORTHING: 1441383.55
REGISTRATION: 55-918648	EASTING: 664047.00
COUNTY: Navajo, Arizona	MP Elevation: 5127.577 feet amsl
DATE COMPLETED: 11/13/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COCONINO WELL M-61 APS CHOLLA POWER PLANT

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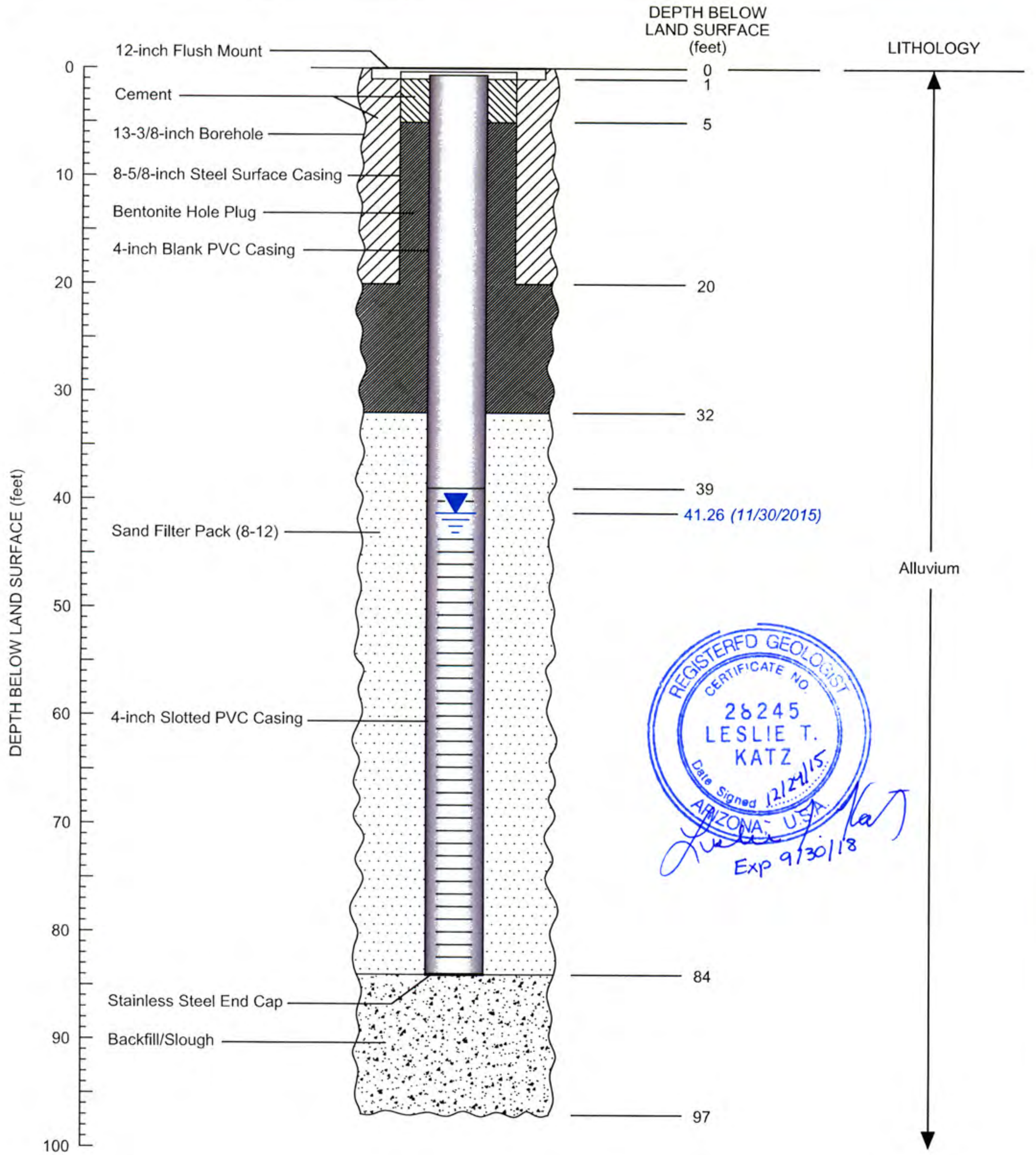

EXPLANATION

▼ Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-62A (SP-1U)	NORTHING: 1434008.665
REGISTRATION: 55-918658	EASTING: 659268.051
COUNTY: Navajo, Arizona	MP Elevation: 5020.874 feet amsl
DATE COMPLETED: 11/17/15	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION
FOR ALLUVIAL WELL M-62A
APS CHOLLA POWER PLANT

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2015

FIGURE A-12

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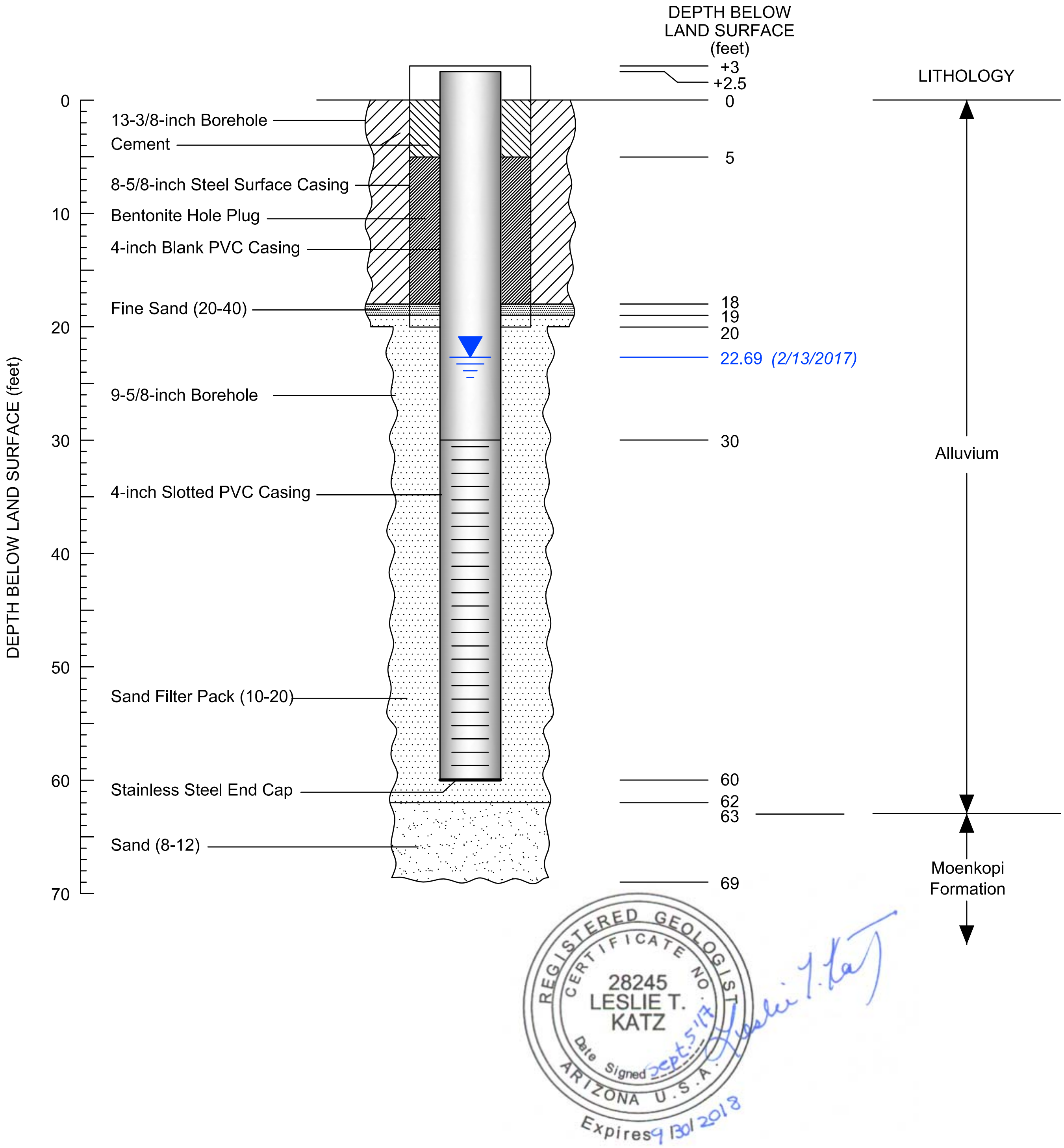

EXPLANATION

Depth to Water Level

Note: All PVC blank and slotted casing is Schedule 80; slot size is 0.020 inches.

WELL: M-64A	NORTHING: 1434030.012
REGISTRATION: 55-920353	EASTING: 647702.043
COUNTY: Navajo, Arizona	MP Elevation: 4,988.904
DATE COMPLETED: 2/9/2017	DATUM: NAD83, State Plane 1983

SCHEMATIC DIAGRAM OF CONSTRUCTION FOR ALLUVIAL WELL M-64A APS CHOLLA POWER PLANT

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2017

FIGURE A-13

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TABLE A-1. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM Monitoring Well M-50A [*55-918641*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 32.0 feet / 5035.649 feet msl	DATE DRILLED: 9/18/2015
CADASTRAL / NAD83 : (A-18-20)30bbc / 1429799.423 N / 669243.755 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded, fine to coarse sand 60%, silt and clay 40%, trace gravel. Gravel fraction: rounded to angular gravel to 1.3 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**CLAYEY SAND (SC)**: Dark reddish gray [5YR4/2]; subangular to rounded, fine to coarse sand 60%, silt and clay 40%, trace gravel. Gravel fraction: rounded to angular gravel to 1 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
10.0 - 15.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 50%, silt and clay 50%, trace gravel. Gravel fraction: rounded to angular gravel to 0.3 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
15.0 - 20.0	**Qal**	**CLAYEY SAND (SC)**: Moderate brown [5YR4/4]; subangular to rounded, fine to coarse sand 60%, silt and clay 30%, gravel 10%. Gravel fraction: gravel to 0.5 in. consisting of gypsum and trace chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
20.0 - 28.0	**Qal**	**WELL GRADED GRAVEL WITH CLAY (GW-GC)**: Yellowish red [5YR4/6]; gravel 80%, subangular to rounded, fine to medium sand 10%, silt and clay 10%. Gravel fraction: gravel to 0.8 in. consisting of gypsum and siltstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: strong.
TRIASSIC MOENKOPI FORMATION (TRm)		
28.0 - 32.0	**TRm**	**WEATHERED SILTSTONE**: Moderate brown [5YR4/4]; Moderately lithified. Well graded. Reaction to acid: strong.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-2. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM Monitoring Well M-51A [*55-918640*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 14.0 feet / 5039.100 feet msl	DATE DRILLED: 9/18/2015
CADASTRAL / NAD83 : (A-18-19)25add / 1430360.144 N / 668733.143 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY GRAVEL WITH SAND (GC)**: Moderate brown [5YR4/4]; gravel 50%, subangular to rounded, fine to coarse sand 25%, silt and clay 25%. Gravel fraction: gravel to 1.6 in. consisting of chert and gypsum. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: strong.
5.0 - 9.0	**Qal**	**WELL GRADED GRAVEL WITH SILT (GW-GM)**: Yellowish red [5YR4/6]; gravel 80%, subangular to rounded, fine to coarse sand 10%, silt and clay 10%. Gravel fraction: gravel to 1.2 in. consisting of weathered siltstone and fine sandstone, and trace gypsum. Weakly lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
9.0 - 14.0	**TRm**	**WEATHERED SILTSTONE AND FINE SANDSTONE WITH TRACE GYPSUM**: Moderate brown [5YR4/4]; Moderately lithified. Reaction to acid: strong.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-3. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-52A [*55-918657*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 38.0 feet / 5047.080 feet msl	DATE DRILLED: 9/21 - 9/22/2015
CADASTRAL / NAD83 : (A-18-19)24bbc / 1437475.711 N / 663614.281 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded, fine to medium sand 65%, silt and clay 30%, gravel 5%. Gravel fraction: gravel to 0.6 in. consisting of multicolored chert. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**CLAYEY SAND (SC)**: Reddish brown [5YR4/3]; subangular to rounded, fine to medium sand 65%, silt and clay 30%, gravel 5%. Gravel fraction: gravel to 0.4 in. consisting of multicolored chert. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: strong.
10.0 - 15.0	**Qal**	**SILTY GRAVEL WITH SAND (GM)**: Reddish brown [5YR4/3]; gravel 50%, subangular to rounded, fine to coarse sand 30%, silt and clay 20%. Gravel fraction: gravel to 0.9 in. consisting of multicolored chert. Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 55%, gravel 30%, silt and clay 15%. Gravel fraction: gravel to 0.8 in. consisting of multicolored chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Dark reddish gray [5YR4/2]; subangular fine sand 65%, gravel 25%, silt and clay 10%. Gravel fraction: gravel to 0.7 in. consisting of multicolored chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Dark reddish gray [5YR4/2]; subangular to rounded fine sand 65%, gravel 25%, silt and clay 10%. Gravel fraction: gravel to 0.9 in. consisting of multicolored chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.4 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 80%, gravel 10%, silt and clay 10%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.4 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-3. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-52A [*55-918657*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.6 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; angular to rounded fine sand 85%, silt and clay 10%, gravel 5%. Gravel fraction: gravel to 0.3 in. consisting of chert, fine grained brown sandstone, and trace siltstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Moderate brown [5YR4/4]; angular to rounded fine sand 65%, gravel 25%, silt and clay 10%. Gravel fraction: gravel to 2.3 in. consisting of fine grained brown sandstone, green sandy siltstone, and trace chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
65.0 - 70.0	**Qal**	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**: Moderate brown [5YR4/4]; gravel 60%, angular to rounded fine sand 30%, silt and clay 10%. Gravel fraction: gravel to 2.6 in. consisting of chert, fine grained brown sandstone, and green sandy siltstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
70.0 - 75.0	**Qal**	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**: Moderate brown [5YR4/4]; gravel 70%, angular to rounded fine sand 20%, silt and clay 10%. Gravel fraction: gravel to 0.6 in. consisting of fine grained brown sandstone, red and green sandy siltstone, and trace chert. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
75.0 - 79.0	**Qal**	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)**: Moderate brown [5YR4/4]; gravel 70%, angular to rounded fine sand 20%, silt and clay 10%. Gravel fraction: gravel to 1.4 in. consisting of fine grained brown sandstone, red and green sandy siltstone, and trace chert. Non-lithified to moderately lithified. Low to medium plasticity. Well graded. Reaction to acid: weak to moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
79.0 - 83.0	**TRm**	**SANDSTONE AND SILTSTONE**: Moderate brown [5YR4/4]; Weakly to moderately lithified. Reaction to acid: weak to moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-4. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-53A [*55-918651*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National	LOGGED BY: C. Stielstra
DEPTH DRILLED / LAND SURFACE ELEVATION: 83.0 feet / 5042.094 feet msl	DATE DRILLED: 9/21 - 9/22/2015
CADASTRAL / NAD83 : (A-18-19)23aab / 1437605.112 N / 662529.371 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 60%, silt and clay 25%, gravel 15%. Gravel fraction: gravel to 1.2 in. consisting of chert and black rock (fill). Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
5.0 - 10.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 60%, silt and clay 25%, gravel 15%. Gravel fraction: gravel to 0.7 in. consisting of chert and black rock (fill). Non-lithified. Low to medium plasticity. Well graded. Reaction to acid: moderate.
10.0 - 15.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 80%, gravel 10%, silt and clay 10%. Gravel fraction: gravel to 1.2 in. consisting of chert and black rock (fill). Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR4/3]; gravel 80%, subangular to rounded fine sand 15%, silt and clay 5%. Gravel fraction: gravel to 0.8 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 75%, gravel 15%, silt and clay 10%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Reddish brown [5YR4/3]; subangular to rounded fine sand 70%, gravel 20%, silt and clay 10%. Gravel fraction: gravel to 0.5 in. consisting of chert and fine grained brown sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
30.0 - 34.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR4/3]; gravel 70%, subangular to rounded fine sand 25%, silt and clay 5%. Gravel fraction: gravel to 0.9 in. consisting of chert, fine grained brown sandstone, and reddish-brown and green siltstone. Non-lithified to moderately lithified. Low plasticity. Well graded. Reaction to acid: moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		
34.0 - 38.0	**TRm**	**FINE GRAINED SANDSTONE AND SILTSTONE**: Moderate brown [5YR4/4]; Moderately to well lithified. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps — LOGGED BY: C. Stielstra

DEPTH DRILLED / LAND SURFACE ELEVATION: 370.0 feet / 5068.208 feet msl — DATE DRILLED: 9/23 - 10/2/2015

CADASTRAL / NAD83 : (A-18-19)13cab / 1440088.611 N / 665508.134 E

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 10	**Qal**	alluvium; moderate brown [5YR4/4]; non-lithified to weakly lithified; reddish-brown and green siltstone; reaction to acid: weak	weathered, clayey cuttings	ARCH, Air Rotary; chips to 1 in
10 - 19	**Qal**	alluvium; moderate brown [5YR4/4]; non-lithified to weakly lithified; reddish-brown and green siltstone; fine grained sandstone; reaction to acid: weak	weathered, clayey cuttings	chips to 0.9 in
TRIASSIC MOENKOPI FORMATION (TRm)				
19 - 30	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; fine grained green sandstone; reaction to acid: weak		chips to 0.7 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; fine grained green sandstone; reaction to acid: weak to moderate	trace clay in cuttings	chips to 1.4 in
40 - 50	**TRm**	sandy siltstone; reddish brown [5YR4/3]; weakly to moderately lithified; reddish-brown siltstone; trace green siltstone; reaction to acid: weak to moderate	clayey cuttings	platy subangular-rounded chips to 0.9 in
50 - 60	**TRm**	sandy siltstone; dark reddish gray [5YR4/2]; moderately to well lithified; dark gray fine-grained sandstone; trace red and green siltstone; reaction to acid: weak		platy subangular-rounded chips to 0.5 in
60 - 70	**TRm**	sandy siltstone; yellowish red [5YR4/6], dark reddish gray [5YR4/2]; moderately to well lithified; reddish-brown siltstone; green fine-grained sandstone; dark grey, fine-grained sandstone; reaction to acid: weak to moderate	trace clay in cuttings	platy subangular-rounded chips to 0.9 in
70 - 80	**TRm**	sandy siltstone; moderate brown [5YR4/4]; weakly to moderately lithified; reddish-brown siltstone; trace green siltstone; reaction to acid: moderate to strong	trace clay in cuttings	platy subangular chips to 0.9 in
80 - 90	**TRm**	sandy siltstone; yellowish red [5YR4/6]; weakly to moderately lithified; reddish-brown siltstone; brown silty sandstone; reaction to acid: strong	trace clay in cuttings	platy subangular chips to 0.7 in

TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
90 - 100	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate to strong		platy subangular chips to 0.6 in
100 - 110	**TRm**	sandy siltstone; moderate brown [5YR4/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate to strong		platy subangular chips to 0.6 in
110 - 120	**TRm**	sandy siltstone; yellowish red [5YR4/6]; moderately to moderately lithified; reddish-brown and green siltstone; reaction to acid: strong		platy subangular chips to 0.8 in
120 - 130	**TRm**	sandy siltstone; yellowish red [5YR4/6]; moderately to moderately lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate	trace clay in cuttings	platy subangular chips to 0.6 in
130 - 140	**TRm**	sandy siltstone; yellowish red [5YR4/6]; moderately to moderately lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate	trace clay in cuttings	platy subangular chips to 0.7 in
140 - 150	**TRm**	sandy siltstone; yellowish red [5YR4/6], dark reddish brown [5YR3/2]; moderately to well lithified; reddish-brown and green siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: weak to moderate	trace clay in cuttings	platy subangular-angular chips to 0.9 in
150 - 160	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to moderately lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: moderate		platy subangular-angular chips to 0.7 in
170 - 180	**TRm**	sandy siltstone; very dark brown [5YR2.5/2]; moderately to well lithified; dark gray fine-grained sandstone; trace fine green sandstone; reaction to acid: moderate to strong		platy rounded chips to 0.6 in
180 - 190	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.6 in

TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
190 - 200	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.9 in
200 - 210	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; reddish-brown and green siltstone; trace gypsum; reaction to acid: weak to moderate		platy subangular-angular chips to 0.8 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; gypsum; reaction to acid: moderate to strong		platy subangular-angular chips to 0.9 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown and green siltstone; gypsum; reaction to acid: moderate to strong		platy subangular-angular chips to 0.9 in
230 - 240	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: moderate to strong		platy subangular-angular chips to 0.7 in
240 - 250	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; well to well lithified; reddish-brown siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: strong		platy subangular-angular chips to 0.8 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; reddish-brown siltstone; dark gray fine-grained sandstone; trace gypsum; reaction to acid: strong		platy subangular-angular chips to 0.7 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; well to well lithified; fine dark reddish brown sandstone; reddish siltstone; trace tan sandstone; reaction to acid: moderate to strong		platy rounded chips to 0.7 in
270 - 280	**TRm**	sandy siltstone; moderate brown [5YR4/4]; well to well lithified; fine dark reddish brown sandstone; reaction to acid: moderate to strong		platy rounded chips to 0.5 in
280 - 290	**TRm**	sandy siltstone; moderate brown [5YR4/4]; well to well lithified; fine dark reddish brown sandstone; reaction to acid: weak to moderate		platy rounded chips to 0.6 in

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TABLE A-5. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-54 [*55-918646*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
290 - 302	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], moderate brown [5YR4/4]; weakly to moderately lithified; fine dark reddish brown sandstone; reddish siltstone; trace green siltstone; reaction to acid: moderate to strong		platy subrounded-angular chips to 0.9 in
PERMIAN COCONINO SANDSTONE (Pc)				
302 - 310	**Pc**	fine sandstone; gray [5YR5/1], dark reddish brown [5YR3/3]; weakly to well lithified; fine reddish brown sandstone; fine gray sandstone; very fine buff sandstone; reaction to acid: weak to moderate		platy subrounded-subangular chips to 0.9 in
310 - 320	**Pc**	fine sandstone; light reddish brown [5YR6/3]; weakly to weakly lithified; very fine buff/tan sandstone; trace red clay; reaction to acid: weak to moderate		mostly pulverized; rounded chips to 0.4 in
320 - 330	**Pc**	fine sandstone; light yellowish brown [2.5Y6/3]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: weak to moderate		mostly pulverized; rounded chips to 0.4 in
330 - 340	**Pc**	fine sandstone; light gray [2.5Y7/2]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: moderate to strong		mostly pulverized; rounded chips to 0.2 in
340 - 350	**Pc**	fine sandstone; light gray [2.5Y7/2]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: moderate		mostly pulverized; rounded chips to 0.3 in
350 - 360	**Pc**	fine sandstone; light gray [2.5Y7/1]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: strong		mostly pulverized; rounded chips to 0.3 in
360 - 370	**Pc**	fine sandstone; light gray [2.5Y7/1]; weakly to weakly lithified; very fine buff/tan sandstone; reaction to acid: strong		mostly pulverized; rounded chips to 0.4 in

TABLE A-6. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-56A [*55-918661*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps — LOGGED BY: J. Laney, C. Stielstra

DEPTH DRILLED / LAND SURFACE ELEVATION: 100.0 feet / 5020.630 feet msl — DATE DRILLED: 10/4 - 10/7/2015

CADASTRAL / NAD83 : (A-18-19)23cbc / 1434257.733 N / 658887.345 E

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 65%, rounded fine sand 25%, gravel 10%. Gravel fraction: subangular gravel to 0.5 in. consisting of chert, coal (fill), and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong. Disturbed surface sample. Disturbed surface sample.
5.0 - 10.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 65%, rounded fine sand 30%, gravel 5%. Gravel fraction: subangular gravel to 0.2 in. consisting of chert, coal (fill), and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong. Disturbed surface sample. Disturbed surface sample.
10.0 - 15.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 20%, trace gravel. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Poorly graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 70%, rounded very fine sand 30%, trace gravel. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded very fine sand 15%, gravel 10%. Gravel fraction: subangular gravel to 0.2 in. consisting of chert, sandstone, and quartz. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 15%, gravel 5%. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 90%, rounded very fine sand 10%, trace gravel. Gravel fraction: subangular gravel to 0.1 in. consisting of chert. Non-lithified. High plasticity. Poorly graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt 95%, rounded very fine sand 5%. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SILTY SAND WITH GRAVEL (SM)**: Dark reddish gray [5YR4/2]; rounded very fine sand 45%, silt 40%, gravel 15%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert, sandstone, and green siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-6. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-56A [*55-918661*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded fine sand 80%, gravel 15%, silt 5%. Gravel fraction: subangular gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 75%, gravel 20%, silt 5%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 75%, gravel 25%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 70%, gravel 30%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
70.0 - 75.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subrounded gravel to 0.3 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subrounded gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
80.0 - 85.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded fine sand 20%. Gravel fraction: subangular to rounded gravel to 1.6 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
85.0 - 90.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded, fine to medium sand 20%. Gravel fraction: subangular to rounded gravel to 1.6 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
90.0 - 95.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 75%, subrounded, fine to coarse sand 20%, silt 5%. Gravel fraction: subangular to rounded gravel to 2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-6. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-56A [*55-918661*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
95.0 - 100.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, subrounded, fine to coarse sand 20%. Gravel fraction: angular to rounded gravel to 3.1 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-7. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-57A [*55-918660*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 100.0 feet / 5021.164 feet msl	DATE DRILLED: 10/7 - 10/8/2015
CADASTRAL / NAD83 : (A-18-19)23cbc / 1434198.679 N / 658767.25 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	Qal	**CLAYEY GRAVEL WITH SAND (GC)**: Dark reddish gray [5YR4/2]; silt and clay 50%, gravel 30%, rounded fine sand 20%. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, coal. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate. Disturbed surface sample. Disturbed surface sample.
5.0 - 10.0	Qal	**CLAYEY GRAVEL WITH SAND (GC)**: Dark reddish gray [5YR4/2]; silt and clay 50%, gravel 30%, rounded fine sand 20%. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, coal. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate. Disturbed surface sample. Disturbed surface sample.
10.0 - 15.0	Qal	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 60%, rounded very fine sand 30%, gravel 10%. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert, sandstone. Non-lithified. High plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	Qal	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded very fine sand 25%, trace gravel. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	Qal	**SANDY LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 20%, trace gravel. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	Qal	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 15%, gravel 5%. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert, sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	Qal	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 80%, gravel 10%, rounded very fine sand 10%. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of chert, sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	Qal	**FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 95%, rounded very fine sand 5%, trace gravel. Non-lithified. High plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	Qal	**SILTY SAND WITH GRAVEL (SM)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 60%, silt and clay 35%, gravel 5%. Gravel fraction: subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-7. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-57A [*55-918660*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 80%, gravel 10%, silt 10%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: weak.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 65%, gravel 30%, silt 5%. Gravel fraction: subangular to rounded gravel to 0.8 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Poorly graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 15%, silt 5%. Gravel fraction: subrounded to rounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 60%, gravel 40%, trace silt. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 70%, gravel 30%, trace silt. Gravel fraction: subangular to subrounded gravel to 2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
70.0 - 75.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 20%, trace silt. Gravel fraction: subangular to rounded gravel to 1.2 in. consisting of chert, sandstone, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%, trace silt. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
80.0 - 85.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded, fine to coarse sand 20%, trace silt. Gravel fraction: subangular to rounded gravel to 2.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
85.0 - 90.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 70%, gravel 30%, trace silt. Gravel fraction: subangular to rounded gravel to 0.4 in. consisting of chert, sandstone, and petrified wood. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-7. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-57A [*55-918660*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
90.0 - 95.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 60%, gravel 40%, trace silt. Gravel fraction: subangular to subrounded gravel to 1.2 in. consisting of chert, sandstone, and petrified wood. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
95.0 - 100.0	**Qal**	**WELL GRADED GRAVEL WITH SAND (GW)**: Reddish brown [5YR5/3]; gravel 80%, rounded, fine to coarse sand 20%, trace silt. Gravel fraction: subangular to rounded gravel to 2 in. consisting of chert, sandstone, and petrified wood. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-8. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-58A [*55-918659*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 100.0 feet / 5021.237 feet msl	DATE DRILLED: 10/8 - 10/13/2015
CADASTRAL / NAD83 : (A-18-19)23cbc / 1434165.11 N / 658698.919 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 65%, rounded, very fine to fine sand 25%, gravel 10%. Gravel fraction: subrounded gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
5.0 - 10.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded, very fine to fine sand 20%, gravel 5%. Gravel fraction: subrounded gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate to strong.
10.0 - 15.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded, very fine to fine sand 20%, trace gravel. Gravel fraction: angular gravel to 0.4 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
15.0 - 20.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 70%, rounded very fine sand 30%, trace gravel. Gravel fraction: angular gravel to 0.2 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded very fine sand 25%, trace gravel. Gravel fraction: angular gravel to 0.2 in. consisting of chert. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
25.0 - 30.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 85%, rounded very fine sand 15%. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
30.0 - 35.0	**Qal**	**LEAN CLAY (CL)**: Dark reddish gray [5YR4/2]; silt and clay 90%, rounded very fine sand 10%. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 80%, rounded very fine sand 20%. Non-lithified. Medium plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SILTY SAND (SM)**: Dark reddish gray [5YR4/2]; rounded fine sand 50%, silt and clay 40%, gravel 10%. Gravel fraction: subangular to rounded gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: moderate.
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 50%, gravel 40%, silt 10%. Gravel fraction: subangular to rounded gravel to 2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-8. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-58A [*55-918659*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 1.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subangular to subrounded gravel to 2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 70%, gravel 30%. Gravel fraction: subangular to subrounded gravel to 1.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 85%, gravel 15%. Gravel fraction: subangular to subrounded gravel to 0.4 in. consisting of sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
70.0 - 75.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subangular to subrounded gravel to 0.2 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Reddish brown [5YR5/3]; rounded, very fine to fine sand 90%, gravel 10%. Gravel fraction: subangular to subrounded gravel to 0.1 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
80.0 - 85.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 0.4 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
85.0 - 90.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to medium sand 80%, gravel 20%. Gravel fraction: subangular to subrounded gravel to 0.6 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
90.0 - 95.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 70%, gravel 30%. Gravel fraction: subangular to subrounded gravel to 2 in. consisting of sandstone and chert. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
95.0 - 100.0	**Qal**	**WELL GRADED SAND WITH GRAVEL (SW)**: Reddish brown [5YR5/3]; rounded, fine to coarse sand 70%, gravel 30%. Gravel fraction: subangular to rounded gravel to 2.4 in. consisting of sandstone, chert, and siltstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 425.0 feet / 5133.863 feet msl	DATE DRILLED: 10/14 - 10/21/2015
CADASTRAL / NAD83 : (A-18-19)13cbb / 1440604.729 N / 664161.355 E	

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 13	**Qal**	alluvium; brownish gray [5YR4/1]; 60% sand (subrounded, fine to coarse); 30% gravel (subangular to rounded, consisting of sandstone and chert); 10% silt; reaction to acid: weak		ARCH, Air Rotary; poorly sorted
TRIASSIC MOENKOPI FORMATION (TRm)				
13 - 20	**TRm**	sandy siltstone; moderate brown [5YR4/4]; non-lithified; 90% reddish brown siltstone; 10% fine-grained gray sandstone; reaction to acid: weak		subangular chips to 1.2 in
20 - 30	**TRm**	sandy siltstone; moderate brown [5YR4/4]; moderately to well lithified; 90% reddish brown siltstone; 10% fine-grained gray sandstone; reaction to acid: weak		subangular chips to 1.2 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; moderately to well lithified; 60% reddish brown siltstone; 40% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.8 in
40 - 50	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 50% reddish brown siltstone; 50% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.8 in
50 - 60	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 50% reddish brown siltstone; 50% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 1 in
60 - 70	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 80% reddish brown siltstone; 20% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 1 in
70 - 80	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; weakly lithified; 60% reddish brown siltstone; 40% blue gray sandstone; platy; reaction to acid: weak		subrounded to subangular chips to 1.2 in
80 - 90	**TRm**	sandy siltstone; gray [5YR5/1]; moderately to well lithified; reddish gray medium to fine-grained sandstone; reaction to acid: none		subrounded chips to 0.4 in

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
90 - 100	**TRm**	sandy siltstone; gray [5YR5/1], dark reddish brown [5YR3/4]; weakly to well lithified; reddish gray medium to fine-grained sandstone; reddish brown siltstone; trace blue green siltstone; platy; reaction to acid: none		subrounded to subangular chips to 0.8 in
100 - 110	**TRm**	sandy siltstone; gray [5YR5/1]; moderately to well lithified; reddish gray medium to fine-grained sandstone; reaction to acid: none		subrounded chips to 0.4 in
110 - 120	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], light greenish gray [5BG7/1]; weakly lithified; 50% reddish brown siltstone; 50% blue gray siltstone; platy; reaction to acid: none		subangular chips to 0.8 in
120 - 130	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 70% reddish brown siltstone; 30% blue gray siltsone; platy; reaction to acid: weak		subangular chips to 0.8 in
130 - 140	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 90% reddish brown siltstone; 10% blue gray siltsone; trace gypsum; platy; reaction to acid: moderate	clayey cuttings	subangular chips to 0.8 in
140 - 150	**TRm**	sandy siltstone; light greenish gray [5BG7/1], gray [5YR5/1]; weakly to moderately lithified; 60% reddish brown siltstone; 40% blue gray siltsone; trace gypsum; reaction to acid: weak		subangular chips to 0.4 in
150 - 160	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 90% reddish brown siltstone; 5% blue gray siltsone; 5% gypsum; platy; reaction to acid: none		subangular to subrounded chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; light greenish gray [5BG7/1], dark reddish brown [5YR3/3]; weakly to moderately lithified; 40% reddish brown siltstone; 60% blue gray sandstone; platy; reaction to acid: weak		subangular chips to 0.4 in
170 - 180	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly lithified; 80% reddish brown siltstone; 20% blue gray siltstone; platy; reaction to acid: none	clayey cuttings	subangular chips to 0.6 in

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
180 - 190	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; weakly to moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; platy; reaction to acid: none		subangular chips to 0.4 in
190 - 200	**TRm**	sandy siltstone; light greenish gray [5BG7/1], dark reddish brown [5YR3/4]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.4 in
200 - 210	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.8 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: weak		subangular chips to 0.4 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately lithified; 80% reddish brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.4 in
230 - 240	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 80% reddish brown siltstone; 15% blue gray sandstone (very fine to fine-grained); 5% gypsum needle crystals; reaction to acid: weak		subangular to subrounded chips to 0.4 in
240 - 250	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 70% reddish brown sandstone (very fine to fine-grained); 30% blue gray sandstone (very fine to fine-grained); trace gypsum needle crystals; reaction to acid: weak		subangular chips to 0.4 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 80% reddish brown sandstone (very fine to fine-grained); 15% blue gray sandstone (very fine to fine-grained); 5% gypsum needle crystals; reaction to acid: moderate		subangular chips to 0.4 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1]; moderately to well lithified; 45% reddish brown sandstone (very fine to fine-grained); 45% reddish brown siltstone; 10% blue gray sandstone (very fine to fine-grained); trace gypsum; reaction to acid: strong		subangular chips to 0.4 in

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TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
270 - 280	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light gray [2.5Y7/2]; well lithified; reddish brown siltstone and sandstone; greenish-tan fine-grained sandstone; reaction to acid: moderate		subangular to subrounded chips to 0.4 in
280 - 290	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light gray [2.5Y7/2]; moderately to well lithified; 80% reddish brown siltstone; 20% red to green very fine-grained sandstone; reaction to acid: strong		subangular chips to 0.4 in
290 - 300	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light gray [2.5Y7/2]; moderately to well lithified; 80% reddish brown siltstone; 20% green-tan grained sandstone (very fine to fine-grained); reaction to acid: strong		subangular chips to 0.4 in
300 - 310	**TRm**	sandy siltstone; dark reddish brown [5YR3/4]; moderately to well lithified; 50% reddish brown siltstone; 50% reddish brown sandstone (very fine to fine-grained); reaction to acid: weak		subangular chips to 0.4 in
310 - 320	**TRm**	sandy siltstone; dark reddish brown [5YR3/4], light greenish gray [5BG7/1], light brown [5YR6/4]; moderately to well lithified; 80% reddish brown sandstone (very fine to fine-grained); 15% blue gray sandstone (very fine to fine-grained); 5% tan sandstone (fine-grained); reaction to acid: moderate		subrounded chips to 0.4 in
320 - 330	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; dark reddish brown sandstone (fine-grained); reaction to acid: none		subrounded chips to 0.4 in
330 - 340	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; dark reddish brown sandstone (fine-grained); reaction to acid: none		subrounded chips to 0.4 in
340 - 350	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; dark reddish brown sandstone (fine-grained); trace light brown sandstone; reaction to acid: none		subrounded chips to 0.4 in
350 - 360	**TRm**	sandy siltstone; dark reddish brown [5YR3/3], gray [5YR5/1]; moderately to well lithified; dark reddish brown sandstone (very fine to fine-grained); reaction to acid: none		subangular to angular chips to 0.4 in

TABLE A-9. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-59 [*55-918647*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PERMIAN COCONINO SANDSTONE (Pc)				
360 - 370	**Pc**	fine sandstone; pale red [2.5YR6/2]; well lithified; greyish tan sandstone (very fine to fine-grained); reaction to acid: weak		subangular chips to 0.6 in
370 - 380	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: strong		mostly pulverized to fine sand; trace rounded chips to 0.2 in
380 - 390	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: strong		pulverized; very fine to fine sand
390 - 400	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: moderate		mostly pulverized to fine sand; trace rounded chips to 0.2 in
400 - 410	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: weak		mostly pulverized to fine sand; trace rounded chips to 0.2 in
410 - 420	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: weak		mostly pulverized to fine sand; trace rounded chips to 0.2 in
420 - 425	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine to fine-grained, rounded, well sorted quartz grains); reaction to acid: weak		mostly pulverized to fine sand; trace rounded chips to 0.2 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps — LOGGED BY: J. Laney

DEPTH DRILLED / LAND SURFACE ELEVATION: 450.0 feet / 5148.694 feet msl — DATE DRILLED: 10/21 - 11/1/2015

CADASTRAL / NAD83 : (A-18-19)13bac / 1441947.886 N / 664249.994 E

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 14	**Qal**	alluvium; grayish orange [10YR7/4]; non-lithified to non lithified; 60% medium to high plasticity clay; 20% very fine to coarse subrounded sand; 20% gravel consisting of sandstone and chert; CL sandy loam clay with gravel; reaction to acid: moderate		ARCH, Air Rotary; subrounded-subangular chips to 0.8 in
TRIASSIC MOENKOPI FORMATION (TRm)				
14 - 20	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; 50% red brown siltstone; 40% blue gray siltstone; 10% gray fine-grained sandstone; reaction to acid: strong		subangular chips to 0.8 in
20 - 30	**TRm**	sandy siltstone; dark reddish brown [5YR3/3]; moderately to well lithified; 50% red brown siltstone; 40% blue gray siltstone; 10% gray fine-grained sandstone; reaction to acid: strong		subangular chips to 0.8 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; moderately to well lithified; 90% red brown siltstone; 10% blue gray siltstone; platy clayey cuttings; reaction to acid: strong		subangular chips to 0.4 in
40 - 50	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; weakly to moderately lithified; 70% red brown siltstone; 30% blue gray siltstone; platy; reaction to acid: strong		subangular chips to 0.4 in
50 - 60	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; weakly to moderately lithified; 70% red brown siltstone; 30% blue gray siltstone; platy; reaction to acid: moderate		subangular chips to 0.6 in
60 - 70	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; weakly to moderately lithified; 80% red brown siltstone; 20% blue gray siltstone; platy; reaction to acid: moderate		subangular chips to 0.4 in
70 - 80	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: moderate		rounded-subrounded chips to 0.8 in
80 - 90	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; Reddish gray fine- to medium-grained sandstone; reaction to acid: moderate		subrounded-subangular chips to 0.4 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
90 - 100	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; 90% red gray to blue gray fine- to medium-grained sandstone; 10% red brown siltstone; reaction to acid: moderate		subrounded-subangular chips to 0.8 in
100 - 110	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: moderate		rounded-subrounded chips to 0.4 in
110 - 120	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: moderate		rounded-subrounded chips to 0.4 in
120 - 130	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], dark reddish gray [2.5YR4/1]; moderately to well lithified; 80% red brown siltstone; 20% dark gray fine- to medium-grained sandstone; reaction to acid: moderate		subangular-subrounded chips to 0.8 in
130 - 140	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; well lithified; Dark gray fine- to medium-grained sandstone; reaction to acid: strong		rounded-subrounded chips to 0.6 in
140 - 150	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown / blue gray siltstone; 40% red brown fine-grained sandstone; platy siltstone; reaction to acid: weak		subangular chips to 0.8 in
150 - 160	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 50% red brown siltstone; 50% red brown / blue gray fine- to medium-grained sandstone; platy siltstone; reaction to acid: weak		subangular chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; weak red [2.5YR5/2], light blue green [5BG6/6]; moderately to well lithified; 60% red gray / blue gray fine-grained sandstone; 40% red brown siltstone; reaction to acid: weak		subangular chips to 0.6 in
170 - 180	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red siltstone; 10% blue gray fine-grained sandstone; trace gypsum; reaction to acid: moderate		subangular chips to 0.6 in
180 - 190	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], dark reddish gray [2.5YR4/1]; moderately to well lithified; 70% red brown siltstone; 30% dark gray fine- to medium-grained sandstone; reaction to acid: weak		subangular-subrounded chips to 0.4 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
190 - 200	**TRm**	sandy siltstone; dark reddish gray [2.5YR4/1]; moderately to well lithified; Dark gray / red gray fine to medium-grained sandstone; trace gypsum; reaction to acid: weak		subrounded chips to 0.4 in
200 - 210	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown siltstone; 40% red brown / blue gray fine-grained sandstone; platy siltstone; reaction to acid: none		subangular chips to 0.6 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown siltstone; 40% red brown / blue gray fine-grained sandstone; and trace gypsum; reaction to acid: none		subangular chips to 0.6 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown siltstone; 40% red brown / blue gray fine-grained sandstone; trace gypsum; reaction to acid: none		subangular chips to 0.6 in
230 - 240	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 60% red brown / blue gray fine-grained sandstone; 40% red brown siltstone; reaction to acid: none		subangular chips to 0.6 in
240 - 250	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 70% red brown siltstone; 30% blue gray siltstone; trace gypsum; platy; reaction to acid: none		subangular chips to 0.6 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 60% blue gray siltstone; 35% red brown siltstone; 5% gypsum needle crystals; platy; reaction to acid: weak		subangular chips to 0.6 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 15% blue gray siltstone; 5% gypsum needle crystals; platy; reaction to acid: moderate		subangular chips to 0.8 in
270 - 280	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; moderately lithified; 95% red brown siltstone; 5% gypsum needle crystals; platy; reaction to acid: weak		subangular chips to 0.8 in

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TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*]
CCR MONITOR WELLS
ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
280 - 290	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; trace gypsum; platy; reaction to acid: weak		subangular chips to 0.4 in
290 - 300	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately to well lithified; 80% red brown siltstone; 20% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.4 in
300 - 310	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; platy; reaction to acid: moderate		subangular chips to 0.8 in
310 - 320	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; platy; reaction to acid: weak		subangular chips to 0.8 in
320 - 330	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], reddish gray [2.5YR6/1]; moderately to well lithified; 90% red brown siltstone; 10% gray fine-grained sandstone; reaction to acid: weak		subangular chips to 0.4 in
330 - 340	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], reddish gray [2.5YR6/1]; moderately to well lithified; 80% red brown siltstone; 20% gray to blue gray fine-grained sandstone; reaction to acid: weak		subangular chips to 0.4 in
340 - 350	**TRm**	sandy siltstone; reddish brown [2.5YR4/4]; well lithified; Red brown fine- to medium-grained sandstone; reaction to acid: weak		subrounded chips to 0.2 in
350 - 360	**TRm**	sandy siltstone; reddish brown [2.5YR4/4]; well lithified; Red brown fine- to medium-grained sandstone; reaction to acid: weak		subrounded chips to 0.6 in
360 - 370	**TRm**	sandy siltstone; light brown [5YR5/6], dark reddish brown [2.5YR3/4]; moderately to well lithified; 60% brown fine-grained sandstone; 40% dark red brown siltstone; reaction to acid: none		subrounded-subangular chips to 0.6 in
370 - 378	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; moderately to well lithified; Dark red brown very fine- to fine-grained sandstone; reaction to acid: none		subangular chips to 0.4 in

TABLE A-10. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-60 [*55-918649*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
378 - 380	**TRm**	sandy siltstone; gray [5YR6/1]; moderately to well lithified; Grayish tan very fine- to fine-grained sandstone; reaction to acid: none		subangular chips to 0.6 in
PERMIAN COCONINO SANDSTONE (Pc)				
380 - 390	**Pc**	fine sandstone; pale yellow [2.5Y7/3]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		pulverized very fine-fine sand size chips
390 - 400	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		mostly pulverized very fine-fine sand size
400 - 410	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		rounded chips to 0.1 in
410 - 420	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		mostly pulverized very fine-fine sand size chips
420 - 430	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		rounded chips to 0.1 in
430 - 440	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		mostly pulverized very fine-fine sand size
440 - 450	**Pc**	fine sandstone; light gray [2.5Y7/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted quartz grains); reaction to acid: none		rounded chips to 0.1 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney
DEPTH DRILLED / LAND SURFACE ELEVATION: 420.0 feet / 5124.949 feet msl	DATE DRILLED: 11/2 - 11/17/2015
CADASTRAL / NAD83 : (A-18-19)13bca / 1441383.546 N / 664047 E	

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
QUATERNARY ALLUVIUM (Qal)				
0 - 5	**Qal**	alluvium; pink [7.5YR7/3]; non-lithified; 60% fine to coarse-grained sand; 20% rounded to subrounded gravel, up to 2.4 in., consisting of sandstone and chert; 20% low plasticity silt; reaction to acid: moderate		ARCH, Air Rotary
TRIASSIC MOENKOPI FORMATION (TRm)				
5 - 10	**TRm**	sandy siltstone; reddish brown [2.5YR4/3], light blue green [5BG6/6]; weakly to moderately lithified; 70% red brown sandy siltstone; 30% blue gray sandy siltstone; clayey cuttings; reaction to acid: moderate	weathered Moenkopi Fm.	subangular chips to 1.6 in
10 - 20	**TRm**	sandy siltstone; light blue green [5BG6/6], reddish brown [2.5YR4/3]; moderately lithified; 80% blue gray sandy siltstone; 20% red brown siltstone; reaction to acid: strong		subangular to subrounded chips to 0.8 in
20 - 30	**TRm**	sandy siltstone; light blue green [5BG6/6], reddish brown [2.5YR4/3]; moderately lithified; 80% blue gray sandy siltstone; 20% red brown siltstone; reaction to acid: strong		subangular to subrounded chips to 0.8 in
30 - 40	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; weakly lithified; red brown siltstone; reaction to acid: strong		subangular chips to 0.4 in
40 - 50	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; 60% red brown fine- to medium-grained sandstone; 40% red brown siltstone; reaction to acid: weak		subrounded to subangular chips to 0.4 in
50 - 60	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; reddish gray fine- to medium-grained sandstone; reaction to acid: weak		subrounded to subangular chips to 0.4 in
60 - 70	**TRm**	sandy siltstone; olive gray [5Y4/2]; moderately to well lithified; olive gray fine- to medium-grained sandstone; reaction to acid: moderate		subrounded to subangular chips to 0.4 in
70 - 80	**TRm**	sandy siltstone; weak red [2.5YR4/2]; moderately to well lithified; dark red gray fine- to medium-grained sandstone; reaction to acid: weak		subrounded to subangular chips to 0.4 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
80 - 90	**TRm**	sandy siltstone; reddish brown [2.5YR4/3], light blue green [5BG6/6]; moderately to well lithified; 80% dark red gray / blue gray fine- to medium-grained sandstone; 20% blue gray siltstone; reaction to acid: weak		round to subangular chips to 0.8 in
90 - 100	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; weakly to moderately lithified; red brown sandy siltstone; reaction to acid: weak		subangular chips to 0.4 in
100 - 110	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], weak red [2.5YR4/2]; moderately to well lithified; 50% red brown siltstone; 50% dark red gray fine- to medium-grained sandstone; reaction to acid: weak		subangular to angular chips to 0.8 in
110 - 120	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately to well lithified; 50% dark red brown fine- to medium-grained sandstone; 40% red brown sandy siltstone; 10% blue gray siltstone; reaction to acid: strong		subangular to subrounded chips to 0.4 in
120 - 130	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; reaction to acid: strong		subangular chips to 0.4 in
130 - 140	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 60% red brown to red gray siltstone; 40% blue gray siltstone; reaction to acid: strong		subangular chips to 0.4 in
140 - 150	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 15% blue gray siltstone; 5% gypsum; reaction to acid: moderate		subrounded to subangular chips to 0.4 in
150 - 160	**TRm**	sandy siltstone; weak red [2.5YR4/2]; well lithified; dark gray fine- to medium-grained sandstone; reaction to acid: moderate		subrounded chips to 0.8 in
160 - 170	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray siltstone; trace gypsum; platy siltstone; reaction to acid: moderate		subangular chips to 0.6 in
170 - 180	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3]; moderately lithified; 90% red brown siltstone; 10% blue gray sandy siltstone; platy; reaction to acid: moderate		subangular chips to 0.6 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
180 - 190	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/3], light blue green [5BG6/6]; moderately lithified; 60% red brown siltstone; 40% blue gray siltstone; trace gypsum; reaction to acid: moderate		subangular chips to 0.4 in
190 - 200	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 50% red brown siltstone; 50% blue gray siltstone; trace gypsum; platy; reaction to acid: moderate		subangular chips to 0.4 in
200 - 210	**TRm**	sandy siltstone; weak red [2.5YR4/2]; well lithified; dark red brown fine-grained sandstone; trace gypsum; reaction to acid: moderate		subrounded to subangular chips to 0.6 in
210 - 220	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 20% blue gray siltstone; trace gypsum; platy; reaction to acid: moderate		subangular chips to 0.6 in
220 - 230	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 80% red brown siltstone; 20% blue gray siltstone; trace gypsum; reaction to acid: moderate		
230 - 240	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 75% red brown siltstone; 20% blue gray siltstone; 5% gypsum needle crystals; platy; reaction to acid: strong		subangular chips to 0.4 in
240 - 250	**TRm**	sandy siltstone; light blue green [5BG6/6], dark reddish brown [2.5YR3/4]; moderately lithified; 60% blue gray siltstone; 40% red brown siltstone; trace gypsum; reaction to acid: strong		subangular chips to 0.4 in
250 - 260	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 50% red brown siltstone; 25% blue gray siltstone; 20% blue gray fine-grained sandstone; 5% gypsum; reaction to acid: strong		subangular chips to 0.4 in
260 - 270	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], light blue green [5BG6/6]; moderately lithified; 90% red brown siltstone; 10% blue gray fine-grained sandstone; trace gypsum; reaction to acid: strong		subangular chips to 0.4 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
270 - 280	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], reddish gray [2.5YR6/1]; moderately to well lithified; 80% red brown siltstone; 20% gray fine-grained sandstone; reaction to acid: strong		subangular chips to 0.4 in
280 - 290	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], reddish gray [2.5YR6/1]; moderately to well lithified; 90% red brown siltstone; 10% gray fine-grained sandstone; reaction to acid: moderate		subangular chips to 0.6 in
290 - 300	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4], reddish gray [2.5YR6/1]; moderately to well lithified; 90% red brown siltstone; 10% gray fine-grained sandstone; reaction to acid: moderate		subangular chips to 0.6 in
300 - 310	**TRm**	sandy siltstone; reddish brown [2.5YR4/3], light gray [2.5Y7/2], light blue green [5BG6/6]; moderately to well lithified; 50% red brown sandy siltstone; 40% light brown fine-grained sandstone; 10% blue gray fine-grained sandstone; reaction to acid: moderate		subangular to subrounded chips to 0.4 in
310 - 320	**TRm**	sandy siltstone; reddish brown [2.5YR4/3]; well lithified; red brown fine-grained sandstone; reaction to acid: none		subrounded chips to 0.3 in
320 - 330	**TRm**	sandy siltstone; reddish brown [2.5YR4/3]; well lithified; red brown fine-grained sandstone; reaction to acid: none		subrounded chips to 0.3 in
330 - 340	**TRm**	sandy siltstone; reddish brown [2.5YR4/3]; well lithified; red brown fine-grained sandstone; reaction to acid: none		subrounded chips to 0.4 in
340 - 348	**TRm**	sandy siltstone; dark reddish brown [2.5YR3/4]; well lithified; dark red brown fine- to very fine-grained sandstone; reaction to acid: none		subangular to subrounded chips to 0.4 in
348 - 350	**TRm**	sandy siltstone; gray [5YR6/1]; well lithified; grayish tan very fine- to fine-grained sandstone; reaction to acid: none		subangular chips to 0.6 in
PERMIAN COCONINO SANDSTONE (Pc)				
350 - 360	**Pc**	fine sandstone; pale yellow [2.5Y7/3]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		mostly pulverized, very fine to fine sand size; round chips to 0.3 in

TABLE A-11. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-61 [*55-918648*]
CCR MONITOR WELLS
ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
360 - 370	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
370 - 380	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
380 - 390	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		mostly pulverized, very fine to fine sand size; round chips to 0.1 in
390 - 400	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
400 - 410	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips
410 - 420	**Pc**	fine sandstone; white [5Y8/1]; moderately lithified; buff sandstone (very fine- to fine-grained; rounded, well sorted/uniform quartz grains); reaction to acid: none		pulverized very fine to fine sand size chips

TABLE A-12. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-62A [*55-918658*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: National Exploration Wells Pumps	LOGGED BY: J. Laney, M. Zelazny
DEPTH DRILLED / LAND SURFACE ELEVATION: 97.0 feet / 5021.006 feet msl	DATE DRILLED: 11/17/2015
CADASTRAL / NAD83 : (A-18-19)23cbd / 1434008.665 N / 659268.051 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
QUATERNARY ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish brown [5YR2.5/2]; silt and clay 60%, rounded to angular, fine to coarse sand 30%, gravel 10%. Gravel fraction: subrounded to subangular gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
5.0 - 10.0	**Qal**	**SANDY LEAN CLAY (CL)**: Dark reddish brown [5YR2.5/2]; silt and clay 60%, rounded to angular, fine to coarse sand 30%, gravel 10%. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
10.0 - 15.0	**Qal**	**FAT CLAY WITH SAND (CH)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded to angular medium sand 25%. Gravel fraction: subrounded to subangular gravel. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
15.0 - 20.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; silt and clay 70%, rounded to angular medium sand 30%. Gravel fraction: subrounded to subangular gravel. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
20.0 - 25.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; rounded to angular fine sand 50%, silt and clay 50%. Gravel fraction: subrounded to subangular gravel. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
25.0 - 30.0	**Qal**	**SANDY FAT CLAY (CH)**: Dark reddish gray [5YR4/2]; rounded to angular fine sand 50%, silt and clay 50%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: weak.
30.0 - 35.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded to angular, fine to medium sand 25%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**LEAN CLAY WITH SAND (CL)**: Dark reddish gray [5YR4/2]; silt and clay 75%, rounded to angular, fine to medium sand 25%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of sandstone. Non-lithified. Medium to high plasticity. Well graded. Reaction to acid: moderate.
40.0 - 45.0	**Qal**	**SANDY SILT (ML)**: Light reddish brown [5YR6/3]; silt and clay 55%, rounded to angular, fine to medium sand 45%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Low plasticity. Well graded. Reaction to acid: weak.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

TABLE A-12. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-62A [*55-918658*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 70%, gravel 20%, silt 10%. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 70%, gravel 20%, silt 10%. Gravel fraction: subrounded to subangular gravel to 0.8 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
55.0 - 60.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, silt 10%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
60.0 - 65.0	**Qal**	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 60%, gravel 30%, silt 10%. Gravel fraction: subrounded to subangular gravel to 0.6 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: weak.
65.0 - 70.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
70.0 - 75.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 0.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
75.0 - 80.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 1.2 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
80.0 - 85.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 1.0 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
85.0 - 90.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 90%, gravel 5%, silt 5%. Gravel fraction: subrounded to subangular gravel to 0.1 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-12. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-62A [*55-918658*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
90.0 - 95.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 95%, silt 5%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.
95.0 - 97.0	**Qal**	**WELL GRADED SAND (SW)**: Light reddish brown [5YR6/3]; angular, medium to coarse sand 95%, silt 5%, trace gravel. Gravel fraction: subrounded to subangular gravel to 0.4 in. consisting of chert and sandstone. Non-lithified. Non-plastic. Well graded. Reaction to acid: moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-13. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-64A [*55-920353*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DRILLING COMPANY: Yellow Jacket Drilling	LOGGED BY: C.Stielstra, M. Zelazny
DEPTH DRILLED / LAND SURFACE ELEVATION: 69.0 feet / 4988.904 feet msl	DATE DRILLED: 2/8/2017
CADASTRAL : (A-18-19)21ccb / 1434030.012 N / 647702.043 E	

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
ALLUVIUM (Qal)		
0.0 - 5.0	**Qal**	**FAT CLAY (CH)**: Reddish brown [5YR4/3]; silt and clay 92%, sand 8%. Non-lithified. High plasticity. Well sorted. Reaction to acid: strong.
5.0 - 10.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 50%, silt 50%. Non-lithified. Very low plasticity. Moderately sorted. Reaction to acid: weak to moderate.
10.0 - 15.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 80%, silt 20%. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
15.0 - 20.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 75%, silt 25%. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
20.0 - 25.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR4/3]; sand 70%, silt 25%, gravel 5%. Gravel fraction: subangular gravel to 1 in. consisting of Sandstone, chert, siltstone and quartzite. Non-lithified. Non-plastic. Moderately sorted. Reaction to acid: weak to moderate.
25.0 - 30.0	**Qal**	**SILTY SANDS WITH GRAVEL (SM)**: Brown [7.5YR4/3]; sand 55%, gravel 25%, silt 20%. Gravel fraction: subangular gravel to 2 in. consisting of Chert, sandstone, coal and limestone. Non-lithified. Non-plastic. Moderately sorted. Reaction to acid: strong.
30.0 - 35.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR4/2]; sand 80%, silt 19%, gravel 1%. Gravel fraction: subangular gravel to 1.5 in. consisting of Chert, limestone, sandstone and quartzite. Non-lithified. Non-plastic. Moderately sorted. Reaction to acid: moderate.
35.0 - 40.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR4/3]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 1.5 in. consisting of Clay stone, sandstone and quartzite. Non-lithified. Non-plastic. Well sorted. Reaction to acid: very strong.
40.0 - 45.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/3]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 1 in. consisting of Clay stone, chert, limestone and sandstone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak.
45.0 - 50.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/2]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 1.8 in. consisting of Clay stone, chert and sandstone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: moderate.
50.0 - 55.0	**Qal**	**WELL GRADED SAND WITH SILT (SW-SM)**: Brown [7.5YR5/2]; sand 90%, silt 10%, trace gravel. Gravel fraction: subangular gravel to 2.5 in. consisting of Clay stone, sandstone, chert and limestone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-13. LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM MONITOR WELL M-64A [*55-920353*] CCR MONITOR WELLS ARIZONA PUBLIC SERVICE CHOLLA POWER PLANT

DEPTH INTERVAL (feet)	FORMATION	DESCRIPTION
55.0 - 60.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/2]; sand 80%, silt 20%, trace gravel. Gravel fraction: subangular gravel to 1.3 in. consisting of Clay stone, sandstone, chert and limestone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
60.0 - 65.0	**Qal**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 75%, silt 25%, trace gravel. Gravel fraction: subangular gravel to 1.3 in. consisting of Clay stone, sandstone, chert and limestone. Non-lithified. Non-plastic. Well sorted. Reaction to acid: weak to moderate.
TRIASSIC MOENKOPI FORMATION (TRm)		.
65.0 - 69.0	**TRm**	**SILTY SANDS (SM)**: Brown [7.5YR5/3]; sand 55%, silt 42%, gravel 3%. Gravel fraction: subangular gravel to 1.3 in. consisting of Moenkopi chips. Non-lithified. Very low plasticity. Moderately sorted. Reaction to acid: weak to moderate.

Gravel/sand division based on USCS scale. Grain size fractions estimated using manual field methods.

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TABLE A-14. SUMMARY OF FIELD PARAMETER STABILITY AT THE END OF DEVELOPMENT OF CCR MONITORING NETWORK WELLS INSTALLED DURING SEPTEMBER 2015 THROUGH FEBRUARY 2017 APS CHOLLA POWER PLANT, NAVAJO COUNTY, ARIZONA

Well Identifier	EC[a] (% difference)[b]	Temp[c] (% difference)[b]	pH[d] (s.u. difference)[e]	ORP[f] (mV difference)[g]	Development Duration (h:mm)[h]	Remarks at End of Development
M-50A	0.77	2.37	<0.1	<10	1:12	Clear
M-51A	0.77	0.99	<0.1	<10	1:42	Clear
M-52A	1.82	5.45	<0.1	<10	6:55	Slightly brown/reddish, no sand
M-53A	1.29	3.37	<0.1	<10	3:17	Clear / no sand
M-54	0.24	0.00	<0.1	<10	4:00	Clear, no color
M-56A	0.08	1.69	<0.1	<10	2:45	Clear
M-57A	0.71	1.12	<0.1	<10	3:04	Clear
M-58A	0.18	1.13	<0.1	<10	2:10	Clear
M-59	0.15	1.53	<0.1	<10	2:25	Clear
M-60	0.72	5.24	<0.1	<10	3:24	Clear
M-61	0.10	0.51	<0.1	<10	2:45	Clear
M-62A	3.31	3.41	<0.1	<10	3:05	Clear
M-64A	12.44	4.14	<0.1	<10	4:03	Sand 1 millimeter per liter

[a] EC = Electrical Conductivity

[b] % difference = maximum percent difference between last three field parameter measurements during development

[c] Temp = temperature (measured in °C)

[d] pH = potential of hydrogen

[e] s.u. difference = maximum standard unit difference between last three pH measurements during development

[f] ORP = Oxygen-Reduction Potential

[g] mV difference = maximum millivolt difference between last three ORP measurements during development

[h] h:mm = hours:minutes

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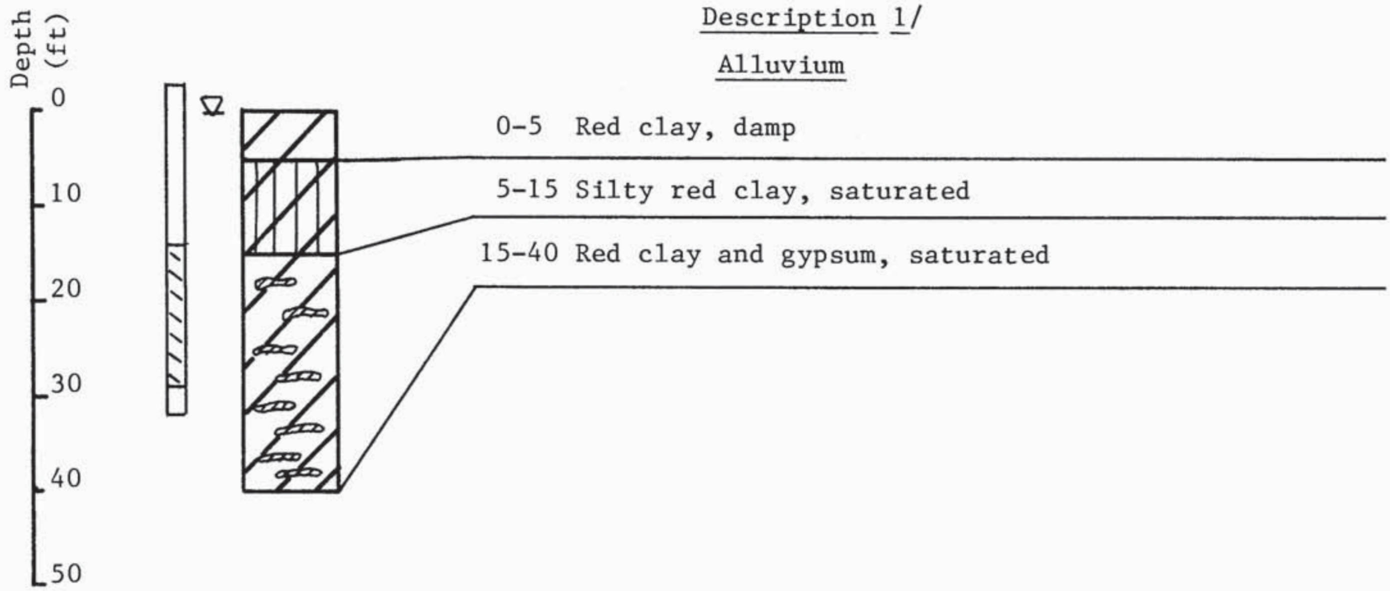
APPENDIX B
CONSTRUCTION DETAILS FOR CCR MONITORING NETWORK
PRE-EXISTING MONITOR WELLS

A total of five pre-existing monitoring wells are incorporated into the CCR monitoring network at Cholla Power Plant. Locations for these wells are shown on **Figure 1** in the main document. Well depths, screened intervals, and lithologic descriptions are provided in **Figures B-1 through B-4**. Wells are sequenced in order of well identification number. A typical well schematic diagram is shown for well W-314 on **Figure B-4** and for wells W-123, W-305 and W-306 on **Figure B-5.**

Log of Well: W-123



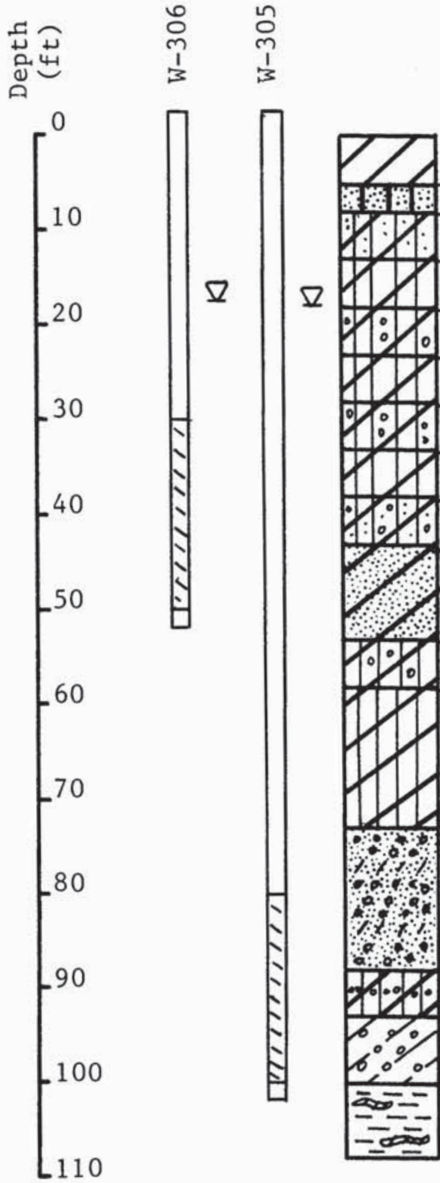
1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

Note: Depth to water shown is for April 5, 1984

Source: Cholla Steam Electric Generating Station, Cholla Ash Ponds, Groundwater Interpretative Report #1, June, 1984. Report prepared by APS with John L. Boyer as the principal investigator

FIGURE B-1

Log of Well: W-305 2/



Description 1/

Tanner Wash Alluvium

0-5	Silty clay, BRN
5-8	Sandy silt, BRN
8-13	Silty clay, BRN , some sand
13-18	Silty clay, BRN
18-23	Silty clay, BRN, some 1/8" gravel
23-28	Silty clay, BRN
28-33	Silty clay, BRN, some 1/8" gravel
33-38	Silty clay, BRN
38-43	Silty clay, BRN, some coarse sand and ¼" gravel
43-53	Sandy clay, BRN
53-58	Silty clay, BRN, some gravel
58-73	Silty clay, BRN
73-88	Sandy gravel, w/layers of clay, BRN
88-93	Silty clay,BRN, thin layers gravel,some GRN sandstone chips
93-100	Clayey sandy gravel

Moqui Member of the Moenkopi Formation

100-108	Red claystone, some gypsum

1/ Descriptions based on inspection of drill cuttings. Samples taken at 5 ft. intervals.

2/ This log also applies for Well W-306 which was drilled approximately 10 feet east of W-305.

Note: Depth to water shown is for April 5, 1984

Source: Cholla Steam Electric Generating Station, Cholla Ash Ponds, Groundwater Interpretative Report #1, June, 1984. Report prepared by APS with John L. Boyer as the principal investigator

FIGURE B-2

LOG OF TEST HOLE No.: W314

DATE: 1/25/92 SURFACE ELEVATION: 5049.1' MSL LOCATION: BOTTOM ASH POND

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)--API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
		ALLUVIUM CLAY, very hard to hard, dry, fat, (to 12'), silty lenses, indistinct laminations, color is pale brown (5 YR 5/2), to moderate brown (5 YR 4/4) to moderate brown (5 YR 3/4), (CH)			
5					
10		- @12' damp			
		- @14' moist			
15		- @16' slightly moist to damp			
20		- @20' clay balls in cuttings			
		- @23' color change to moderate brown (5 YR 4/4)			
25		- @26' gypsum in cuttings - @27' moist with abundant gypsum			
30		CLAY, hard to stiff, very fine sand, slightly moist, with fine rounded chert gravels, color is moderate brown (5 YR 4/4) to light brown (5 YR 5/6)	5019.1 30.0		

Casing Material:	4" SCHEDULE 40 PVC	Completed Well Head Elev:	5051.10' MSL
Casing Inner Dia:	3.96 INCHES	Geologist:	STEVEN C KAMINSKI
Slot Size:	0.01 INCH	Bit Diameter:	7.87
Screened Interval:	46' TO 61'	Drill Rig:	BARBER
Filter Pack Material:	20-40 SILICA SAND	Drill Contractor:	MAHER ENVIRONMENTAL
Casing Connection:	FLUSH THREAD W/ O-RING GASKET	Geophysic Contractor:	NOT CONDUCTED
Temporary Steel Casing (TSC) Dia:	10 INCH	Initial Water:	31' BG, POSSIBLY 15'
TSC Depth Of Penetration:	62'		
Drilling Method:	DUAL AIR ROTARY		

Completion Depth: **63.0 Ft.**

Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drawn By: STEVEN C KAMINSKI Reviewed By: LEO LEONHART

3/28/92 WCGEOP 1236A

Woodward-Clyde Consultants

LOG OF TEST HOLE No.: W314

DATE: **1/25/92** SURFACE ELEVATION: **5049.1' MSL** LOCATION: **BOTTOM ASH POND**

DEPTH, ft.	SYMBOL	DESCRIPTION	STRATUM EL / DEPTH	WELL	GAMMA (NATURAL)-API-GR 0–200; DENSITY--G-CC 0–5; RESISTIVITY(16N)--OHM-M 0–100
		- @31' wet - @37' less sand, damp, forms clay balls	5010.1		
40, 45, 50, 55		GRAVEL, dense to very dense, wet, clayey, sandy, fine to coarse gravels of fine grained very friable, very dusky red (10 R 2/2) to dark reddish brown (10 R 3/4) sandstone,with chert and petrified wood of various colors, silty clay interbeds ranging up to 4 feet in thickness are moderate brown (5 YR 4/4) to moderate reddish brown (10 R 4/6)	39.0 4989.1		
60		BEDROCK Formation: Moenkopi, Member: Mouqi Shale, siltstone and sandstone, very soft (sandstones are friable), deeply weathered, fine grained fraction is moderate brown (5 YR 4/4), while sandstone fraction is greyish brown (5 YR 3/2) to moderate brown (5 YR 3/4) with some greyish green (10 GY 5/2) to greyish green (5 GY 5/2) - @62' Standard penetration split spoon sample collected produced poor recovery of deeply weathered pale brown (5 YR 5/2) to moderate brown (5 YR 3/4) sandy siltstone bedrock	60.0 4986.1 63.0		
		TOTAL DEPTH OF HOLE AT 63 FEET BELOW GRADE Surface protection consists of a 20 length of 5" dia. steel riser embedded to 18 feet. A second 7' length of 6" dia. steel riser with lockable cap was installed as well head security and embedded to approximately 5 feet			

Completion Depth: **63.0 Ft.**

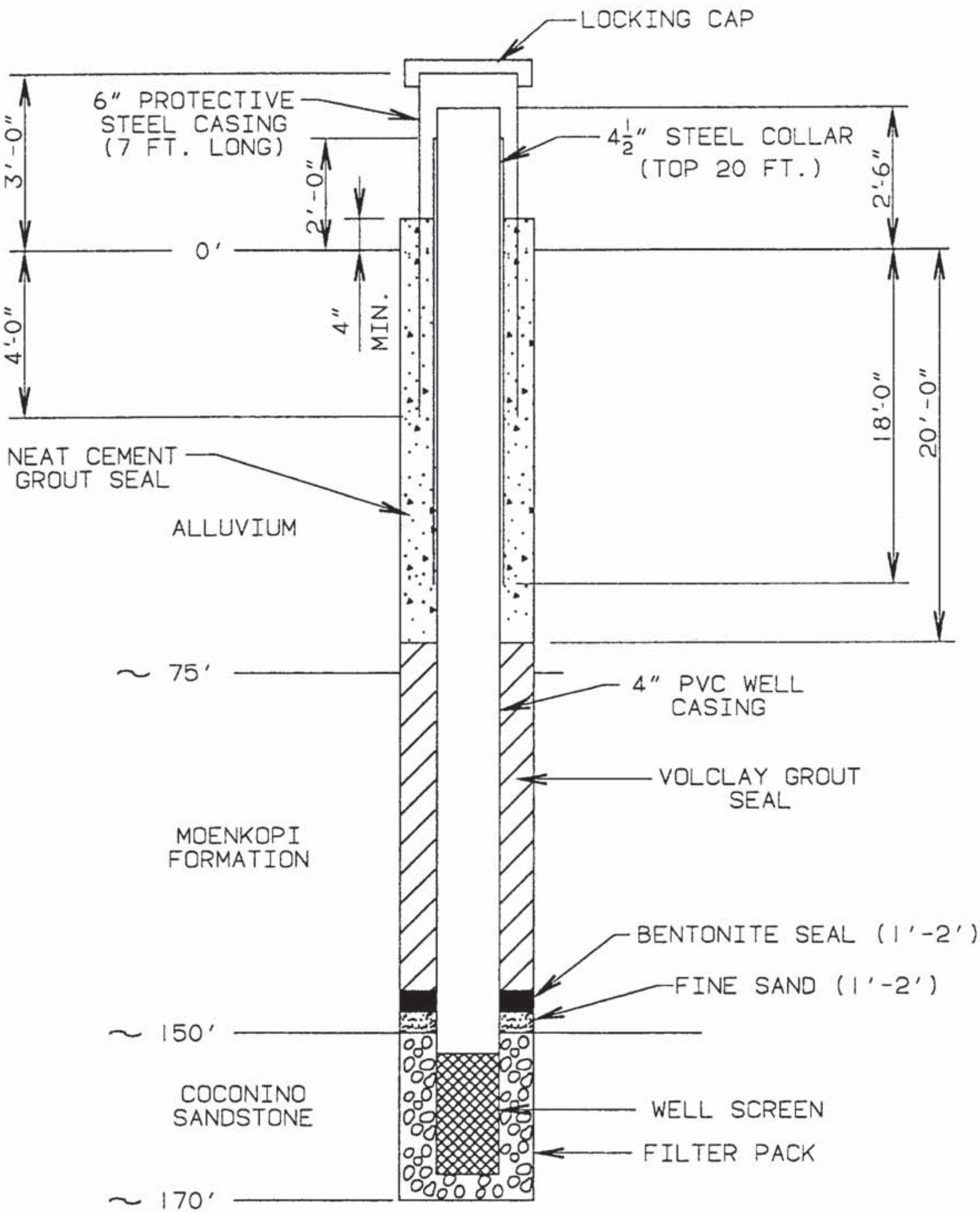
Water Depth: ______ ft., After ______ hrs.
______ ft., After ______ hrs.

Project No.: **914X236B**

Project Name: **APS - CHOLLA POWER PLANT**

Drilling Method: **DUAL AIR ROTARY**

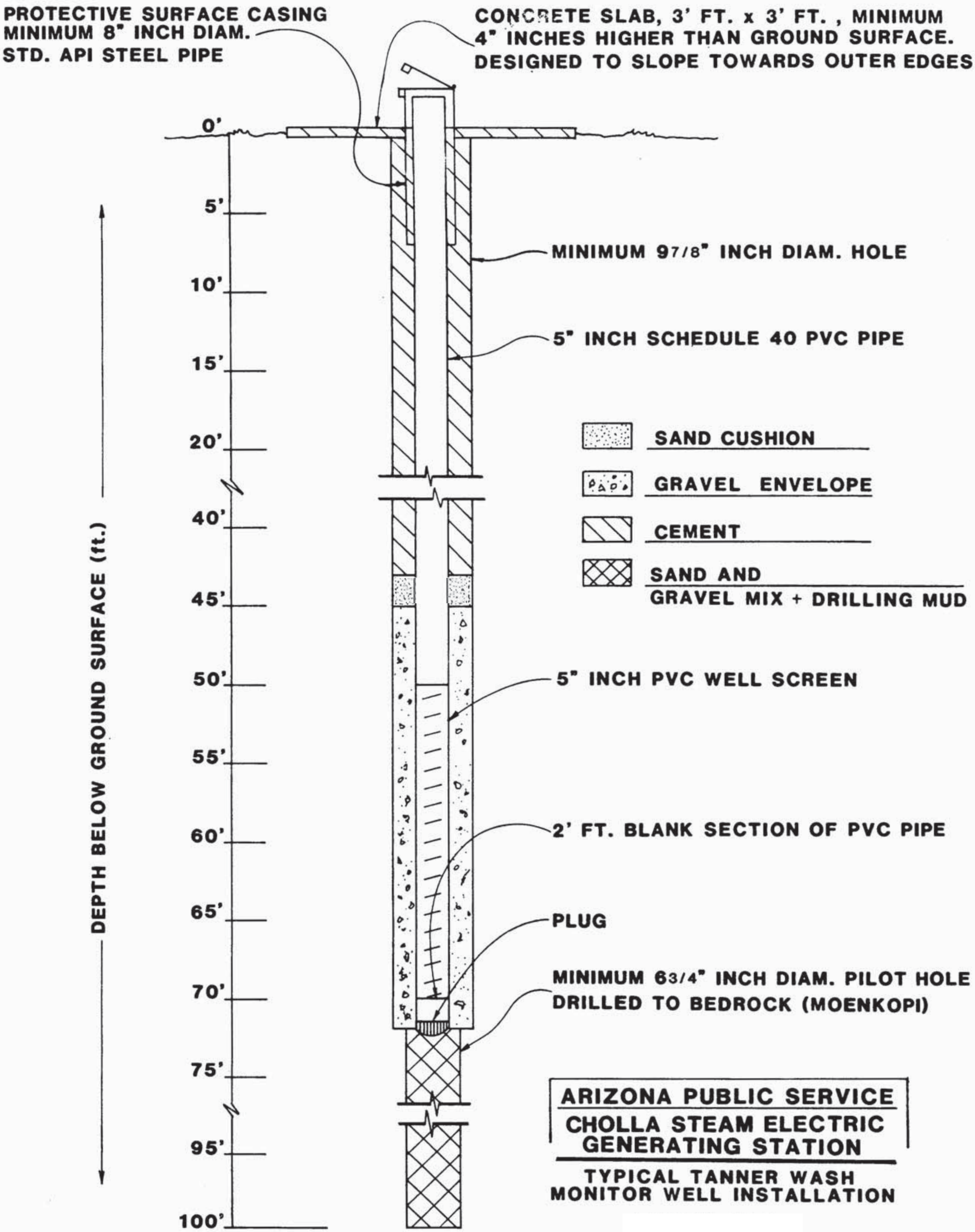
Woodward-Clyde Consultants



Source: Evaluation of Hydrogeologic Conditions, Bottom Ash Pond,
Cholla Steam Electric Station, May 22, 1992
prepared by Woodward-Clyde Consultants

FIGURE B-4

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APPD	W.A.



Source: Cholla Steam Electric Generating Station, Cholla Ash Ponds, Groundwater Interpretative Report #1, June, 1984. Report prepared by APS with John L. Boyer as the principal investigator

FIGURE B-5

Groundwater Sampling Results for FAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																
			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			FAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			FAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-64A	Background	Alluvial	2/20/2017	**1.1**	**570**	**4,000**	< 8.0	**7.4**	**4,100**	**11,000**	< 0.0010	**0.00087**	--	**0.036**	< 0.0010	**0.00011**	**0.0018**	**0.0024**	--	< 8.0	< 0.00050	**0.26**	< 0.00020	**0.0065**	**0.00074**	< 0.00010	**0.8**
M-64A	Background	Alluvial	2/20/2017	**1.2**	**520**	**4,500**	< 0.80	**7.4**	**4,400**	**10,000**	< 0.0010	**0.00094**	--	**0.034**	< 0.0010	< 0.00010	**0.0021**	**0.0015**	--	< 0.80	< 0.00050	**0.27**	< 0.00020	**0.0061**	**0.00082**	< 0.00010	< 0.6
M-64A	Background	Alluvial	4/12/2017	**1.2**	**550**	**4,200**	< 2.0	**7.7**	**4,300**	**13,000**	< 0.0010	**0.0026**	--	**0.019**	< 0.0010	< 0.00010	**0.00078**	**0.00082**	--	< 2.0	< 0.00050	**0.25**	< 0.00020	**0.0053**	< 0.00050	< 0.00010	**0.8**
M-64A	Background	Alluvial	4/12/2017	**1.2**	**500**	**4,200**	< 0.80	**7.6**	**4,200**	**13,000**	< 0.0010	**0.0026**	--	**0.019**	< 0.0010	< 0.00010	**0.0015**	**0.00068**	--	< 0.80	**0.00071**	**0.25**	< 0.00020	**0.0050**	< 0.00050	< 0.00010	< 0.6
M-64A	Background	Alluvial	4/25/2017	**1.3**	**490**	**4,100**	< 0.80	**7.5**	**4,300**	**11,000**	< 0.0010	**0.0017**	--	**0.015**	< 0.0010	< 0.00010	< 0.00050	**0.00056**	--	< 0.80	< 0.00050	**0.27**	< 0.00020	**0.0050**	< 0.00050	< 0.00010	**1.6**
M-64A	Background	Alluvial	5/18/2017	**1.3**	**510**	**4,400**	< 0.80	**7.6**	**4,400**	**12,000**	< 0.0010	**0.0016**	--	**0.012**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	< 0.80	< 0.00050	**0.28**	< 0.00020	**0.0042**	< 0.00050	< 0.00010	**1.3**
M-64A	Background	Alluvial	5/24/2017	**1.2**	**520**	**4,000**	< 0.80	**7.4**	**4,100**	**12,000**	< 0.0010	**0.0023**	--	**0.014**	< 0.0010	< 0.00010	**0.00063**	**0.00052**	--	< 0.80	< 0.0020	**0.27**	< 0.00020	**0.0050**	< 0.00050	< 0.00040	**1.1**
M-64A	Background	Alluvial	5/24/2017	**1.3**	**520**	**4,200**	< 0.80	**7.4**	**4,400**	**12,000**	< 0.0010	**0.0019**	--	**0.014**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	< 0.80	< 0.0020	**0.27**	< 0.00020	**0.0051**	< 0.00050	< 0.00040	**0.4**
M-64A	Background	Alluvial	6/30/2017	**1.2**	**600**	**5,100**	< 0.80	**7.3**	**4,700**	**13,000**	< 0.0010	**0.0033**	--	**0.017**	< 0.0010	< 0.00010	< 0.00050	**0.0011**	--	< 0.80	< 0.00050	**0.25**	< 0.00020	**0.0050**	< 0.00050	< 0.00010	< 0.7
M-64A	Background	Alluvial	7/27/2017	**1.3**	**620**	**4,700**	< 0.80	**7.4**	**4,600**	**13,000**	< 0.0020	**0.0027**	--	**0.017**	< 0.0010	< 0.00020	< 0.0010	< 0.0010	--	< 0.80	< 0.0010	**0.25**	< 0.00020	**0.0051**	< 0.0010	< 0.00020	< 0.7
M-64A	Background	Alluvial	7/27/2017	**1.3**	**640**	**4,900**	< 0.80	**7.4**	**4,800**	**13,000**	< 0.0020	**0.0028**	--	**0.017**	< 0.0010	< 0.00020	< 0.0010	< 0.0010	--	< 0.80	< 0.0010	**0.25**	< 0.00020	**0.0051**	< 0.0010	< 0.00020	< 0.7
M-64A	Background	Alluvial	9/7/2017	**1.2**	**620**	**4,700**	< 0.80	**7.3**	**4,300**	**12,000**	< 0.0040	**0.0025**	--	**0.017**	< 0.0010	< 0.00040	< 0.0040	< 0.0020	--	< 0.80	< 0.0020	**0.26**	< 0.00020	**0.0059**	< 0.0020	< 0.00040	< 0.7
M-64A	Background	Alluvial	12/8/2017	**1.2**	**500**	**3,500**	< 0.80	**7.4**	**4,400**	**12,000**	--	--	--	--	--	--	--	--	--	< 0.80	--	--	--	--	--	--	--
M-64A	Background	Alluvial	2/15/2018	--	--	--	< 0.80	--	--	--	< 0.0020	< 0.0010	--	**0.015**	< 0.0010	< 0.00020	**0.0022**	< 0.00050	--	< 0.80	< 0.0010	**0.27**	< 0.00020	**0.0058**	< 0.00050	< 0.00020	**1.0**
M-64A	Background	Alluvial	2/15/2018	--	--	--	< 0.80	--	--	--	< 0.0020	< 0.0010	--	**0.015**	< 0.0010	< 0.00020	**0.0022**	< 0.00050	--	< 0.80	< 0.0010	**0.27**	< 0.00020	**0.0058**	< 0.00050	< 0.00020	**0.966**
M-64A	Background	Alluvial	5/19/2018	**1.4**	**460**	**4,700**	< 0.80	**7.3**	**4,600**	**13,000**	< 0.0020	**0.0012**	--	**0.012**	--	< 0.00020	< 0.0020	< 0.0010	--	< 0.80	< 0.0010	**0.26**	--	**0.0055**	< 0.0010	< 0.00020	< 0.7
M-64A	Background	Alluvial	10/22/2018	**1.3**	**500**	**4,100**	< 2.0	**7.3**	**4,000**	**12,000**	--	**0.0011**	--	**0.011**	--	< 0.00010	< 0.0010	< 0.00050	--	< 2.0	< 0.00050	**0.25**	--	**0.0050**	< 0.00050	< 0.00010	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-64A	Background	Alluvial	10/22/2018	**1.3**	**510**	**3,900**	< 0.80	**7.4**	**3,700**	**13,000**	--	**0.0013**	--	**0.011**	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.25**	--	**0.0052**	< 0.00050	< 0.00010	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-64A	Background	Alluvial	2/13/2019	--	--	--	< 0.80	--	--	--	< 0.0010	**0.00089**	--	**0.012**	< 0.0010	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.29**	< 0.00020	**0.0049**	**0.00052**	< 0.00010	< 0.6
M-64A	Background	Alluvial	4/11/2019	**1.3**	**500**	**4,400**	< 0.80	**7.3 J**	**4,300**	**12,000**	--	**0.00058**	--	**0.011**	--	< 0.0001	< 0.001	< 0.0005	--	< 0.80	< 0.0005	**0.27**	--	**0.0050**	**0.00053**	--	--
M-64A	Background	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	**0.00058**	--	**0.012**	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.25**	--	**0.0050**	**0.00078**	< 0.00010	< 0.7
M-64A	Background	Alluvial	8/1/2019	**1.3**	**450**	**4,300**	< 0.8	**7.4 J**	**4,300**	**12,000**	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
M-64A	Background	Alluvial	8/1/2019	**1.3**	**450**	**4,200**	< 0.8	**7.4 J**	**4,300**	**12,000**	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/24/2019	**1.2**	**460**	**8,400**	< 0.80	**7.5 J**	**8,600**	**13,000**	< 0.0020	**0.0018**	--	**0.013 J**	< 0.0010	< 0.00020	< 0.0020	< 0.0010	--	< 0.80	< 0.0010	**0.26**	< 0.00020	**0.0059**	< 0.0010	< 0.00020	--
M-64A	Background	Alluvial	5/6/2020	**1.3**	**510**	**4,100**	< 0.8	**7.6 J**	**4,100**	**12,000**	--	< 0.001	**0.00093**	**0.012**	< 0.001	< 0.0001	< 0.002	< 0.001	< 0.0005	< 0.8	< 0.0005	**0.47**	--	**0.0043**	< 0.001	--	< 0.8
M-64A	Background	Alluvial	5/6/2020	**1.2**	**520**	**3,900**	< 0.8	**7.3 J**	**3,900**	**12,000**	--	**0.00086**	**0.00050**	**0.013**	< 0.001	< 0.0001	< 0.001	< 0.0005	< 0.0005	< 0.8	< 0.0005	**0.47**	--	**0.0042**	< 0.001	--	< 0.8
M-44D	Supplementary	Coconino	12/2/2015	**0.26**	**91**	**1,100**	**0.70**	**7.49**	**310**	**2,200**	< 0.0025	**0.0019**	--	**0.022**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.70**	< 0.00050	< 0.20	< 0.00020	**0.0024**	< 0.00010	< 0.00010	**3.8**
M-44D	Supplementary	Coconino	3/10/2016	**0.23**	**88**	**1,100**	**0.72**	**7.13**	**310**	**2,200**	< 0.015	< 0.0049	--	**0.020**	< 0.0010	< 0.00046	< 0.0087	< 0.0013	--	**0.72**	< 0.0044	< 0.20	< 0.00020	< 0.0040	< 0.0015	< 0.00026	**3.1**
M-44D	Supplementary	Coconino	5/22/2016	**0.25**	**91**	**1,100**	**0.78**	--	**310**	**2,300**	< 0.00010	**0.0015**	--	**0.019**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.78**	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**3.9**
M-44D	Supplementary	Coconino	8/26/2016	**0.24**	**90**	**1,100**	**0.77**	**7.1**	**320**	**2,300**	**0.00013**	**0.0015**	--	**0.019**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.77**	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**4.6**
M-44D	Supplementary	Coconino	9/23/2016	**0.25**	**91**	**1,000**	**0.76**	**7.1**	**320**	**2,200**	< 0.00050	**0.0014**	--	**0.019**	< 0.0010	< 0.00010	**0.00061**	< 0.00020	--	**0.76**	< 0.00010	< 0.20	< 0.00020	**0.0026**	< 0.00060	< 0.00010	**4.4**
M-44D	Supplementary	Coconino	2/20/2017	**0.26**	**92**	**1,100**	**0.68**	**7.1**	**430**	**2,200**	< 0.0010	**0.0012**	--	**0.018**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.68**	< 0.00050	< 0.20	< 0.00020	**0.0021**	< 0.00050	< 0.00010	**3.6**
M-44D	Supplementary	Coconino	4/13/2017	**0.25**	**93**	**1,200**	**0.72**	**7.6**	**320**	**2,300**	< 0.0010	**0.0014**	--	**0.019**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.72**	< 0.00050	< 0.20	< 0.00020	**0.0026**	< 0.00050	< 0.00010	**4.2**
M-44D	Supplementary	Coconino	4/24/2017	**0.26**	**91**	**1,000**	**0.73**	**7.2**	**330**	**2,200**	< 0.0010	**0.0015**	--	**0.020**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.73**	< 0.00050	< 0.20	< 0.00020	**0.0023**	< 0.00050	< 0.00010	**2.0**
M-44D	Supplementary	Coconino	4/24/2017	**0.26**	**89**	**1,000**	**0.73**	**7.2**	**370**	**2,300**	< 0.0010	**0.0015**	--	**0.019**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.73**	< 0.00050	< 0.20	< 0.00020	**0.0023**	< 0.00050	< 0.00010	**2.4**
M-44D	Supplementary	Coconino	5/22/2017	**0.26**	**93**	**1,100**	**0.75**	**7.4**	**330**	**2,200**	< 0.0010	**0.0013**	--	**0.017**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.75**	< 0.00050	< 0.20	< 0.00020	**0.0019**	< 0.00050	< 0.00010	**3.6**
M-44D	Supplementary	Coconino	5/25/2017	**0.26**	**96**	**1,400**	**0.76**	**7.4**	**400**	**2,300**	< 0.0010	**0.0015**	--	**0.02**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.76**	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**4.7**
M-44D	Supplementary	Coconino	6/29/2017	**0.25**	**88**	**1,200**	**0.79**	**7.2**	**340**	**2,200**	< 0.0010	**0.0015**	--	**0.019**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**0.79**	< 0.00050	< 0.20	< 0.00020	**0.0023**	< 0.00050	< 0.00010	**4.6**
M-44D	Supplementary	Coconino	7/29/2017	**0.26**	**93**	**1,200**	**0.78**	**7.1**	**350**	**2,400**	< 0.0040	< 0.0020	--	**0.020**	< 0.0010	< 0.00040	< 0.0020	< 0.0020	--	**0.78**	< 0.0020	< 0.20	< 0.00020	**0.0023**	< 0.0020	< 0.00040	**3.2**
M-44D	Supplementary	Coconino	9/5/2017	**0.27**	**93**	**1,100**	**0.77**	**7.1**	**330**	**2,300**	< 0.0010	**0.0015**	--	**0.020**	< 0.0010	< 0.00010	< 0.0010	< 0.00050	--	**0.77**	< 0.00050	< 0.20	< 0.00020	**0.0021**	< 0.00050	< 0.00010	**4.3**
M-44D	Supplementary	Coconino	5/7/2020	--	**89**	**970**	**0.81**	--	**310**	--	--	--	--	--	--	--	--	--	--	**0.81**	--	--	--	--	--	--	--
M-46A	Supplementary	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.5**
M-46A	Supplementary	Alluvial	11/26/2019	**0.64**	**1,300**	**6,400**	< 0.80	**7.0 J**	**1,900**	**13,000**	--	**0.0042**	--	**0.037**	--	< 0.00010	< 0.0040	< 0.0020	--	< 0.80	**0.00052**	**0.23**	--	**0.026**	< 0.0020	--	--
M-46A	Supplementary	Alluvial	5/5/2020	**0.64**	**1,300**	**7,100 J**	< 0.8 UJ	**7.4 J**	**7,800 J**	**13,000**	--	**0.0013**	**0.0011**	**0.031**	< 0.001	< 0.0001	**0.0011**	**0.00081**	**0.00079**	< 0.8 UJ	< 0.0005	**0.35**	--	**0.0068**	< 0.001	--	< 0.8
M-50A	Downgradient	Alluvial	12/2/2015	**2.8**	**680**	**2,800**	**2.0**	**7.55**	**2,900**	**8,300**	< 0.0025	**0.0023**	--	**0.018**	< 0.0010	< 0.00010	< 0.00050	**0.00051**	--	**2.0**	< 0.00050	**0.51**	< 0.00020	**0.0050**	**0.0068**	< 0.00010	< 0.7
M-50A	Downgradient	Alluvial	12/2/2015	**2.7**	**670**	**2,900**	**2.0**	**7.23**	**2,900**	**8,300**	< 0.0025	**0.0022**	--	**0.016**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	**2.0**	< 0.00050	**0.51**	< 0.00020	**0.0049**	**0.0066**	< 0.00010	< 0.7
M-50A	Downgradient	Alluvial	3/8/2016	**2.9**	**660**	**5,300**	**2.0**	**7.37**	**5,700**	**8,300**	< 0.015	< 0.0049	--	**0.013**	< 0.0010	< 0.00046	< 0.0087	< 0.0013	--	**2.0**	< 0.0044	**0.47**	< 0.00020	**0.0059 J**	**0.0050 J**	< 0.00026	< 0.5
M-50A	Downgradient	Alluvial	5/5/2016	**3.0**	**680**	**2,500**	**2.2**	--	**2,700**	**8,300**	**0.00026**	**0.0025**	--	**0.011**	< 0.0010	< 0.00010	< 0.00050	**0.00051**	--	**2.2**	< 0.00050	**0.47**	< 0.00020	**0.0056**	**0.0054**	< 0.00010	**0.7**
M-50A	Downgradient	Alluvial	8/25/2016	**2.6**	**650**	**2,600**	**2.3**	**7.2**	**2,800**	**8,400**	**0.00018**	**0.0025**	--	**0.0084**	< 0.0010	< 0.00010	< 0.00050	**0.00056**	--	**2.3**	< 0.00050	**0.45**	< 0.00020	**0.0059**	**0.0049**	< 0.00010	< 0.6
M-50A	Downgradient	Alluvial	9/23/2016	**2.8**	**630**	**2,500**	**2.1**	**7.4**	**2,900**	**8,500**	< 0.00050	**0.0024**	--	**0.0093**	< 0.0010	< 0.00010	**0.0024**	**0.00084**	--	**2.1**	**0.00012**	**0.50**	< 0.00020	**0.0075**	**0.0046**	**0.00013**	**1.1**
M-50A	Downgradient	Alluvial	2/21/2017	**2.9**	**680**	**2,400**	**2.1**	**7.5**	**2,800**	**7,900**	< 0.0010	**0.0026**	--	**0.014**	< 0.0010	< 0.00010	**0.022**	**0.00090**	--	**2.1**	< 0.00050	**0.50**	< 0.00020	**0.0091**	**0.0043**	< 0.00010	< 0.6

Groundwater Sampling Results for FAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																
			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			FAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			FAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-50A	Downgradient	Alluvial	4/13/2017	**2.8**	**680**	**2,800**	**2.0**	**7.8**	**3,000**	**8,200**	< 0.0010	**0.0030**	--	**0.010**	< 0.0010	< 0.00010	**0.015**	**0.00093**	--	**2.0**	< 0.00050	**0.46**	< 0.00020	**0.0083**	**0.0040**	< 0.00010	< 0.6
M-50A	Downgradient	Alluvial	4/26/2017	**2.8**	**620**	**2,400**	**2.0**	**7.2**	**2,900**	**7,900**	< 0.0010	**0.0024**	--	**0.0084**	< 0.0010	< 0.00010	**0.0066**	**0.00069**	--	**2.0**	< 0.00050	**0.48**	< 0.00020	**0.0067**	**0.0042**	< 0.00010	< 0.6
M-50A	Downgradient	Alluvial	5/18/2017	**2.8**	**670**	**2,600**	**2.2**	**7.6**	**3,200**	**7,300**	< 0.0010	**0.0023**	--	**0.0081**	< 0.0010	< 0.00010	**0.0049**	**0.00056**	--	**2.2**	< 0.00050	**0.48**	< 0.00020	**0.0059**	**0.0037**	< 0.00010	**0.6**
M-50A	Downgradient	Alluvial	5/24/2017	**3.0**	**680**	**2,700**	**2.3**	**7.4**	**3,200**	**8,300**	< 0.0010	**0.0026**	--	**0.0085**	< 0.0010	< 0.00010	**0.0037**	**0.00067**	--	**2.3**	< 0.00050	**0.49**	< 0.00020	**0.0061**	**0.0044**	< 0.00010	**0.8**
M-50A	Downgradient	Alluvial	6/30/2017	**2.7**	**630**	**2,700**	**2.4**	**7.3**	**3,300**	**8,100**	< 0.0010	**0.0025**	--	**0.0084**	< 0.0010	< 0.00010	**0.0038**	**0.0014**	--	**2.4**	< 0.00050	**0.45**	< 0.00020	**0.028**	**0.0040**	**0.00011**	< 0.7
M-50A	Downgradient	Alluvial	7/27/2017	**2.8**	**660**	**2,600**	**2.5**	**7.4**	**3,100**	**8,400**	< 0.0040	**0.0025**	--	**0.0089**	< 0.0010	< 0.00040	< 0.0020	< 0.0020	--	**2.5**	< 0.0020	**0.46**	< 0.00020	**0.0077**	**0.0039**	< 0.00040	< 0.7
M-50A	Downgradient	Alluvial	9/7/2017	**3.0**	**660**	**2,500**	**2.2**	**7.2**	**3,100**	**8,400**	< 0.0040	**0.0026**	--	**0.0091**	< 0.0010	< 0.00040	< 0.0040	< 0.0020	--	**2.2**	< 0.0020	**0.48**	< 0.00020	**0.0091**	**0.0030**	< 0.00040	< 0.6
M-50A	Downgradient	Alluvial	12/8/2017	**2.9**	**650**	**2,600**	**2.2**	**7.4**	**3,000**	**8,000**	--	--	--	--	--	--	--	--	--	**2.2**	--	--	--	--	--	--	--
M-50A	Downgradient	Alluvial	2/14/2018	--	--	--	**2.4**	--	--	--	< 0.0020	**0.0026**	--	**0.0095**	< 0.0010	< 0.00020	< 0.0020	< 0.0010	--	**2.4**	< 0.0010	**0.43**	< 0.00020	**0.0088**	**0.0034**	< 0.00020	**0.2**
M-50A	Downgradient	Alluvial	2/14/2018	--	--	--	**2.6**	--	--	--	< 0.0010	**0.0027**	--	**0.0087**	< 0.0010	< 0.00010	**0.0010**	**0.00055**	--	**2.6**	**0.0012**	**0.44**	< 0.00020	**0.0085**	**0.0029**	< 0.00010	**0.5**
M-50A	Downgradient	Alluvial	5/21/2018	**3.0**	**610**	**2,400**	**2.4**	**7.2**	**3,100**	**7,900**	--	**0.0025**	--	**0.0086**	--	< 0.00010	**0.0012**	**0.00079**	--	**2.4**	< 0.00050	**0.43**	--	**0.0070**	**0.0027**	--	**0.4**
M-50A	Downgradient	Alluvial	10/24/2018	**3.1**	**630**	**2,200**	**1.9**	**7.4**	**3,100**	**8,100**	--	**0.0028**	--	**0.0092**	--	< 0.00010	**0.0046**	**0.00063**	--	**1.9**	< 0.00050	**0.43**	--	**0.0071**	**0.0026**	--	< 0.6
M-50A	Downgradient	Alluvial	2/13/2019	--	--	--	< 0.80	--	--	--	< 0.0010	**0.00076**	--	**0.012**	< 0.0010	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.29**	< 0.00020	**0.0048**	< 0.00050	< 0.00010	**0.9**
M-50A	Downgradient	Alluvial	2/13/2019	--	--	--	**2.2**	--	--	--	< 0.0010	**0.0028**	--	**0.0086**	< 0.0010	< 0.00010	**0.0014**	**0.00069**	--	**2.2**	< 0.00050	**0.46**	< 0.00020	**0.0070**	**0.0027**	< 0.00010	< 0.6
M-50A	Downgradient	Alluvial	4/11/2019	**47**	**750**	**6,700**	**3.7**	**7.4**	**3,900**	**16,000**	--	**0.0016**	--	**0.0094**	--	< 0.0001	**0.0069**	**0.0041**	--	**3.7**	< 0.0005	**0.73**	--	**0.22**	**0.0019**	--	--
M-50A	Downgradient	Alluvial	4/11/2019	**3.1**	**610**	**2,200**	**2.0**	**7.4**	**3,000**	**7,700**	--	**0.0030**	--	**0.0088**	--	< 0.0001	**0.0011**	**0.00062**	--	**2.0**	< 0.0005	**0.44**	--	**0.0071**	**0.0025**	--	< 0.7
M-50A	Downgradient	Alluvial	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-50A	Downgradient	Alluvial	11/25/2019	**3.1**	**610**	**2,100**	**2.1**	**7.1 J**	**3,000**	**7,800**	--	**0.0027**	--	**0.010**	--	< 0.00010	**0.0071**	**0.00053**	--	**2.1**	< 0.00050	**0.43**	--	**0.0083**	**0.0022**	--	--
M-50A	Downgradient	Alluvial	5/6/2020	**3.0**	**600**	**1,900**	**2.3**	**7.5 J**	**3,000**	**7,700**	--	**0.0027**	**0.0024**	**0.0093**	< 0.001	< 0.0001	**0.0024**	**0.00066**	< 0.0005	**2.3**	< 0.0005	**0.55**	--	**0.0065**	**0.0018**	--	< 0.8
M-51A	Downgradient	Alluvial	12/2/2015	**33**	**940**	**6,700**	**4.8**	**7.29**	**2,800**	**13,000**	< 0.0025	**0.020**	--	**0.012**	< 0.0010	< 0.00010	< 0.010	< 0.010	--	**4.8**	< 0.00050	**0.60**	< 0.00020	**0.034**	< 0.00010	**0.00020**	< 0.9
M-51A	Downgradient	Alluvial	3/9/2016	**33**	**930**	**6,400**	**5.2**	**7.27**	**2,700**	**14,000**	< 0.015	**0.016 J**	--	**0.0095**	< 0.0010	< 0.00046	< 0.022	< 0.0031	--	**5.2**	< 0.0044	**0.54**	< 0.00020	**0.031**	< 0.0037	< 0.00026	< 0.9
M-51A	Downgradient	Alluvial	3/9/2016	**32**	**920**	**6,500**	**6.1**	**7.22**	**2,700**	**14,000**	< 0.015	**0.018 J**	--	**0.011**	< 0.0010	< 0.00046	< 0.022	< 0.0031	--	**6.4**	< 0.0044	**0.56**	< 0.00020	**0.034**	< 0.0037	< 0.00026	< 0.8
M-51A	Downgradient	Alluvial	5/5/2016	**35**	**980**	**6,600**	**5.5**	--	**2,800**	**14,000**	< 0.00010	**0.0029**	--	**0.011**	< 0.0010	< 0.00010	< 0.0020	< 0.0020	--	**5.5**	< 0.00050	**0.57**	< 0.00020	**0.029**	< 0.0020	**0.00015**	< 0.8
M-51A	Downgradient	Alluvial	8/25/2016	**36**	**960**	**6,500**	**6.0**	**7.1**	**3,000**	**15,000**	**0.00015**	**0.029**	--	**0.010**	< 0.0010	**0.00011**	< 0.0050	< 0.0050	--	**6.0**	< 0.00050	**0.56**	< 0.00020	**0.042**	< 0.0050	**0.00027**	< 0.6
M-51A	Downgradient	Alluvial	9/23/2016	**36**	**920**	**6,000**	**5.4**	**7.3**	**2,800**	**15,000**	< 0.0025	**0.025**	--	**0.010**	< 0.0010	< 0.00050	< 0.0025	**0.0025**	--	**5.4**	< 0.00050	**0.61**	< 0.00020	**0.043**	< 0.0030	< 0.00050	< 0.7
M-51A	Downgradient	Alluvial	2/21/2017	**33**	**920**	**6,500**	**4.4**	**7.1**	**2,800**	**13,000**	< 0.0010	**0.023**	--	**0.0091**	< 0.0010	< 0.00010	**0.053**	**0.0023**	--	**4.4**	< 0.00050	**0.58**	< 0.00020	**0.038**	< 0.0020	**0.00014**	**0.6**
M-51A	Downgradient	Alluvial	4/13/2017	**35**	**970**	**7,500**	**4.1**	**7.6**	**2,900**	**14,000**	< 0.0010	**0.020**	--	**0.0099**	< 0.0010	< 0.00010	**0.014**	< 0.0020	--	**4.1**	< 0.00050	**0.49**	< 0.00020	**0.038**	< 0.0020	**0.00014**	< 0.6
M-51A	Downgradient	Alluvial	4/26/2017	**35**	**880**	**6,300**	**4.6**	**7.2**	**2,900**	**13,000**	< 0.0010	**0.024**	--	**0.0096**	< 0.0010	< 0.00010	**0.0081**	< 0.0050	--	**4.6**	< 0.0010	**0.57**	< 0.00020	**0.036**	< 0.0050	< 0.00020	< 0.6
M-51A	Downgradient	Alluvial	5/18/2017	**35**	**890**	**6,800**	**5.0**	**7.3**	**3,200**	**13,000**	< 0.0010	**0.024**	--	**0.0096**	< 0.0010	< 0.00010	**0.0081**	< 0.0050	--	**5.0**	< 0.00050	**0.56**	< 0.00020	**0.030**	< 0.0050	**0.00012**	< 0.6
M-51A	Downgradient	Alluvial	5/24/2017	**38**	**940**	**6,600**	**5.3**	**7.3**	**3,100**	**13,000**	< 0.010	**0.028**	--	**0.012**	< 0.0010	< 0.0010	**0.0084**	< 0.0050	--	**5.3**	< 0.0050	**0.54**	< 0.00020	**0.036**	< 0.0050	< 0.0010	**0.6**
M-51A	Downgradient	Alluvial	6/30/2017	**36**	**860**	**7,100**	**5.1**	**7.2**	**3,300**	**14,000**	< 0.0010	**0.029**	--	**0.010**	< 0.0010	< 0.00010	**0.012**	< 0.010	--	**5.1**	< 0.00050	**0.52**	< 0.00020	**0.038**	< 0.010	**0.00019**	< 0.7
M-51A	Downgradient	Alluvial	6/30/2017	**36**	**880**	**7,000**	**4.9**	**7.2**	**3,300**	**14,000**	< 0.0010	**0.029**	--	**0.010**	< 0.0010	< 0.00010	< 0.010	< 0.010	--	**4.9**	< 0.00050	**0.54**	< 0.00020	**0.038**	< 0.010	**0.00021**	< 0.7
M-51A	Downgradient	Alluvial	7/27/2017	**38**	**950**	**7,100**	**6.0**	**7.3**	**3,500**	**14,000**	< 0.0020	**0.026**	--	**0.0098**	< 0.0010	< 0.00020	**0.070**	< 0.0050	--	**6.0**	< 0.0010	**0.54**	< 0.00020	**0.054**	< 0.0050	**0.00021**	< 0.7
M-51A	Downgradient	Alluvial	9/7/2017	**38**	**950**	**6,600**	**5.7**	**7.2**	**3,100**	**14,000**	< 0.0040	**0.035**	--	**0.0097**	< 0.0010	< 0.00040	**0.036**	< 0.0050	--	**5.7**	< 0.0020	**0.55**	< 0.00020	**0.054**	< 0.0050	< 0.00040	< 0.6
M-51A	Downgradient	Alluvial	12/8/2017	**34**	**910**	**5,900**	**5.1**	**7.3**	**2,800**	**13,000**	--	--	--	--	--	--	--	--	--	**5.1**	--	--	--	--	--	--	--
M-51A	Downgradient	Alluvial	2/14/2018	--	--	--	**5.4**	--	--	--	< 0.0020	**0.015**	--	**0.0089**	< 0.0010	< 0.00020	**0.0034**	**0.0010**	--	**5.4**	< 0.0010	**0.49**	< 0.00020	**0.046**	< 0.00050	< 0.00020	**0.2**
M-51A	Downgradient	Alluvial	5/21/2018	**34**	**820**	**5,800**	**5.7**	**7.1**	**3,100**	**12,000**	--	**0.022**	--	**0.010**	--	< 0.00020	**0.040**	**0.0018**	--	**5.7**	< 0.0010	**0.48**	--	**0.057**	< 0.0010	--	< 0.6
M-51A	Downgradient	Alluvial	10/24/2018	**30**	**870**	**5,400**	**5.0**	**7.3**	**2,900**	**12,000**	--	**0.032**	--	**0.0074**	--	**0.00010**	**0.021**	< 0.0050	--	**5.0**	< 0.00050	**0.46**	--	**0.09**	< 0.0050	--	< 0.6
M-51A	Downgradient	Alluvial	2/13/2019	--	--	--	**4.5**	--	--	--	< 0.0010	**0.025**	--	**0.0070**	< 0.0010	< 0.00010	**0.013**	< 0.0020	--	**4.5**	< 0.00050	**0.49**	< 0.00020	**0.082**	< 0.0020	**0.00013**	< 0.6
M-51A	Downgradient	Alluvial	4/10/2019	**31**	**790**	**5,000**	**5.4**	**7.2**	**2,800**	**12,000**	--	**0.032**	--	**0.0091**	--	< 0.0002	**0.016**	< 0.005	--	**5.4**	< 0.0005	**0.45**	--	**0.09**	< 0.005	--	< 0.7
M-51A	Downgradient	Alluvial	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-51A	Downgradient	Alluvial	11/25/2019	**30**	**820**	**5,300**	**4.8**	**7.2 J**	**2,900**	**12,000**	--	**0.018**	--	**0.0086**	--	< 0.00010	< 0.0010	**0.00076**	--	**4.8**	< 0.00050	**0.45**	--	**0.11**	< 0.00050	--	--
M-51A	Downgradient	Alluvial	5/6/2020	**32**	**860**	**5,300**	**5.6**	**7.2 J**	**2,900**	**12,000**	--	**0.015**	**0.015**	**0.0091**	< 0.001	< 0.0001	**0.0026**	**0.0013**	**0.00078**	**5.6**	< 0.0005	**0.65**	--	**0.09**	< 0.0005	--	< 0.8
MW-65A	Downgradient	Alluvial	12/5/2018	**43**	**760**	**6,900**	**3.6 J,UJ**	**7.4 J**	**4,100**	**16,000**	< 0.0010	**0.0013 J**	--	**0.015 J**	--	< 0.00010	**0.0016 J**	**0.0038 J**	--	**3.6 J,UJ**	< 0.00050	**0.76**	< 0.00020	**0.17**	**0.0020 J**	< 0.00010	**0.9**
MW-65A	Downgradient	Alluvial	12/5/2018	**12**	**780**	**3,900**	**1.9 J,UJ**	**7.3 J**	**2,700**	**9,900**	< 0.0010	**0.0025**	--	**0.040**	--	**0.00013**	**0.0035**	**0.0047**	--	**1.9 J,UJ**	**0.0010**	**0.54**	< 0.00020	**0.059**	**0.0021**	**0.00011**	**0.9**
MW-65A	Downgradient	Alluvial	2/14/2019	--	--	--	**1.7**	--	--	--	< 0.0010	**0.0017**	--	**0.015**	< 0.0010	< 0.00010	**0.0028**	**0.0033**	--	**1.7**	< 0.00050	**0.58**	< 0.00020	**0.059**	**0.0022**	< 0.00010	< 0.6
MW-65A	Downgradient	Alluvial	4/11/2019	**11**	**730**	**3,600**	**1.9**	**7.2 J**	**2,700**	**9,400**	--	**0.0018**	--	**0.016**	--	**0.00011**	**0.010**	**0.0036**	--	**1.9**	< 0.0005	**0.52**	--	**0.067**	**0.0024**	--	--
MW-65A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
MW-65A	Downgradient	Alluvial	11/26/2019	**12**	**760**	**3,500**	**1.7**	**7.1 J**	**2,900**	**9,300**	--	< 0.0020	--	**0.017**	--	**0.00014**	**0.015**	**0.0032**	--	**1.7**	< 0.00050	**0.52**	--	**0.080**	< 0.0020	--	--
MW-65A	Downgradient	Alluvial	5/5/2020	**11**	**750**	**3,600**	**1.8**	**7.4 J**	**2,900**	**9,400**	--	**0.0016**	**0.0017**	**0.015**	< 0.001	**0.00010**	**0.0052**	**0.0033**	**0.0026**	**1.8**	< 0.0005	**0.67**	--	**0.065**	**0.0017**	--	< 0.8
MW-66A	Downgradient	Alluvial	12/5/2018	**1.2**	**830**	**4,600**	**0.93 J,UJ**	**8.1 J**	**2,900**	**11,000**	< 0.0010	**0.0034**	--	**0.095**	--	**0.00029**	**0.0098**	**0.0026**	--	**0.93 J,UJ**	**0.0040**	**0.51**	< 0.00020	**0.016**	**0.031**	**0.00015**	< 0.6
MW-66A	Downgradient	Alluvial	2/14/2019	--	--	--	**1.1**	--	--	--	< 0.0010	**0.0021**	--	**0.016**	< 0.0010	**0.00027**	< 0.0010	**0.0013**	--	**1.1**	< 0.00050	**0.55**	< 0.00020	**0.014**	**0.027**	**0.00012**	< 0.6
MW-66A	Downgradient	Alluvial	4/11/2019	**1.5**	**790**	**4,300**	**1.4**	**7.2 J**	**2,800**	**11,000**	--	**0.0025**	--	**0.016**	--	**0.00028**	**0.21**	**0.0017**	--	**1.4**	< 0.0005	**0.50**	--	**0.039**	**0.027**	--	--

Groundwater Sampling Results for FAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																
			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			FAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			FAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
MW-66A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
MW-66A	Downgradient	Alluvial	11/26/2019	1.5	780	4,600	1.1	7.2 J	3,100	11,000	--	< 0.0020	--	0.016 J	--	0.00028	0.0026 J	< 0.0020	--	1.1	< 0.00050	0.48	--	0.015	0.026 J	--	--
MW-66A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
MW-66A	Downgradient	Alluvial	11/26/2019	1.5	780	4,600	1.1	7.2 J	3,100	11,000	--	0.0039	--	0.022 J	--	0.00038	0.016 J	< 0.0020	--	1.1	0.00061	0.48	--	0.016	0.060 J	--	--
MW-66A	Downgradient	Alluvial	5/5/2020	1.6	800	4,600	1.1	7.3 J	3,100	11,000	--	0.0017	0.0017	0.015	< 0.001	0.00027	0.016	0.0014	0.0010	1.1	< 0.0005	0.68	--	0.014	0.027	--	< 0.8
MW-67A	Downgradient	Alluvial	12/5/2018	0.38	1,500	5,000	1.0 J,UJ	6.9 J	1,500	9,300	< 0.0010	0.018	--	0.058	--	< 0.00010	0.0082	0.0058	--	1.0 J,UJ	0.0019	< 0.20	< 0.00020	0.0061	0.0011	< 0.00010	< 0.6
MW-67A	Downgradient	Alluvial	2/14/2019	--	--	--	< 0.80	--	--	--	< 0.0010	0.016	--	0.022	< 0.0010	< 0.00010	0.0012	0.0037	--	< 0.80	< 0.00050	< 0.20	< 0.00020	0.0050	0.00066	< 0.00010	1.4
MW-67A	Downgradient	Alluvial	4/11/2019	0.37	1,500	4,900	< 0.80	6.9 J	1,500	11,000	--	0.016	--	0.023	--	< 0.0001	< 0.001	0.0041	--	< 0.80	< 0.0005	< 0.20	--	0.0052	0.00075	--	--
MW-67A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.9
MW-67A	Downgradient	Alluvial	11/26/2019	0.38	1,500	5,000	< 0.80	6.8 J	1,500	11,000	--	0.015	--	0.026	--	< 0.00010	< 0.0040	0.0042	--	< 0.80	< 0.00050	< 0.20	--	0.0052	< 0.0020	--	--
MW-67A	Downgradient	Alluvial	5/5/2020	0.36	1,700	5,400	0.95	7.1 J	1,500	11,000	--	0.017	0.015	0.028	< 0.001	< 0.0001	< 0.002	0.0045	0.0038	0.95	< 0.0005	0.25	--	0.0043	< 0.001	--	< 0.8
W-123	Downgradient	Moenkopi-Moqui	12/3/2015	36	790	6,100	3.7	7.55	3,400	13,000	< 0.0025	0.0027	--	0.011	< 0.0010	< 0.00010	0.00099	0.0023	--	3.7	0.00094	0.60	< 0.00020	0.35	0.0017	0.00026	0.7
W-123	Downgradient	Moenkopi-Moqui	3/8/2016	34	800	6,100	3.6	7.47	3,300	14,000	< 0.015	< 0.0049	--	0.011	< 0.0010	< 0.00046	< 0.0087	0.0025 J	--	3.6	< 0.0044	0.58	< 0.00020	0.34	0.0023 J	0.00030 J	< 0.4
W-123	Downgradient	Moenkopi-Moqui	5/6/2016	35	830	6,200	3.6	--	3,300	14,000	0.00026	0.0021	--	0.012	< 0.0010	< 0.00010	0.0010	0.0019	--	3.6	< 0.00050	0.60	< 0.00020	0.33	0.0024	< 0.00010	< 0.8
W-123	Downgradient	Moenkopi-Moqui	8/25/2016	36	800	5,900	4.1	7.6	3,600	14,000	0.00055	0.0025	--	0.0097	< 0.0010	< 0.00010	0.0018	0.0020	--	4.1	< 0.00050	0.62	< 0.00020	0.36	0.0032	< 0.00010	0.5
W-123	Downgradient	Moenkopi-Moqui	9/22/2016	37	810	6,000	3.7	7.7	3,600	15,000	< 0.0010	0.0019	--	0.0096	< 0.0010	< 0.00020	0.041	0.0020	--	3.7	< 0.00020	0.64	< 0.00020	0.34	0.0033	< 0.00020	0.6
W-123	Downgradient	Moenkopi-Moqui	2/20/2017	37	860	6,200	< 8.0	7.6	3,400	13,000	< 0.0010	0.0017	--	0.0094	< 0.0010	< 0.00010	0.13	0.0014	--	< 8.0	< 0.00050	0.66	< 0.00020	0.34	0.0031	< 0.00010	< 0.6
W-123	Downgradient	Moenkopi-Moqui	4/13/2017	35	880	6,600	4.0	8.1	3,600	14,000	< 0.0010	0.0020	--	0.010	< 0.0010	< 0.00010	0.045	0.0014	--	4.0	< 0.00050	0.59	< 0.00020	0.36	0.0034	< 0.00010	< 0.6
W-123	Downgradient	Moenkopi-Moqui	4/26/2017	34	780	6,300	3.5	7.7	3,600	14,000	< 0.0010	0.0017	--	0.010	< 0.0010	< 0.00010	0.016	0.0014	--	3.5	< 0.0010	0.64	< 0.00020	0.35	0.0033	< 0.00020	< 0.6
W-123	Downgradient	Moenkopi-Moqui	5/22/2017	35	850	6,300	3.8	7.6	3,500	14,000	< 0.0010	0.0014	--	0.0095	< 0.0010	< 0.00010	0.0099	0.0012	--	3.8	< 0.00050	0.65	< 0.00020	0.30	0.0032	< 0.00010	< 0.6
W-123	Downgradient	Moenkopi-Moqui	5/24/2017	34	810	6,200	3.8	7.6	3,500	14,000	< 0.0010	0.0020	--	0.010	< 0.0010	< 0.00010	0.018	0.0015	--	3.8	< 0.0020	0.68	< 0.00020	0.35	0.0038	< 0.00040	< 0.6
W-123	Downgradient	Moenkopi-Moqui	6/30/2017	35	810	6,700	3.8	7.5	3,700	14,000	< 0.0010	0.0020	--	0.011	< 0.0010	< 0.00010	0.0080	0.0013	--	3.8	< 0.00050	0.63	< 0.00020	0.33	0.0046	< 0.00010	< 0.7
W-123	Downgradient	Moenkopi-Moqui	7/27/2017	36	860	6,900	3.7	7.6	3,800	14,000	< 0.0020	0.0015	--	0.010	< 0.0010	< 0.00020	0.046	0.0017	--	3.7	< 0.0010	0.66	< 0.00020	0.33	0.0043	< 0.00020	< 0.6
W-123	Downgradient	Moenkopi-Moqui	9/7/2017	36	870	6,700	3.7	7.5	3,600	14,000	< 0.0040	< 0.0020	--	0.011	< 0.0010	< 0.00040	0.097	0.0022	--	3.7	< 0.0020	0.70	< 0.00020	0.36	0.0045	< 0.00040	< 0.7
W-123	Downgradient	Moenkopi-Moqui	12/8/2017	37	890	6,700	4.1	7.6	3,600	14,000	--	--	--	--	--	--	--	--	--	4.1	--	--	--	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	2/14/2018	--	--	--	4.2	--	--	--	< 0.0020	0.0018	--	0.010	< 0.0010	< 0.00020	0.12	0.0021	--	4.2	< 0.0010	0.63	< 0.00020	0.37	0.0035	< 0.00020	0.5
W-123	Downgradient	Moenkopi-Moqui	5/21/2018	35	790	6,400	4.3	7.5	3,600	15,000	--	0.0030	--	0.011	--	< 0.00020	0.084	< 0.0020	--	4.3	< 0.0010	0.63	--	0.38	0.0058	--	0.8
W-123	Downgradient	Moenkopi-Moqui	10/24/2018	36	850	6,700	3.9	7.7	3,600	15,000	--	0.0027	--	0.0092	--	< 0.00010	0.045	0.0015	--	3.9	< 0.00050	0.65	--	0.36	0.0056	--	< 0.7
W-123	Downgradient	Moenkopi-Moqui	10/24/2018	37	850	6,600	4.0	7.7	3,600	14,000	--	0.0026	--	0.0092	--	< 0.00010	0.043	0.0016	--	4.0	< 0.00050	0.65	--	0.37	0.0059	--	< 0.6
W-123	Downgradient	Moenkopi-Moqui	2/13/2019	--	--	--	3.7	--	--	--	< 0.0010	0.0024	--	0.010	< 0.0010	< 0.00010	0.12	0.0018	--	3.7	< 0.00050	0.75	< 0.00020	0.37	0.0063	< 0.00010	< 0.6
W-123	Downgradient	Moenkopi-Moqui	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
W-123	Downgradient	Moenkopi-Moqui	4/11/2019	37	790	6,200	3.9	7.6 J	3,400	14,000	--	0.0019	--	0.011	--	< 0.0001	0.097	0.0019	--	3.9	< 0.0005	0.67	--	0.41	0.0053	--	< 0.7
W-123	Downgradient	Moenkopi-Moqui	8/1/2019	3.2	600	2,200	2.3	7.3 J	3,000	8,500	--	--	--	--	--	--	--	--	--	2.3	--	--	--	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
W-123	Downgradient	Moenkopi-Moqui	11/25/2019	35	780	6,600	3.6	7.6 J	3,700	15,000	--	0.0023	--	0.0097	--	< 0.0010	0.14	0.0026	--	3.6	< 0.00050	0.66	--	0.41	0.0052	--	--
W-123	Downgradient	Moenkopi-Moqui	5/6/2020	37	780	5,700	4.8	7.5 J	3,400	13,000	--	0.0012	0.0015	0.011	< 0.001	< 0.0001	0.076	0.0030	0.0023	4.8	< 0.0005	0.83	--	0.30	0.0027	--	< 0.8
W-125	Supplementary	Coconino	12/2/2015	0.17	130	820	0.57	7.24	320	1,900	< 0.0025	0.018	--	0.024	< 0.0010	< 0.00010	0.0014	0.0036	--	0.57	0.00066	< 0.20	< 0.00020	0.0018	0.00013	< 0.00010	5.4
W-125	Supplementary	Coconino	3/9/2016	0.15	120	780	0.48	7.63	330	1,800	< 0.015	< 0.0049	--	0.018	< 0.0010	< 0.00046	< 0.0087	< 0.0013	--	0.48	< 0.0044	< 0.20	< 0.00020	< 0.0040	< 0.0015	0.00040 J	2.0
W-125	Supplementary	Coconino	5/22/2016	0.16	120	810	0.53	--	320	1,900	0.00031	0.0087	--	0.019	< 0.0010	< 0.00010	< 0.00050	0.0016	--	0.53	< 0.00050	< 0.20	< 0.00020	0.0017	< 0.00050	< 0.00010	2.6
W-125	Supplementary	Coconino	8/26/2016	0.16	130	820	0.55	7.4	320	1,900	0.00018	0.0081	--	0.028	< 0.0010	< 0.00010	0.00060	0.0043	--	0.55	< 0.00050	< 0.20	< 0.00020	0.037	< 0.00050	< 0.00010	5.5
W-125	Supplementary	Coconino	9/23/2016	0.17	120	760	0.57	7.6	310	1,900	< 0.00050	0.0046	--	0.024	< 0.0010	< 0.00010	< 0.00050	0.0022	--	0.57	< 0.00010	< 0.20	< 0.00020	0.014	0.00069	< 0.00010	1.2
W-125	Supplementary	Coconino	2/20/2017	0.17	130	760	< 4.0	7.5	320	1,800	< 0.0010	0.0043	--	0.020	< 0.0010	< 0.00010	< 0.00050	0.0012	--	< 4.0	< 0.00050	< 0.20	< 0.00020	0.0024	< 0.00050	< 0.00010	3.0
W-125	Supplementary	Coconino	4/13/2017	0.16	130	810	0.52	7.9	320	1,900	< 0.0010	0.0039	--	0.020	< 0.0010	< 0.00010	< 0.00050	0.00097	--	0.52	< 0.00050	< 0.20	< 0.00020	0.0025	< 0.00050	< 0.00010	2.5
W-125	Supplementary	Coconino	4/26/2017	0.17	120	760	0.54	7.7	320	1,900	< 0.0010	0.0035	--	0.020	< 0.0010	< 0.00010	< 0.00050	0.00069	--	0.54	< 0.00050	< 0.20	< 0.00020	0.0026	< 0.00050	< 0.00010	3.5
W-125	Supplementary	Coconino	5/22/2017	0.17	130	790	0.53	7.7	320	1,800	< 0.0010	0.0024	--	0.017	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	0.53	< 0.00050	< 0.20	< 0.00020	0.0020	< 0.00050	< 0.00010	1.3
W-125	Supplementary	Coconino	5/22/2017	0.17	130	790	0.52	7.8	320	1,800	< 0.0010	0.0026	--	0.018	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	0.52	< 0.00050	< 0.20	< 0.00020	0.0022	< 0.00050	< 0.00010	2.7
W-125	Supplementary	Coconino	5/24/2017	0.17	130	800	0.55	7.7	330	1,800	< 0.0040	0.0022	--	0.020	< 0.0010	< 0.00040	< 0.0020	< 0.0020	--	0.55	< 0.0020	< 0.20	< 0.00020	0.0031	< 0.0020	< 0.00040	3.1
W-125	Supplementary	Coconino	6/29/2017	0.15	120	800	0.56	7.7	340	1,800	< 0.0010	0.0028	--	0.020	< 0.0010	< 0.00010	< 0.00050	0.00063	--	0.56	< 0.00050	< 0.20	< 0.00020	0.0024	< 0.00050	< 0.00010	2.6
W-125	Supplementary	Coconino	7/27/2017	0.18	130	780	< 0.80	7.6	330	1,900	< 0.0020	0.0030	--	0.021	< 0.0010	< 0.00020	< 0.0010	< 0.0010	--	< 0.80	< 0.0010	< 0.20	< 0.00020	0.0024	< 0.0010	< 0.00020	2.8
W-125	Supplementary	Coconino	9/6/2017	0.17	130	800	0.54	7.6	330	1,800	< 0.0040	0.0026	--	0.021	< 0.0010	< 0.00040	< 0.0040	< 0.0020	--	0.54	< 0.0020	< 0.20	< 0.00020	0.0026	< 0.0020	< 0.00040	1.2
W-125	Supplementary	Coconino	9/6/2017	0.17	130	800	0.54	7.6	330	1,900	< 0.0040	0.0027	--	0.020	< 0.0010	< 0.00040	< 0.0040	< 0.0020	--	0.54	< 0.0020	< 0.20	< 0.00020	0.0027	< 0.0020	< 0.00040	2.8
W-125	Supplementary	Coconino	5/6/2020	--	130	680	< 0.8	--	320	--	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	1/3/2018	--	--	6,100	3.7	--	3,800	--	--	--	--	--	--	--	--	--	--	3.7	--	--	--	--	--	--	--

Groundwater Sampling Results for FAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																
			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			FAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			FAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
W-126	Downgradient	Moenkopi-Moqui	12/5/2018	**43**	**760**	**7,400**	**3.5 J,UJ**	**7.4 J**	**4,200**	**17,000**	< 0.0010	**0.0027 J**	--	**0.021 J**	--	< 0.00010	**0.0026 J**	**0.0049 J**	--	**3.5 J,UJ**	**0.00072**	**0.78 J**	< 0.00020	**0.20**	**0.0015 J**	**0.00015**	< 0.6
W-126	Downgradient	Moenkopi-Moqui	4/11/2019	**46**	**740**	**6,700**	**3.7**	**7.4 J**	**3,900**	**16,000**	--	**0.0017**	--	**0.011**	--	< 0.0001	**0.0085 J**	**0.0042**	--	**3.7**	< 0.0005	**0.73**	--	**0.22**	**0.0020**	--	--
W-126	Downgradient	Moenkopi-Moqui	5/15/2019	--	--	--	**4.0**	--	--	--	--	--	--	--	--	--	--	--	--	**4.0**	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	6/24/2019	**45**	--	**7,000**	**3.8**	**7.4**	**3,800**	**17,000**	--	--	--	--	--	< 0.00010	**0.012**	--	--	**3.8**	< 0.00050	--	--	--	--	**0.00012**	--
W-126	Downgradient	Moenkopi-Moqui	7/11/2019	--	--	**7,200**	**3.7**	--	**3,900**	--	--	--	--	--	--	--	--	--	--	**3.7**	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	8/19/2019	--	--	**7,200**	**2.8**	--	**4,200**	--	--	--	--	--	--	--	--	--	--	**2.8**	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/14/2019	--	--	**7,200**	**4.1**	--	**4,200**	--	--	--	--	--	--	--	--	--	--	**4.1**	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/14/2019	--	--	**7,000**	**4.0**	--	**4,200**	--	--	--	--	--	--	--	--	--	--	**4.0**	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
W-126	Downgradient	Moenkopi-Moqui	11/26/2019	**48**	**720**	**7,000**	**3.6**	**7.3 J**	**4,200**	**15,000**	--	**0.0023**	--	**0.010**	--	< 0.00040	**0.019**	**0.0040**	--	**3.6**	< 0.00050	**0.70**	--	**0.21**	< 0.0020	--	--
W-126	Downgradient	Moenkopi-Moqui	5/5/2020	**50**	**780**	**6,900**	**4.1**	**7.5 J**	**4,100**	**16,000**	--	**0.0014**	**0.0023**	**0.011**	< 0.001	< 0.0002	**0.0053**	**0.0038**	**0.0036**	**4.1**	< 0.0005	**1.1**	--	**0.22**	**0.0015**	--	< 0.8

Groundwater Sampling Results for FAP Monitoring Wells

				Additional Analyses																					
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SiO2, Silica	Sodium	Total Organic Carbon	Uranium
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L	mg/L
			FAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			FAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	2/20/2017	520	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	17	0.8	< 0.6	--	3,600	--	--
M-64A	Background	Alluvial	2/20/2017	520	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	17	< 0.4	< 0.6	--	3,600	--	--
M-64A	Background	Alluvial	4/12/2017	520	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	14	< 0.4	0.8	--	3,700	--	--
M-64A	Background	Alluvial	4/12/2017	520	< 6.0	< 6.0	--	--	--	--	210	--	--	--	--	--	--	--	14	< 0.5	< 0.6	--	3,800	--	--
M-64A	Background	Alluvial	4/25/2017	530	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	14	0.8	0.8	--	3,600	--	--
M-64A	Background	Alluvial	5/18/2017	530	< 6.0	< 6.0	--	--	--	--	230	--	--	--	--	--	--	--	14	< 0.5	1.3	--	3,600	--	--
M-64A	Background	Alluvial	5/24/2017	530	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	13	< 0.3	1.1	--	3,600	--	--
M-64A	Background	Alluvial	5/24/2017	530	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	14	0.4	< 0.6	--	3,700	--	--
M-64A	Background	Alluvial	6/30/2017	450	< 6.0	< 6.0	--	--	--	--	210	--	--	--	--	--	--	--	14	< 0.4	< 0.7	--	3,700	--	--
M-64A	Background	Alluvial	7/27/2017	470	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	14	< 0.4	< 0.7	--	3,600	--	--
M-64A	Background	Alluvial	7/27/2017	470	< 6.0	< 6.0	--	--	--	--	220	--	--	--	--	--	--	--	15	< 0.4	< 0.7	--	3,700	--	--
M-64A	Background	Alluvial	9/7/2017	460	< 6.0	< 6.0	--	--	--	--	210	--	--	--	--	--	--	--	14	< 0.5	< 0.7	--	3,700	--	--
M-64A	Background	Alluvial	12/8/2017	540	< 6.0	< 6.0	--	--	--	--	210	--	--	--	--	--	--	--	14	--	--	--	3,000	--	--
M-64A	Background	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	0.7	--	--	--	--
M-64A	Background	Alluvial	2/15/2018	520	< 6.0	< 6.0	--	--	--	--	200	--	--	--	--	--	--	--	13	< 0.5	< 0.7	--	4,000	--	--
M-64A	Background	Alluvial	5/19/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.6	--	--	--	--
M-64A	Background	Alluvial	2/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--	--
M-64A	Background	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/24/2019	470	< 6	< 6	0.75	5.5	5.5	4.8	220	2.3	1.9	--	< 0.5	--	--	--	19	< 0.4	< 0.8	--	3,800	5.5	--
M-64A	Background	Alluvial	5/6/2020	490	< 6	< 6	0.73	5.0	5.5	5.0	230	2.2	1.9	--	< 0.5	--	--	--	20	< 0.4	< 0.8	--	3,400	5.1	--
M-64A	Background	Alluvial	5/6/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.261	0.704	--	--	--	--
M-44D	Supplementary	Coconino	12/2/2015	120	< 6.0	< 6.0	--	--	--	--	48	--	--	--	--	--	--	--	4.4	2.8	1.0	6.2	670	--	--
M-44D	Supplementary	Coconino	3/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8	1.3	--	--	--	--
M-44D	Supplementary	Coconino	5/22/2016	120	< 6.0	< 6.0	--	--	--	--	47	--	--	--	--	--	--	--	4.1	2.7	1.2	5.6	670	--	--
M-44D	Supplementary	Coconino	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3	2.3	--	--	--	--
M-44D	Supplementary	Coconino	9/23/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3	2.1	--	--	--	--
M-44D	Supplementary	Coconino	2/20/2017	120	< 6.0	< 6.0	--	--	--	--	48	--	--	--	--	--	--	--	4.6	2.6	1.0	--	680	--	--
M-44D	Supplementary	Coconino	4/13/2017	120	< 6.0	< 6.0	--	--	--	--	47	--	--	--	--	--	--	--	4.3	2.0	2.2	--	640	--	--
M-44D	Supplementary	Coconino	4/24/2017	120	< 6.0	< 6.0	--	--	--	--	48	--	--	--	--	--	--	--	4.5	2.0	< 0.6	--	680	--	--
M-44D	Supplementary	Coconino	4/24/2017	120	< 6.0	< 6.0	--	--	--	--	48	--	--	--	--	--	--	--	4.5	1.7	0.7	--	670	--	--
M-44D	Supplementary	Coconino	5/22/2017	120	< 6.0	< 6.0	--	--	--	--	49	--	--	--	--	--	--	--	4.5	2.5	1.1	--	680	--	--
M-44D	Supplementary	Coconino	5/25/2017	120	< 6.0	< 6.0	--	--	--	--	50	--	--	--	--	--	--	--	4.7	2.1	2.6	--	700	--	--
M-44D	Supplementary	Coconino	6/29/2017	100	< 6.0	< 6.0	--	--	--	--	47	--	--	--	--	--	--	--	4.1	3.1	1.5	--	640	--	--
M-44D	Supplementary	Coconino	7/29/2017	120	< 6.0	< 6.0	--	--	--	--	50	--	--	--	--	--	--	--	4.5	2.2	1.0	--	670	--	--
M-44D	Supplementary	Coconino	9/5/2017	120	< 6.0	< 6.0	--	--	--	--	49	--	--	--	--	--	--	--	4.5	2.9	1.4	--	680	--	--
M-44D	Supplementary	Coconino	5/7/2020	100	< 6	< 6	--	--	--	--	49	--	--	--	--	--	--	--	4.8	--	--	--	630	--	--
M-46A	Supplementary	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	1.0	--	--	--	--
M-46A	Supplementary	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-46A	Supplementary	Alluvial	5/5/2020	200	< 6	< 6	0.82	3.8	1.0	0.68	240	3.8	3.6 J	--	< 0.5 UJ	--	--	--	21	< 0.4	< 0.8	--	2,700	3.2 J	--
M-50A	Downgradient	Alluvial	12/2/2015	170	< 6.0	< 6.0	--	--	--	--	250	--	--	--	--	--	--	--	8.8	< 0.4	< 0.7	16	1,900	--	--
M-50A	Downgradient	Alluvial	12/2/2015	180	< 6.0	< 6.0	--	--	--	--	250	--	--	--	--	--	--	--	8.7	< 0.4	< 0.7	16	1,900	--	--
M-50A	Downgradient	Alluvial	3/8/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.5	--	--	--	--
M-50A	Downgradient	Alluvial	5/5/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	< 0.8	--	--	--	--
M-50A	Downgradient	Alluvial	8/25/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
M-50A	Downgradient	Alluvial	9/23/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	1.1	--	--	--	--
M-50A	Downgradient	Alluvial	2/21/2017	170	< 6.0	< 6.0	--	--	--	--	240	--	--	--	--	--	--	--	8.7	< 0.4	< 0.6	--	1,800	--	--

Groundwater Sampling Results for FAP Monitoring Wells

				Additional Analyses																					
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SiO2, Silica	Sodium	Total Organic Carbon	Uranium
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L	mg/L
			FAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			FAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-50A	Downgradient	Alluvial	4/13/2017	**180**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	**7.9**	< 0.6	< 0.6	--	**1,700**	--	--
M-50A	Downgradient	Alluvial	4/26/2017	**180**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	**8.0**	< 0.4	< 0.6	--	**1,800**	--	--
M-50A	Downgradient	Alluvial	5/18/2017	**180**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	**8.1**	**0.6**	< 0.6	--	**1,800**	--	--
M-50A	Downgradient	Alluvial	5/24/2017	**180**	< 6.0	< 6.0	--	--	--	--	**250**	--	--	--	--	--	--	--	**8.8**	**0.8**	< 0.6	--	**1,900**	--	--
M-50A	Downgradient	Alluvial	6/30/2017	**180**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	**7.8**	< 0.5	< 0.7	--	**1,800**	--	--
M-50A	Downgradient	Alluvial	7/27/2017	**180**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	**8.1**	< 0.4	< 0.7	--	**1,800**	--	--
M-50A	Downgradient	Alluvial	9/7/2017	**180**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	**8.3**	< 0.4	< 0.6	--	**1,800**	--	--
M-50A	Downgradient	Alluvial	12/8/2017	**180**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	**8.4**	--	--	--	**1,700**	--	--
M-50A	Downgradient	Alluvial	2/14/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.2**	**0.1**	--	--	--	--
M-50A	Downgradient	Alluvial	2/14/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**	**0.4**	--	--	--	--
M-50A	Downgradient	Alluvial	5/21/2018	**180**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	**7.5**	**0.4**	< 0.6	--	**1,700**	--	--
M-50A	Downgradient	Alluvial	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
M-50A	Downgradient	Alluvial	2/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.9**	--	--	--	--
M-50A	Downgradient	Alluvial	2/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.6	--	--	--	--
M-50A	Downgradient	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-50A	Downgradient	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.6	< 0.7	--	--	--	--
M-50A	Downgradient	Alluvial	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
M-50A	Downgradient	Alluvial	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-50A	Downgradient	Alluvial	5/6/2020	**160**	< 6	< 6	< 0.5	**2.9 J**	< 0.1	< 0.1	**200**	**0.25**	**0.23**	--	< 0.5	--	--	--	**9.8**	< 0.4	< 0.8	--	**1,600**	**2.9**	--
M-51A	Downgradient	Alluvial	12/2/2015	**99**	< 6.0	< 6.0	--	--	--	--	**370**	--	--	--	--	--	--	--	**36**	< 0.5	< 0.9	**13**	**3,600**	--	--
M-51A	Downgradient	Alluvial	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.9	--	--	--	--
M-51A	Downgradient	Alluvial	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.8	--	--	--	--
M-51A	Downgradient	Alluvial	5/5/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.8	--	--	--	--
M-51A	Downgradient	Alluvial	8/25/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
M-51A	Downgradient	Alluvial	9/23/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
M-51A	Downgradient	Alluvial	2/21/2017	**94**	< 6.0	< 6.0	--	--	--	--	**330**	--	--	--	--	--	--	--	**33**	< 0.4	**0.6**	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	4/13/2017	**97**	< 6.0	< 6.0	--	--	--	--	**330**	--	--	--	--	--	--	--	**32**	< 0.6	< 0.6	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	4/26/2017	**97**	< 6.0	< 6.0	--	--	--	--	**330**	--	--	--	--	--	--	--	**34**	< 0.4	< 0.6	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	5/18/2017	**100**	< 6.0	< 6.0	--	--	--	--	**320**	--	--	--	--	--	--	--	**35**	< 0.4	< 0.6	--	**3,400**	--	--
M-51A	Downgradient	Alluvial	5/24/2017	**100**	< 6.0	< 6.0	--	--	--	--	**360**	--	--	--	--	--	--	--	**38**	< 0.4	**0.6**	--	**3,600**	--	--
M-51A	Downgradient	Alluvial	6/30/2017	**99**	< 6.0	< 6.0	--	--	--	--	**330**	--	--	--	--	--	--	--	**36**	< 0.5	< 0.7	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	6/30/2017	**99**	< 6.0	< 6.0	--	--	--	--	**340**	--	--	--	--	--	--	--	**37**	< 0.5	< 0.7	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	7/27/2017	**98**	< 6.0	< 6.0	--	--	--	--	**340**	--	--	--	--	--	--	--	**39**	< 0.4	< 0.7	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	9/7/2017	**99**	< 6.0	< 6.0	--	--	--	--	**340**	--	--	--	--	--	--	--	**38**	< 0.4	< 0.6	--	**3,500**	--	--
M-51A	Downgradient	Alluvial	12/8/2017	**95**	< 6.0	< 6.0	--	--	--	--	**310**	--	--	--	--	--	--	--	**34**	--	--	--	**3,300**	--	--
M-51A	Downgradient	Alluvial	2/14/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**	**0.1**	--	--	--	--
M-51A	Downgradient	Alluvial	5/21/2018	**95**	< 6.0	< 6.0	--	--	--	--	**290**	--	--	--	--	--	--	--	**31**	< 0.4	< 0.6	--	**3,800**	--	--
M-51A	Downgradient	Alluvial	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
M-51A	Downgradient	Alluvial	2/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.6	--	--	--	--
M-51A	Downgradient	Alluvial	4/10/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.6	< 0.7	--	--	--	--
M-51A	Downgradient	Alluvial	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
M-51A	Downgradient	Alluvial	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-51A	Downgradient	Alluvial	5/6/2020	**83**	< 6	< 6	< 0.5	**1.8**	< 0.1	< 0.1	**280**	**0.89**	**0.84**	--	< 0.5	--	--	--	**35**	< 0.4	< 0.8	--	**3,000**	**1.7**	--
MW-65A	Downgradient	Alluvial	12/5/2018	**100**	< 6.0	< 6.0	--	--	--	--	**470**	--	--	--	--	--	--	--	**89**	< 0.4	**0.9**	**20**	**4,000**	--	--
MW-65A	Downgradient	Alluvial	12/5/2018	**160**	< 6.0	< 6.0	--	--	--	--	**290**	--	--	--	--	--	--	--	**28**	< 0.4	**0.9**	**32**	**2,000**	--	--
MW-65A	Downgradient	Alluvial	2/14/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.6	--	--	--	--
MW-65A	Downgradient	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-65A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
MW-65A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-65A	Downgradient	Alluvial	5/5/2020	**150**	< 6	< 6	< 0.5	**2.4**	< 0.1	< 0.1	**270**	**0.31**	**0.29**	--	< 0.5	--	--	--	**30**	< 0.4	< 0.8	--	**1,900**	**2.1**	--
MW-66A	Downgradient	Alluvial	12/5/2018	**80**	< 6.0	< 6.0	--	--	--	--	**280**	--	--	--	--	--	--	--	**11**	< 0.4	< 0.6	**55**	**2,500**	--	--
MW-66A	Downgradient	Alluvial	2/14/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
MW-66A	Downgradient	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Groundwater Sampling Results for FAP Monitoring Wells

			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SiO2, Silica	Sodium	Total Organic Carbon	Uranium
				Additional Analyses																					
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L	mg/L
			FAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			FAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-66A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
MW-66A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-66A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
MW-66A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-66A	Downgradient	Alluvial	5/5/2020	**150**	< 6	< 6	< 0.5	**2.3**	**0.23**	**0.15**	**280**	**4.3**	**4.1**	--	< 0.5	--	--	--	**14**	< 0.4	< 0.8	--	**2,400**	**2.7**	--
MW-67A	Downgradient	Alluvial	12/5/2018	**180**	< 6.0	< 6.0	--	--	--	--	**270**	--	--	--	--	--	--	--	**12**	< 0.4	< 0.6	**41**	**1,400**	--	--
MW-67A	Downgradient	Alluvial	2/14/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**1.4**	--	--	--	--
MW-67A	Downgradient	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-67A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.9**	--	--	--	--
MW-67A	Downgradient	Alluvial	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-67A	Downgradient	Alluvial	5/5/2020	**170**	< 6	< 6	**1.4**	**2.2**	**8.0**	**7.8**	**290**	**5.1**	**4.9**	--	< 0.5	--	--	--	**14**	< 0.4	< 0.8	--	**1,500**	**2.3**	--
W-123	Downgradient	Moenkopi-Moqui	12/3/2015	**59**	< 6.0	< 6.0	--	--	--	--	**310**	--	--	--	--	--	--	--	**34**	**0.7**	< 0.7	**15**	**4,000**	--	--
W-123	Downgradient	Moenkopi-Moqui	3/8/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.4	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	5/6/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.8	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	8/25/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	< 0.6	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.6**	< 0.7	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	2/20/2017	**68**	< 6.0	< 6.0	--	--	--	--	**310**	--	--	--	--	--	--	--	**47**	< 0.4	< 0.6	--	**3,900**	--	--
W-123	Downgradient	Moenkopi-Moqui	4/13/2017	**69**	< 6.0	< 6.0	--	--	--	--	**300**	--	--	--	--	--	--	--	**43**	< 0.4	< 0.6	--	**3,800**	--	--
W-123	Downgradient	Moenkopi-Moqui	4/26/2017	**70**	< 6.0	< 6.0	--	--	--	--	**290**	--	--	--	--	--	--	--	**44**	< 0.4	< 0.6	--	**3,700**	--	--
W-123	Downgradient	Moenkopi-Moqui	5/22/2017	**73**	< 6.0	< 6.0	--	--	--	--	**310**	--	--	--	--	--	--	--	**48**	< 0.5	< 0.6	--	**4,100**	--	--
W-123	Downgradient	Moenkopi-Moqui	5/24/2017	**72**	< 6.0	< 6.0	--	--	--	--	**290**	--	--	--	--	--	--	--	**44**	< 0.3	< 0.6	--	**3,800**	--	--
W-123	Downgradient	Moenkopi-Moqui	6/30/2017	**77**	< 6.0	< 6.0	--	--	--	--	**310**	--	--	--	--	--	--	--	**47**	< 0.4	< 0.7	--	**3,900**	--	--
W-123	Downgradient	Moenkopi-Moqui	7/27/2017	**79**	< 6.0	< 6.0	--	--	--	--	**310**	--	--	--	--	--	--	--	**51**	< 0.4	< 0.6	--	**3,900**	--	--
W-123	Downgradient	Moenkopi-Moqui	9/7/2017	**84**	< 6.0	< 6.0	--	--	--	--	**320**	--	--	--	--	--	--	--	**52**	< 0.5	< 0.7	--	**3,900**	--	--
W-123	Downgradient	Moenkopi-Moqui	12/8/2017	**69**	< 6.0	< 6.0	--	--	--	--	**300**	--	--	--	--	--	--	--	**48**	--	--	--	**3,800**	--	--
W-123	Downgradient	Moenkopi-Moqui	2/14/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**	**0.4**	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	5/21/2018	**74**	< 6.0	< 6.0	--	--	--	--	**290**	--	--	--	--	--	--	--	**45**	< 0.4	**0.8**	--	**4,500**	--	--
W-123	Downgradient	Moenkopi-Moqui	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	2/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.6	< 0.7	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.6	< 0.7	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-123	Downgradient	Moenkopi-Moqui	5/6/2020	**54**	< 6	< 6	< 0.5	**1.9**	**0.16**	< 0.1	**270**	< 0.01	< 0.01	--	**0.83**	--	--	--	**48**	< 0.4	< 0.8	--	**3,500**	**2.1**	--
W-125	Supplementary	Coconino	12/2/2015	**170**	< 6.0	< 6.0	--	--	--	--	**51**	--	--	--	--	--	--	--	**3.7**	**2.8**	**2.6**	**12**	**500**	--	--
W-125	Supplementary	Coconino	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.4**	**0.6**	--	--	--	--
W-125	Supplementary	Coconino	5/22/2016	**170**	< 6.0	< 6.0	--	--	--	--	**48**	--	--	--	--	--	--	--	**3.5**	**1.3**	**1.3**	**11**	**460**	--	--
W-125	Supplementary	Coconino	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**2.4**	**3.1**	--	--	--	--
W-125	Supplementary	Coconino	9/23/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.2**	< 0.7	--	--	--	--
W-125	Supplementary	Coconino	2/20/2017	**170**	< 6.0	< 6.0	--	--	--	--	**49**	--	--	--	--	--	--	--	**3.7**	**1.7**	**1.3**	--	**490**	--	--
W-125	Supplementary	Coconino	4/13/2017	**170**	< 6.0	< 6.0	--	--	--	--	**47**	--	--	--	--	--	--	--	**3.4**	**1.3**	**1.2**	--	**450**	--	--
W-125	Supplementary	Coconino	4/26/2017	**180**	< 6.0	< 6.0	--	--	--	--	**48**	--	--	--	--	--	--	--	**3.6**	**1.3**	**2.2**	--	**480**	--	--
W-125	Supplementary	Coconino	5/22/2017	**180**	< 6.0	< 6.0	--	--	--	--	**51**	--	--	--	--	--	--	--	**3.7**	**1.3**	< 0.6	--	**480**	--	--
W-125	Supplementary	Coconino	5/22/2017	**180**	< 6.0	< 6.0	--	--	--	--	**50**	--	--	--	--	--	--	--	**3.6**	**1.0**	**1.7**	--	**470**	--	--
W-125	Supplementary	Coconino	5/24/2017	**180**	< 6.0	< 6.0	--	--	--	--	**51**	--	--	--	--	--	--	--	**3.7**	**1.8**	**1.3**	--	**490**	--	--
W-125	Supplementary	Coconino	6/29/2017	**180**	< 6.0	< 6.0	--	--	--	--	**48**	--	--	--	--	--	--	--	**3.4**	**1.1**	**1.5**	--	**440**	--	--
W-125	Supplementary	Coconino	7/27/2017	**180**	< 6.0	< 6.0	--	--	--	--	**51**	--	--	--	--	--	--	--	**3.7**	**1.7**	**1.1**	--	**480**	--	--
W-125	Supplementary	Coconino	9/6/2017	**180**	< 6.0	< 6.0	--	--	--	--	**50**	--	--	--	--	--	--	--	**3.7**	< 0.5	**1.2**	--	**470**	--	--
W-125	Supplementary	Coconino	9/6/2017	**180**	< 6.0	< 6.0	--	--	--	--	**50**	--	--	--	--	--	--	--	**3.7**	**1.7**	**1.1**	--	**470**	--	--
W-125	Supplementary	Coconino	5/6/2020	**160**	< 6	< 6	--	--	--	--	**51**	--	--	--	--	--	--	--	**4.3**	--	--	--	**450**	--	--
W-126	Downgradient	Moenkopi-Moqui	1/3/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Groundwater Sampling Results for FAP Monitoring Wells

			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SiO2, Silica	Sodium	Total Organic Carbon	Uranium
				Additional Analyses																					
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L	mg/L
			FAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			FAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	12/5/2018	**100**	< 6.0	< 6.0	--	--	--	--	**470**	--	--	--	--	--	--	--	**91**	< 0.4	< 0.6	**24 J**	**4,000**	--	--
W-126	Downgradient	Moenkopi-Moqui	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	5/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	6/24/2019	--	--	--	--	--	--	--	--	--	--	< 0.10	< 0.10	< 0.10	< 0.10	< 0.50	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	7/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	8/19/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/14/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/14/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	11/26/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-126	Downgradient	Moenkopi-Moqui	5/5/2020	**95**	< 6	< 6	< 0.5	**2.3**	< 0.1	< 0.1	**500**	**0.12**	**0.10**	--	< 0.5	--	--	--	**87**	< 0.4	< 0.8	--	**4,200**	**2.3**	--

Notes:

BTV exceedances are shown in grey shaded cells. GWPS exceedence are shown in red text.

*Background well for the FAP and BAP.

Duplicate sample dates under the same locations are either field duplicates or are instances of samples with multiple filed/lab sample IDs on the same date.

Abbreviations and Data Qualifiers:

< = less than

BTV = Background Threshold Value

degrees C = degrees Celsius

FAP = Fly Ash Pond

GWPS = Groundwater Protection Standard

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/L = milligrams per liter

pCi/L = Picocuries per liter

su = standard units

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

umhos/cm = micromhos per centimeter

uS/cm = microsiemens per centimeter

Groundwater Sampling Results for the BAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																
			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			BAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-64A	Background	Alluvial	2/20/2017	**1.1**	**570**	**4,000**	< 8.0	**7.4**	**4,100**	**11,000**	< 0.0010	**0.00087**	--	**0.036**	< 0.0010	**0.00011**	**0.0018**	**0.0024**	--	< 8.0	< 0.00050	**0.26**	< 0.00020	**0.0065**	**0.00074**	< 0.00010	**0.8**
M-64A	Background	Alluvial	2/20/2017	**1.2**	**520**	**4,500**	< 0.80	**7.4**	**4,400**	**10,000**	< 0.0010	**0.00094**	--	**0.034**	< 0.0010	< 0.00010	**0.0021**	**0.0015**	--	< 0.80	< 0.00050	**0.27**	< 0.00020	**0.0061**	**0.00082**	< 0.00010	< 0.6
M-64A	Background	Alluvial	4/12/2017	**1.2**	**550**	**4,200**	< 2.0	**7.7**	**4,300**	**13,000**	< 0.0010	**0.0026**	--	**0.019**	< 0.0010	< 0.00010	**0.00078**	**0.00082**	--	< 2.0	< 0.00050	**0.25**	< 0.00020	**0.0053**	< 0.00050	< 0.00010	**0.8**
M-64A	Background	Alluvial	4/12/2017	**1.2**	**500**	**4,200**	< 0.80	**7.6**	**4,200**	**13,000**	< 0.0010	**0.0026**	--	**0.019**	< 0.0010	< 0.00010	**0.0015**	**0.00068**	--	< 0.80	**0.00071**	**0.25**	< 0.00020	**0.0050**	< 0.00050	< 0.00010	< 0.6
M-64A	Background	Alluvial	4/25/2017	**1.3**	**490**	**4,100**	< 0.80	**7.5**	**4,300**	**11,000**	< 0.0010	**0.0017**	--	**0.015**	< 0.0010	< 0.00010	< 0.00050	**0.00056**	--	< 0.80	< 0.00050	**0.27**	< 0.00020	**0.0050**	< 0.00050	< 0.00010	**1.6**
M-64A	Background	Alluvial	5/18/2017	**1.3**	**510**	**4,400**	< 0.80	**7.6**	**4,400**	**12,000**	< 0.0010	**0.0016**	--	**0.012**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	< 0.80	< 0.00050	**0.28**	< 0.00020	**0.0042**	< 0.00050	< 0.00010	**1.3**
M-64A	Background	Alluvial	5/24/2017	**1.2**	**520**	**4,000**	< 0.80	**7.4**	**4,100**	**12,000**	< 0.0010	**0.0023**	--	**0.014**	< 0.0010	< 0.00010	**0.00063**	**0.00052**	--	< 0.80	< 0.0020	**0.27**	< 0.00020	**0.0050**	< 0.00050	< 0.00040	**1.1**
M-64A	Background	Alluvial	5/24/2017	**1.3**	**520**	**4,200**	< 0.80	**7.4**	**4,400**	**12,000**	< 0.0010	**0.0019**	--	**0.014**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	--	< 0.80	< 0.0020	**0.27**	< 0.00020	**0.0051**	< 0.00050	< 0.00040	**0.4**
M-64A	Background	Alluvial	6/30/2017	**1.2**	**600**	**5,100**	< 0.80	**7.3**	**4,700**	**13,000**	< 0.0010	**0.0033**	--	**0.017**	< 0.0010	< 0.00010	< 0.00050	**0.0011**	--	< 0.80	< 0.00050	**0.25**	< 0.00020	**0.0050**	< 0.00050	< 0.00010	< 0.7
M-64A	Background	Alluvial	7/27/2017	**1.3**	**620**	**4,700**	< 0.80	**7.4**	**4,600**	**13,000**	< 0.0020	**0.0027**	--	**0.017**	< 0.0010	< 0.00020	< 0.0010	< 0.0010	--	< 0.80	< 0.0010	**0.25**	< 0.00020	**0.0051**	< 0.0010	< 0.00020	< 0.7
M-64A	Background	Alluvial	7/27/2017	**1.3**	**640**	**4,900**	< 0.80	**7.4**	**4,800**	**13,000**	< 0.0020	**0.0028**	--	**0.017**	< 0.0010	< 0.00020	< 0.0010	< 0.0010	--	< 0.80	< 0.0010	**0.25**	< 0.00020	**0.0051**	< 0.0010	< 0.00020	< 0.7
M-64A	Background	Alluvial	9/7/2017	**1.2**	**620**	**4,700**	< 0.80	**7.3**	**4,300**	**12,000**	< 0.0040	**0.0025**	--	**0.017**	< 0.0010	< 0.00040	< 0.0040	< 0.0020	--	< 0.80	< 0.0020	**0.26**	< 0.00020	**0.0059**	< 0.0020	< 0.00040	< 0.7
M-64A	Background	Alluvial	12/8/2017	**1.2**	**500**	**3,500**	< 0.80	**7.4**	**4,400**	**12,000**	--	--	--	--	--	--	--	--	--	< 0.80	--	--	--	--	--	--	--
M-64A	Background	Alluvial	2/15/2018	--	--	--	< 0.80	--	--	--	< 0.0020	< 0.0010	--	**0.015**	< 0.0010	< 0.00020	**0.0022**	< 0.00050	--	< 0.80	< 0.0010	**0.27**	< 0.00020	**0.0058**	< 0.00050	< 0.00020	**1.0**
M-64A	Background	Alluvial	5/19/2018	**1.4**	**460**	**4,700**	< 0.80	**7.3**	**4,600**	**13,000**	< 0.0020	**0.0012**	--	**0.012**	--	< 0.00020	< 0.0020	< 0.0010	--	< 0.80	< 0.0010	**0.26**	--	**0.0055**	< 0.0010	< 0.00020	< 0.7
M-64A	Background	Alluvial	10/22/2018	**1.3**	**500**	**4,100**	< 2.0	**7.3**	**4,000**	**12,000**	--	**0.0011**	--	**0.011**	--	< 0.00010	< 0.0010	< 0.00050	--	< 2.0	< 0.00050	**0.25**	--	**0.0050**	< 0.00050	< 0.00010	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-64A	Background	Alluvial	10/22/2018	**1.3**	**510**	**3,900**	< 0.80	**7.4**	**3,700**	**13,000**	--	**0.0013**	--	**0.011**	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.25**	--	**0.0052**	< 0.00050	< 0.00010	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-64A	Background	Alluvial	2/13/2019	--	--	--	< 0.80	--	--	--	< 0.0010	**0.00089**	--	**0.012**	< 0.0010	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.29**	< 0.00020	**0.0049**	**0.00052**	< 0.00010	< 0.6
M-64A	Background	Alluvial	4/11/2019	**1.3**	**500**	**4,400**	< 0.80	**7.3 J**	**4,300**	**12,000**	--	**0.00058**	--	**0.011**	--	< 0.0001	< 0.001	< 0.0005	--	< 0.80	< 0.0005	**0.27**	--	**0.0050**	**0.00053**	--	--
M-64A	Background	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	**0.00058**	--	**0.012**	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.25**	--	**0.0050**	**0.00078**	< 0.00010	< 0.7
M-64A	Background	Alluvial	8/1/2019	**1.3**	**450**	**4,300**	< 0.8	**7.4 J**	**4,300**	**12,000**	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
M-64A	Background	Alluvial	8/1/2019	**1.3**	**450**	**4,200**	< 0.8	**7.4 J**	**4,300**	**12,000**	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/24/2019	**1.2**	**460**	**8,400**	< 0.80	**7.5 J**	**8,600**	**13,000**	< 0.0020	**0.0018**	--	**0.013 J**	< 0.0010	< 0.00020	< 0.0020	< 0.0010	--	< 0.80	< 0.0010	**0.26**	< 0.00020	**0.0059**	< 0.0010	< 0.00020	--
M-64A	Background	Alluvial	5/6/2020	**1.3**	**510**	**4,100**	< 0.8	**7.6 J**	**4,100**	**12,000**	--	< 0.001	**0.00093**	**0.012**	< 0.001	< 0.0001	< 0.002	< 0.001	< 0.0005	< 0.8	< 0.0005	**0.47**	--	**0.0043**	< 0.001	--	< 0.8
M-64A	Background	Alluvial	5/6/2020	**1.2**	**520**	**3,900**	< 0.8	**7.3 J**	**3,900**	**12,000**	--	**0.00086**	**0.00050**	**0.013**	< 0.001	< 0.0001	< 0.001	< 0.0005	< 0.0005	< 0.8	< 0.0005	**0.47**	--	**0.0042**	< 0.001	--	< 0.8
M-52A	Downgradient	Alluvial/Moqui	12/1/2015	**3.9**	**790**	**3,600**	**0.53**	**6.99**	**3,000**	**9,600**	< 0.0025	**0.00050**	--	**0.027**	< 0.0010	**0.00071**	**0.0014**	**0.060**	--	**0.53**	< 0.00050	**0.27**	< 0.00020	**0.021**	**0.00074**	< 0.00010	**0.4**
M-52A	Downgradient	Alluvial/Moqui	3/9/2016	**3.4**	**780**	**3,800**	< 2.0	**7.01**	**2,700**	**10,000**	< 0.015	< 0.0049	--	**0.022**	< 0.0010	**0.0012 J**	< 0.0087	**0.054**	--	< 2.0	< 0.0044	**0.25**	< 0.00020	**0.016**	< 0.0015	**0.0015 J**	< 0.6
M-52A	Downgradient	Alluvial/Moqui	5/10/2016	**3.4**	**910**	**5,100**	< 2.0	--	**2,400**	**12,000**	< 0.00020	< 0.0010	--	**0.023**	< 0.0010	**0.00048**	< 0.0010	**0.043**	--	< 2.0	< 0.0010	**0.28**	< 0.00020	**0.013**	< 0.0010	< 0.00020	< 0.4
M-52A	Downgradient	Alluvial/Moqui	8/26/2016	**3.3**	**890**	**4,000**	**0.97**	**6.8**	**2,600**	**11,000**	**0.00012**	< 0.00050	--	**0.024**	< 0.0010	**0.0013**	**0.0012**	**0.061**	--	**0.97**	< 0.00050	**0.24**	< 0.00020	**0.040**	**0.00057**	< 0.00010	**0.6**
M-52A	Downgradient	Alluvial/Moqui	9/22/2016	**3.2**	**810**	**3,700**	**0.89**	**7.2**	**2,700**	**11,000**	< 0.00050	**0.00047**	--	**0.019**	< 0.0010	**0.0014**	**0.0011**	**0.054**	--	**0.89**	**0.00048**	**0.24**	< 0.00020	**0.050**	< 0.00060	**0.00011**	**0.6**
M-52A	Downgradient	Alluvial/Moqui	2/21/2017	**3.7**	**810**	**3,900**	**0.98**	**7.4**	**2,900**	**10,000**	< 0.0010	**0.00061**	--	**0.016**	< 0.0010	**0.00055**	**0.0042**	**0.044**	--	**0.98**	< 0.00050	**0.26**	< 0.00020	**0.020**	**0.00065**	< 0.00010	< 0.6
M-52A	Downgradient	Alluvial/Moqui	2/21/2017	**3.8**	**850**	**3,700**	**0.98**	**7.2**	**2,600**	**9,700**	< 0.0010	**0.00071**	--	**0.016**	< 0.0010	**0.00051**	**0.0058**	**0.043**	--	**0.98**	< 0.00050	**0.26**	< 0.00020	**0.021**	**0.00078**	< 0.00010	< 0.6
M-52A	Downgradient	Alluvial/Moqui	4/11/2017	**3.6**	**850**	**4,600**	**0.80**	**7.5**	**2,800**	**11,000**	< 0.0010	**0.00097**	--	**0.016**	< 0.0010	**0.00048**	**0.019**	**0.045**	--	**0.80**	< 0.00050	**0.24**	< 0.00020	**0.018**	**0.00079**	< 0.00010	< 0.6
M-52A	Downgradient	Alluvial/Moqui	4/25/2017	**3.6**	**810**	**4,100**	**0.99**	**7.0**	**2,700**	**11,000**	< 0.0010	< 0.00050	--	**0.015**	< 0.0010	**0.00049**	**0.014**	**0.041**	--	**0.99**	< 0.00050	**0.26**	< 0.00020	**0.018**	< 0.00050	< 0.00010	**0.9**
M-52A	Downgradient	Alluvial/Moqui	5/18/2017	**3.7**	**880**	**4,400**	**0.86**	**7.3**	**2,900**	**10,000**	< 0.0010	**0.00054**	--	**0.013**	< 0.0010	**0.00052**	**0.016**	**0.037**	--	**0.86**	< 0.00050	**0.27**	< 0.00020	**0.017**	**0.00052**	< 0.00010	**0.6**
M-52A	Downgradient	Alluvial/Moqui	5/24/2017	**3.6**	**850**	**4,300**	**0.96**	**7.2**	**2,800**	**10,000**	< 0.0010	**0.00050**	--	**0.016**	< 0.0010	**0.0006**	**0.034**	**0.044**	--	**0.96**	< 0.0020	**0.26**	< 0.00020	**0.024**	**0.00064**	< 0.00040	< 0.6
M-52A	Downgradient	Alluvial/Moqui	6/30/2017	**3.3**	**790**	**4,000**	**1.0**	**7.0**	**3,100**	**9,800**	< 0.0010	< 0.00050	--	**0.014**	< 0.0010	**0.0013**	**0.0071**	**0.051**	--	**1.0**	< 0.00050	**0.23**	< 0.00020	**0.038**	**0.00051**	< 0.00010	< 0.7
M-52A	Downgradient	Alluvial/Moqui	7/28/2017	**3.1**	**780**	**3,500**	**1.0**	**7.0**	**3,100**	**9,200**	< 0.0020	< 0.0010	--	**0.014**	< 0.0010	**0.0018**	**0.0046**	**0.063**	--	**1.0**	< 0.0010	**0.21**	< 0.00020	**0.062**	< 0.0010	< 0.00020	< 0.7
M-52A	Downgradient	Alluvial/Moqui	9/7/2017	**3.2**	**790**	**3,200**	**0.90**	**7.1**	**2,900**	**9,100**	< 0.0040	< 0.0020	--	**0.014**	< 0.0010	**0.0019**	< 0.0040	**0.066**	--	**0.90**	< 0.0020	**0.22**	< 0.00020	**0.071**	< 0.0020	< 0.00040	**0.6**
M-52A	Downgradient	Alluvial/Moqui	12/7/2017	**3.1**	**820**	**3,600**	**0.84**	**7.1**	**2,700**	**9,700**	--	--	--	--	--	--	--	--	--	**0.84**	--	--	--	--	--	--	--
M-52A	Downgradient	Alluvial/Moqui	2/15/2018	--	--	--	**1.1**	--	--	--	< 0.0010	**0.0018**	--	**0.017**	< 0.0010	**0.0011**	**0.011**	**0.052**	--	**1.1**	**0.0010**	**0.25**	< 0.00020	**0.048**	**0.00091**	**0.00018**	**0.9**
M-52A	Downgradient	Alluvial/Moqui	5/20/2018	**3.7**	**850**	**4,500**	**1.2**	**6.9**	**2,800**	**11,000**	< 0.0010	**0.01**	--	**0.026**	--	**0.015**	**0.051**	**0.100**	--	--	**0.0027**	**0.25**	--	**0.11**	**0.0017**	**0.00017**	--
M-52A	Downgradient	Alluvial/Moqui	6/7/2018	**3.5**	**810**	**4,600**	**0.99**	**6.8**	**2,900**	**11,000**	< 0.0010	**0.0026**	--	**0.018**	--	**0.00094**	**0.018**	**0.062**	--	**0.99**	**0.0010**	**0.24**	--	**0.052**	**0.0013**	**0.00013**	**0.7**
M-52A	Downgradient	Alluvial/Moqui	10/24/2018	**3.5**	**840**	**3,900**	**0.89**	**7.0**	**2,700**	**10,000**	--	**0.0025**	--	**0.016**	--	**0.0011**	**0.059**	**0.055**	--	**0.87**	**0.00057**	**0.24**	--	**0.061**	**0.00063**	< 0.00010	--
M-52A	Downgradient	Alluvial/Moqui	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-52A	Downgradient	Alluvial/Moqui	12/8/2018	**4.3**	**920**	**4,900**	**1.0 J,UJ**	**6.8 J**	**2,700**	**11,000**	< 0.0050	**0.0022**	--	**0.019**	--	< 0.0010	**0.043**	**0.036**	--	**1.0 J,UJ**	< 0.0010	**0.29**	< 0.00020	**0.031**	< 0.0060	< 0.0010	< 0.7
M-52A	Downgradient	Alluvial/Moqui	2/15/2019	--	--	--	< 0.80	--	--	--	< 0.0010	**0.0018 J**	--	**0.016 J**	< 0.0010	**0.00012**	**0.0015**	**0.022**	--	< 0.80	**0.0024 J**	**0.22**	< 0.00020	**0.026 J**	**0.00070**	< 0.00010	--
M-52A	Downgradient	Alluvial/Moqui	2/15/2019	--	--	--	**0.93**	--	--	--	< 0.0010	**0.00077**	--	**0.015**	< 0.0010	**0.00027**	**0.037**	**0.029**	--	**0.93**	< 0.00050	**0.32**	< 0.00020	**0.020**	**0.0015**	< 0.00010	< 0.6
M-52A	Downgradient	Alluvial/Moqui	4/16/2019	--	--	--	< 0.80	--	--	--	--	**0.00057**	--	**0.012**	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	**0.25**	--	**0.0051**	< 0.00050	< 0.00010	< 0.7
M-52A	Downgradient	Alluvial/Moqui	4/16/2019	--	--	--	**1.1**	--	--	--	--	< 0.00050	--	**0.019**	--	**0.00047**	**0.080**	**0.027**	--	**1.1**	< 0.00050	**0.30**	--	**0.021**	**0.0017**	< 0.00010	< 0.7
M-52A	Downgradient	Alluvial/Moqui	8/1/2019	**3.5**	**880**	**5,000**	**1.0**	**6.9 J**	**2,800**	**12,000**	--	--	--	--	--	--	--	--	--	**1.0**	--	--	--	--	--	--	--
M-52A	Downgradient	Alluvial/Moqui	10/24/2019	**3.2**	**760**	**3,400**	**0.91**	**7.0 J**	**2,900**	**9,300**	< 0.0020	**0.0012**	--	**0.017**	< 0.0010	**0.0019**	**0.024**	**0.070**	--	**0.91**	< 0.0010	**0.22**	< 0.00020	**0.078**	**0.0011**	< 0.00020	--
M-52A	Downgradient	Alluvial/Moqui	4/19/2020	**4.1**	**700**	**4,300**	**0.88**	**7.2 J**	**3,400**	**11,000**	--	< 0.0025	< 0.0025	**0.014**	**0.00056 J**	< 0.0005	**0.018**	**0.039**	**0.042**	**0.88**	< 0.0005	< 0.2	--	**0.022**	< 0.005	**0.00010**	--
M-53A	Downgradient	Alluvial	12/1/2015	**2.9**	**740**	**2,600**	**0.87**	**7.57**	**2,900**	**8,100**	< 0.0025	**0.0014**	--	**0.021**	< 0.0010	**0.0013**	**0.0014**	**0.024**	--	**0.87**	**0.00058**	**0.21**	< 0.00020	**0.041**	**0.00071**	< 0.00010	< 0.7
M-53A	Downgradient	Alluvial	3/9/2016	**2.4**	**770**	**2,500**	**0.94**	**7.44**	**2,600**	**7,400**	< 0.015	< 0.0049	--	**0.024**	< 0.0010	**0.0024**	< 0.0087	**0.023**	--	**0.94**	< 0.0044	< 0.20	< 0.00020	**0.036**	< 0.0015	< 0.00026	**0.5**

Groundwater Sampling Results for the BAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																
			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			BAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-53A	Downgradient	Alluvial	5/10/2016	2.4	750	2,400	< 2.0	--	2,600	7,800	< 0.00020	0.0018	--	0.021	< 0.0010	0.0014	0.0010	0.022	--	< 2.0	< 0.0010	< 0.20	< 0.00020	0.037	< 0.0010	< 0.00020	< 0.5
M-53A	Downgradient	Alluvial	5/10/2016	2.4	750	2,400	< 2.0	--	2,500	7,800	< 0.00020	0.0018	--	0.021	< 0.0010	0.0014	0.0015	0.023	--	< 2.0	< 0.0010	< 0.20	< 0.00020	0.037	< 0.0010	< 0.00020	< 0.4
M-53A	Downgradient	Alluvial	8/26/2016	3.1	660	2,400	2.3	7.4	3,000	8,100	0.00010	0.0012	--	0.0092	< 0.0010	0.0017	0.00090	0.016	--	2.3	0.00057	0.20	< 0.00020	0.049	< 0.00050	< 0.00010	< 0.6
M-53A	Downgradient	Alluvial	8/26/2016	3.0	660	2,400	2.3	7.4	3,000	8,000	< 0.00010	0.0012	--	0.0094	< 0.0010	0.0018	0.0011	0.018	--	2.3	0.00057	0.20	< 0.00020	0.053	< 0.00050	< 0.00010	0.6
M-53A	Downgradient	Alluvial	9/22/2016	3.0	640	2,500	0.98	7.6	3,000	8,300	< 0.00050	0.0013	--	0.0092	< 0.0010	0.0016	0.0010	0.017	--	2.2	0.00062	0.21	< 0.00020	0.048	0.00066	< 0.00010	< 0.7
M-53A	Downgradient	Alluvial	2/21/2017	3.1	660	2,300	2.0	7.5	2,900	7,600	< 0.0010	0.00098	--	0.0091	< 0.0010	0.0015	0.0062	0.018	--	2.0	< 0.00050	0.21	< 0.00020	0.047	< 0.00050	< 0.00010	< 0.6
M-53A	Downgradient	Alluvial	4/12/2017	3.0	710	2,800	1.3	7.5	2,700	8,100	< 0.0010	0.0017	--	0.018	< 0.0010	0.0015	0.0038	0.018	--	1.3	0.00077	< 0.20	< 0.00020	0.037	0.00067	< 0.00010	0.6
M-53A	Downgradient	Alluvial	4/25/2017	2.6	740	2,500	1.3	7.4	2,700	7,900	< 0.0010	0.00083	--	0.013	< 0.0010	0.0018	0.0020	0.015	--	1.3	< 0.00050	< 0.20	< 0.00020	0.027	< 0.00050	< 0.00010	< 0.6
M-53A	Downgradient	Alluvial	5/18/2017	3.1	640	2,400	2.2	7.7	3,200	8,100	< 0.0010	0.00096	--	0.0079	< 0.0010	0.0014	0.0011	0.016	--	2.2	< 0.00050	0.21	< 0.00020	0.041	< 0.00050	< 0.00010	< 0.6
M-53A	Downgradient	Alluvial	5/24/2017	3.3	660	2,300	2.4	7.6	3,100	7,600	< 0.0010	0.0011	--	0.0083	< 0.0010	0.0015	0.0014	0.016	--	2.4	0.00052	0.20	< 0.00020	0.043	< 0.00050	< 0.00010	< 0.4
M-53A	Downgradient	Alluvial	7/1/2017	3.1	600	2,500	2.6	7.4	3,300	7,700	< 0.0010	0.0011	--	0.0085	< 0.0010	0.0014	0.0014	0.016	--	2.6	< 0.00050	0.20	< 0.00020	0.042	< 0.00050	< 0.00010	< 0.7
M-53A	Downgradient	Alluvial	7/28/2017	3.3	670	2,500	2.4	7.5	3,300	7,900	< 0.0020	0.0010	--	0.0087	< 0.0010	0.0014	0.0017	0.017	--	2.4	< 0.0010	0.20	< 0.00020	0.045	< 0.0010	< 0.00020	< 0.7
M-53A	Downgradient	Alluvial	9/7/2017	3.3	650	2,400	2.3	7.5	3,100	7,900	< 0.0040	< 0.0020	--	0.0086	< 0.0010	0.0015	< 0.0040	0.017	--	2.3	< 0.0020	0.20	< 0.00020	0.046	< 0.0020	< 0.00040	< 0.6
M-53A	Downgradient	Alluvial	12/7/2017	3.2	630	2,400	2.3	7.6	3,000	7,900	--	--	--	--	--	--	--	--	--	2.3	--	--	--	--	--	--	--
M-53A	Downgradient	Alluvial	2/15/2018	--	--	--	1.4	--	--	--	< 0.0010	0.00076	--	0.018	< 0.0010	0.0012	0.0010	0.011	--	1.4	< 0.00050	< 0.20	< 0.00020	0.0059	0.00057	0.00012	0.4
M-53A	Downgradient	Alluvial	5/20/2018	3.2	600	2,300	2.6	7.4	3,100	7,900	< 0.0010	0.0011	--	0.0090	--	0.0012	0.0015	0.015	--	2.6	< 0.00050	< 0.20	< 0.00020	0.044	< 0.00050	< 0.00010	< 0.7
M-53A	Downgradient	Alluvial	5/20/2018	3.3	620	2,400	2.4	7.4	3,400	7,800	< 0.0010	0.0011	--	0.0091	--	0.0013	0.0015	0.016	--	2.4	< 0.00050	< 0.20	--	0.045	< 0.00050	0.00015	< 0.7
M-53A	Downgradient	Alluvial	10/26/2018	3.2	620	2,200	2.1	7.5	2,900	7,500	--	0.0012	--	0.0081	--	0.0013	0.0019	0.013	--	2.1	< 0.00050	< 0.20	--	0.042	< 0.00050	< 0.00010	--
M-53A	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-53A	Downgradient	Alluvial	12/7/2018	3.3	600	2,300	2.3 J,UJ	7.4 J	3,100	8,000	< 0.0050	< 0.0020	--	0.0087	--	0.0012	< 0.0050	0.013	--	2.3 J,UJ	0.0014	< 0.20	< 0.00020	0.039	< 0.0060	< 0.0010	0.9
M-53A	Downgradient	Alluvial	12/7/2018	3.4	620	2,300	2.3 J,UJ	7.4 J	3,000	7,600	< 0.0050	< 0.0020	--	0.0085	--	0.0014	< 0.0050	0.014	--	2.3 J,UJ	< 0.0010	0.20	< 0.00020	0.042	< 0.0060	< 0.0010	1.1
M-53A	Downgradient	Alluvial	2/15/2019	--	--	--	1.2	--	--	--	< 0.0010	0.00064	--	0.013	< 0.0010	0.0011	0.0025	0.011	--	1.2	< 0.00050	0.21	< 0.00020	0.0067	0.00078	< 0.00010	0.8
M-53A	Downgradient	Alluvial	4/17/2019	--	--	--	2.1	--	--	--	--	0.0011	--	0.0085	--	0.0012	0.0014	0.014	--	2.1	< 0.00050	< 0.20	--	0.043	< 0.00050	< 0.00010	< 0.7
M-53A	Downgradient	Alluvial	8/1/2019	3.2	590	2,200	2.3	7.5 J	2,900	7,800	--	--	--	--	--	--	--	--	--	2.3	--	--	--	--	--	--	--
M-53A	Downgradient	Alluvial	10/23/2019	3.3	590	2,200 J	2.2 J	7.5 J	2,900 J	7,900 J	< 0.0020	0.0018	--	0.0099	< 0.0010	0.0015	< 0.0020	0.013	--	2.2 J	< 0.0010	< 0.20	< 0.00020	0.044	0.0011	0.00022	--
M-53A	Downgradient	Alluvial	4/19/2020	3.7	620	2,300	2.1	7.4 J	3,000	7,800	--	< 0.0025	< 0.0025	0.0088	0.00050 J	0.0012	< 0.005	0.014	0.014	2.1	< 0.0005	0.27 J	--	0.039	< 0.0025	< 0.0001	--
M-53A	Downgradient	Alluvial	4/19/2020	3.7	610	2,400	2.1	7.5 J	3,100	8,200	--	< 0.0025	< 0.0025	0.0087	0.00055 J	0.0012	< 0.005	0.014	0.016	2.1	< 0.0005	< 0.2	--	0.038	< 0.0025	< 0.0001	--
M-55A	Supplementary	Alluvial	12/1/2015	0.40	630	2,300	0.57	7.33	3,800	8,900	< 0.0025	0.0030	--	0.046	< 0.0010	< 0.00010	0.0017	0.00071	--	0.57	0.00094	0.33	< 0.00020	0.0048	0.082	< 0.00010	< 0.9
M-55A	Supplementary	Alluvial	3/9/2016	0.39	630	2,900	< 0.80	7.49	3,500	9,600	< 0.015	< 0.0049	--	0.021	< 0.0010	< 0.00046	< 0.0087	< 0.0013	--	< 0.80	< 0.0044	0.31	< 0.00020	< 0.0040	0.069	< 0.00026	0.2
M-55A	Supplementary	Alluvial	5/10/2016	0.41	620	2,900	< 2.0	--	3,400	9,900	0.00029	0.0028	--	0.016	< 0.0010	< 0.00020	0.0017	< 0.0010	--	< 2.0	< 0.0010	0.34	< 0.00020	0.0031	0.075	< 0.00020	< 0.5
M-55A	Supplementary	Alluvial	8/26/2016	0.43	660	3,200	< 0.80	7.3	3,500	10,000	0.00047	0.0033	--	0.017	< 0.0010	0.00019	0.0013	< 0.00050	--	< 0.80	< 0.00050	0.33	< 0.00020	0.043	0.087	< 0.00010	< 0.6
M-55A	Supplementary	Alluvial	9/22/2016	0.42	630	3,400	< 0.80	7.7	3,700	11,000	< 0.00050	0.00082	--	0.014	< 0.0010	< 0.00010	0.0091	0.00074	--	< 0.80	< 0.00010	0.36	< 0.00020	0.0059	0.065	< 0.00010	0.8
M-55A	Supplementary	Alluvial	2/21/2017	0.40	660	3,500	< 0.80	7.5	3,400	10,000	< 0.0010	0.0023	--	0.014	< 0.0010	< 0.00010	0.018	0.00057	--	< 0.80	< 0.00050	0.38	< 0.00020	0.0068	0.079	< 0.00010	< 0.6
M-55A	Supplementary	Alluvial	4/12/2017	0.40	670	3,800	< 0.80	7.5	3,500	11,000	< 0.0010	0.0025	--	0.014	< 0.0010	< 0.00010	0.014	< 0.00050	--	< 0.80	< 0.00050	0.35	< 0.00020	0.0055	0.082	0.00010	1.4
M-55A	Supplementary	Alluvial	4/25/2017	0.44	680	3,600	< 0.80	7.3	3,500	10,000	< 0.0010	0.0025	--	0.013	< 0.0010	< 0.00010	0.020	< 0.00050	--	< 0.80	< 0.00050	0.37	< 0.00020	0.0065	0.080	< 0.00010	1.0
M-55A	Supplementary	Alluvial	5/18/2017	0.41	670	3,800	< 0.80	7.6	3,700	10,000	< 0.0010	0.0021	--	0.011	< 0.0010	< 0.00010	0.023	< 0.00050	--	< 0.80	< 0.00050	0.37	< 0.00020	0.0061	0.075	< 0.00010	1.1
M-55A	Supplementary	Alluvial	5/24/2017	0.42	690	3,700	< 0.80	7.4	3,500	10,000	< 0.0010	0.0031	--	0.014	< 0.0010	< 0.00010	0.024	< 0.00050	--	< 0.80	< 0.00050	0.37	< 0.00020	0.0059	0.090	< 0.00010	1.5
M-55A	Supplementary	Alluvial	7/1/2017	0.42	650	3,900	< 0.80	7.4	3,700	11,000	< 0.0010	0.0034	--	0.014	< 0.0010	< 0.00010	0.017	0.0016	--	< 0.80	< 0.00050	0.35	< 0.00020	0.022	0.095	< 0.00010	0.9
M-55A	Supplementary	Alluvial	7/28/2017	0.44	710	4,100	< 0.80	7.3	3,800	11,000	< 0.0020	0.0031	--	0.014	< 0.0010	< 0.00020	0.051	0.0040	--	< 0.80	< 0.0010	0.35	< 0.00020	0.0091	0.085	< 0.00020	< 0.7
M-55A	Supplementary	Alluvial	9/7/2017	0.45	710	3,900	< 0.80	7.3	3,600	11,000	< 0.0040	0.0022	--	0.014	< 0.0010	< 0.00040	0.038	< 0.0020	--	< 0.80	< 0.0020	0.37	< 0.00020	0.0075	0.082	< 0.00040	1.2
M-55A	Supplementary	Alluvial	12/8/2018	0.43	700	4,300	< 0.80 J,UJ	7.3 J	3,400	11,000	< 0.0050	< 0.0020	--	0.014	--	< 0.0010	0.17	< 0.0020	--	< 0.80 J,UJ	< 0.0010	0.39	< 0.00020	0.020	0.083	< 0.0010	0.9
M-55A	Supplementary	Alluvial	2/15/2019	--	--	--	< 0.80	--	--	--	< 0.0010	0.0033	--	0.014	< 0.0010	< 0.00010	0.14	0.00095	--	< 0.80	< 0.00050	0.43	< 0.00020	0.019	0.13	< 0.00010	1.2
M-55A	Supplementary	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	0.0025	--	0.014	--	< 0.00010	0.044	0.00083	--	< 0.80	< 0.00050	0.37	--	0.0067	0.12	< 0.00010	--
M-55A	Supplementary	Alluvial	8/1/2019	0.41	680	4,200	< 0.8	7.3 J	3,300	11,000	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
M-55A	Supplementary	Alluvial	10/24/2019	0.40	670	4,300	< 0.80	7.4 J	3,400	12,000	< 0.0020	0.0023	--	0.016	< 0.0010	< 0.00020	0.0044	< 0.0010	--	< 0.80	< 0.0010	0.38	< 0.00020	0.0051	0.078	< 0.00020	--
M-55A	Supplementary	Alluvial	4/17/2020	0.46	700	4,600	< 0.8	7.5 J	3,500	11,000	--	0.0071	0.0050	0.014	0.00059 J	< 0.0005	0.016	< 0.0025	< 0.0025	< 0.8	< 0.0005	< 0.2	--	0.0048	0.12	< 0.0001	--
MW-69A	Supplementary	Alluvial	4/19/2020	3.7	630	2,500	1.5	7.5 J	3,000	8,000	--	< 0.0025	< 0.0025	0.027	0.00052 J	0.00011	< 0.005	0.027	0.026	1.5	< 0.0005	< 0.2	--	0.055	< 0.0025	< 0.0001	--
MW-70M	Supplementary	Moqui	4/19/2020	2.4	640	2,400	1.2	7.5 J	2,700	7,400	--	< 0.0025	< 0.0025	0.014	< 0.0005	0.00053	< 0.005	0.025	0.024	1.2	0.0023	< 0.2	--	0.034	< 0.0025	< 0.0001	--
W-301	Supplementary	Alluvial	12/7/2018	2.4	760	4,000	< 0.80 J,UJ	7.2 J	3,300	10,000	< 0.0050	< 0.0020	--	0.013	--	< 0.0010	< 0.0050	0.017	--	< 0.80 J,UJ	0.0012	0.43	< 0.00020	0.080	< 0.0060	< 0.0010	< 0.7
W-301	Supplementary	Alluvial	2/15/2019	--	--	--	< 0.40 UJ	--	--	--	< 0.0010	0.0017	--	0.0080	< 0.0010	0.00018	< 0.0010	0.018	--	< 0.40 UJ	< 0.00050	0.59	< 0.00020	0.0046	0.0084	< 0.00010	0.7
W-301	Supplementary	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	0.0019	--	0.0083	--	0.00014	0.0017	0.018	--	< 0.80	< 0.00050	0.50	--	0.0051	0.0076	< 0.00010	--
W-301	Supplementary	Alluvial	8/9/2019	0.72	810	6,200	< 0.8	7.2 J	3,500	14,000	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
W-301	Supplementary	Alluvial	10/23/2019	0.65	760	6,300 J	< 0.80 UJ	7.3 J	3,600 J	14,000 J	< 0.0020	0.0030	--	0.0092	< 0.0010	< 0.00020	< 0.0040	0.016	--	< 0.80 UJ	< 0.0010	0.52	< 0.00020	0.0069	0.0056	< 0.00020	--
W-301	Supplementary	Alluvial	4/18/2020	0.70	690	6,400	< 0.8	7.4 J	3,600	14,000	--	< 0.0025	< 0.0025	0.0082	0.00063 J	< 0.0005	< 0.005	0.021	0.022	< 0.8	< 0.0005	0.41 J	--	0.0051	0.0060	< 0.0001	--
W-302	Supplementary	Alluvial	12/7/2018	0.64	560	2,600	0.98 J,UJ	7.3 J	2,400	7,200	< 0.0050	< 0.0020	--	0.014	--	< 0.0010	< 0.0050	0.0049	--	0.98 J,UJ	< 0.0010	0.32	< 0.00020	0.068	< 0.0060	< 0.0010	< 0.7
W-302	Supplementary	Alluvial	2/15/2019	--	--	--	0.88	--	--	--	< 0.0010	0.0043	--	0.36	< 0.0010	0.00089	0.020	0.022	--	0.88	0.028	0.37	0.00022	0.0039	0.0035	0.00016	0.7
W-302	Supplementary	Alluvial	4/17/2019	--	--	--	0.82	--	--	--	--	0.00076	--	0.015	--	< 0.00010	< 0.0010	0.0054	--	0.82	< 0.00050	0.31	--	0.016	< 0.00050	< 0.00010	--

Groundwater Sampling Results for the BAP Monitoring Wells

			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
				Appendix III Constituents							Appendix IV Constituents																
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			BAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
W-302	Supplementary	Alluvial	8/9/2019	**0.66**	**610**	**2,700**	**0.80**	**7.3 J**	**2,300**	**7,700**	--	--	--	--	--	--	--	--	--	**0.80**	--	--	--	--	--	--	--
W-302	Supplementary	Alluvial	10/23/2019	**0.59**	**570**	**2,700 J**	**0.80 J**	**7.4 J**	**2,300 J**	**8,000 J**	< 0.0020	**0.0015**	--	**0.014**	< 0.0010	< 0.00020	**0.019**	**0.0055**	--	**0.80 J**	< 0.0010	**0.32**	< 0.00020	**0.015**	< 0.0010	< 0.00020	--
W-302	Supplementary	Alluvial	4/17/2020	**0.64**	**590**	**3,000**	**0.97**	**7.4 J**	**2,300**	**8,100**	--	< 0.0025	< 0.0025	**0.013**	< 0.0005	< 0.0005	**0.086**	**0.0064**	**0.0064**	**0.97**	< 0.0005	< 0.2	--	**0.012**	< 0.0025	< 0.0001	--
W-303	Supplementary	Moenkopi - Moqui	4/18/2020	**3.7**	**620**	**2,800**	< 0.80	**7.5**	**3,300**	**8,900**	--	< 0.0025	< 0.0025	**0.0048**	< 0.0010	< 0.00025	< 0.0050	**0.027**		< 0.8	< 0.0005	< 0.2	--	**0.024**	< 0.0025	< 0.0001	--
W-304	Supplementary	Alluvial	12/7/2018	**0.50**	**590**	**2,900**	< 0.80 J,UJ	**7.3 J**	**2,900**	**8,100**	< 0.0050	< 0.0020	--	**0.0083**	--	< 0.0010	< 0.0050	**0.0034**	--	< 0.80 J,UJ	< 0.0010	**0.40**	< 0.00020	**0.026**	< 0.0060	< 0.0010	< 0.7
W-304	Supplementary	Alluvial	2/15/2019	--	--	--	< 0.80	--	--	--	< 0.0010	**0.0020**	--	**0.011**	< 0.0010	< 0.00010	< 0.0010	**0.0029**	--	< 0.80	< 0.00050	**0.48**	< 0.00020	**0.0017**	**0.00059**	< 0.00010	< 0.6
W-304	Supplementary	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	< 0.00050	--	**0.0089**	--	< 0.00010	< 0.0010	**0.0020**	--	< 0.80	< 0.00050	**0.41**	--	**0.0048**	**0.00066**	< 0.00010	--
W-304	Supplementary	Alluvial	8/8/2019	**0.54**	**630**	**3,200**	< 0.8	**7.3 J**	**3,000**	**8,700**	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
W-304	Supplementary	Alluvial	10/24/2019	**0.52**	**610**	**3,400 J**	< 0.80 UJ	**7.4 J**	**2,900 J**	**9,200 J**	< 0.0010	**0.00093**	--	**0.015**	< 0.0010	< 0.00010	**0.0016**	**0.0029**	--	< 0.80 UJ	< 0.00050	**0.45**	< 0.00020	**0.0036**	< 0.00050	< 0.00010	--
W-304	Supplementary	Alluvial	10/24/2019	**0.52**	**610**	**3,300**	< 0.80	**7.4 J**	**2,900**	**9,100**	< 0.0020	**0.0014**	--	**0.014**	< 0.0010	< 0.00020	< 0.0020	**0.0028**	--	< 0.80	< 0.0010	**0.45**	< 0.00020	**0.0042**	**0.0012**	< 0.00020	--
W-304	Supplementary	Alluvial	4/17/2020	**0.52**	**570**	**2,700**	< 0.8	**7.4 J**	**2,600**	**8,400**	--	< 0.0025	**0.0029**	**0.0069**	< 0.0005	< 0.0005	< 0.005	**0.0030**	**0.0032**	< 0.8	< 0.0005	**0.46 J**	--	**0.0046**	< 0.0025	< 0.0001	--
W-305	Downgradient	Alluvial	12/2/2015	**0.32**	**770**	**2,600**	**1.4**	**7.05**	**2,300**	**7,000**	< 0.0025	**0.00088**	--	**0.013**	< 0.0010	**0.00022**	**0.00066**	**0.0100**	--	**1.4**	**0.0017**	**0.23**	< 0.00020	**0.016**	**0.00024**	< 0.00020	--
W-305	Downgradient	Alluvial	3/9/2016	**0.3**	**690**	**2,300**	< 0.80	**7.32**	**2,300**	**7,000**	< 0.050	< 0.01	--	**0.0083**	< 0.0010	< 0.0020	< 0.010	**0.0160**	--	< 0.8	< 0.01	**0.21**	< 0.00020	**0.017**	< 0.01	< 0.02	--
W-305	Downgradient	Alluvial	5/11/2016	**0.29**	**710**	**2,100**	< 2.0	--	**2,200**	**7,000**	< 0.00010	**0.00058**	--	**0.0059**	< 0.0010	**0.00012**	< 0.00050	**0.0140**	--	< 2.0	< 0.00050	**0.21**	< 0.00020	**0.014**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	8/27/2016	**0.31**	**720**	**2,200**	< 0.80	**7.3**	**2,400**	**7,200**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	9/22/2016	**0.32**	**700**	**2,300**	< 2.0	**7.6**	**2,400**	**7,400**	< 0.0005	**0.0006**	--	**0.011**	< 0.0010	< 0.0010	**0.0098**	**0.0016**	--	--	**0.0025**	**0.22**	< 0.00020	**0.024**	**0.00067**	< 0.00010	--
W-305	Downgradient	Alluvial	2/21/2017	**0.32**	**730**	**2,200**	< 0.80	**7.4**	**2,300**	**6,800**	< 0.00010	**0.00066**	--	**0.012**	< 0.0010	**0.00011**	**0.0022**	**0.0180**	--	< 0.80	**0.0021**	**0.22**	< 0.00020	**0.020**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	4/11/2017	**0.32**	**730**	**2,300**	< 0.80	**7.7**	**2,400**	**7,300**	< 0.00010	**0.00098**	--	**0.012**	< 0.0010	< 0.0010	**0.00092**	**0.0190**	--	< 0.80	**0.0024**	**0.20**	< 0.00020	**0.021**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	4/24/2017	**0.33**	**690**	**2,300**	< 0.80	**7.6**	**2,400**	**6,800**	< 0.00010	**0.00078**	--	**0.012**	< 0.0010	< 0.0010	**0.0031**	**0.0170**	--	< 0.80	**0.0020**	**0.21**	< 0.00020	**0.020**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	5/22/2017	**0.33**	**750**	**2,300**	< 0.80	**7.6**	**2,400**	**7,200**	< 0.00010	**0.00070**	--	**0.010**	< 0.0010	< 0.0010	**0.00070**	**0.0150**	--	< 0.80	**0.0017**	**0.20**	< 0.00020	**0.017**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	5/24/2017	**0.35**	**740**	**2,400**	< 0.80	**7.5**	**2,500**	**6,800**	< 0.00010	< 0.0020	--	**0.012**	< 0.0010	< 0.00040	< 0.0020	**0.0170**	--	< 0.80	< 0.0020	**0.23**	< 0.00020	**0.020**	< 0.0020	< 0.0004	--
W-305	Downgradient	Alluvial	6/29/2017	**0.31**	**670**	**2,600**	< 0.40	**7.5**	**2,500**	**6,900**	< 0.00010	**0.00076**	--	**0.012**	< 0.0010	< 0.0010	**0.0040**	**0.0180**	--	< 0.40	**0.0025**	**0.21**	< 0.00020	**0.020**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	7/28/2017	**0.35**	**750**	**2,300**	< 0.80	**7.3**	**2,300**	**7,200**	< 0.0010	**0.00078**	--	**0.010**	< 0.0010	< 0.0010	**0.00062**	**0.0170**	--	< 0.80	**0.0021**	**0.21**	< 0.00020	**0.018**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	9/6/2017	**0.33**	**770**	**2,200**	< 0.80	**7.4**	**2,400**	**6,900**	< 0.0010	**0.00073**	--	**0.011**	< 0.0010	**0.0001**	**0.0038**	**0.0180**	--	< 0.80	**0.0020**	**0.20**	< 0.00020	**0.021**	< 0.00050	< 0.00010	--
W-305	Downgradient	Alluvial	12/7/2017	**0.34**	**760**	**2,500**	< 0.80	**7.4**	**2,400**	**7,000**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	2/15/2018	--	--	--	< 0.80	--	--	--	< 0.0010	**0.00092**	--	**0.012**	< 0.0010	< 0.00010	< 0.0010	**0.017**	--	< 0.80	**0.0020**	**0.21**	< 0.00020	**0.021**	< 0.00050	< 0.00010	**0.643**
W-305	Downgradient	Alluvial	5/19/2018	**0.34**	**700**	**2,700**	< 0.80	**7.3**	**2,800**	**7,000**	< 0.0010	**0.00099**	--	**0.012**	--	< 0.00010	**0.0012**	**0.017**	--	< 0.80	**0.0020**	**0.21**	--	**0.020**	< 0.00050	< 0.00010	< 0.7
W-305	Downgradient	Alluvial	5/19/2018	--	--	**2,400**	--	--	**2,300**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	10/26/2018	**0.34**	**730**	**2,300**	< 0.80	**7.3**	**2,300**	**7,000**	--	**0.00092**	--	**0.011**	--	< 0.00010	**0.0012**	**0.018**	--	< 0.80	**0.0019**	**0.20**	--	**0.021**	**0.00053**	< 0.00010	--
W-305	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
W-305	Downgradient	Alluvial	12/7/2018	**0.35**	**710**	**2,400**	< 0.80 J,UJ	**7.3 J**	**2,300**	**7,000**	< 0.0050	< 0.0020	--	**0.012**	--	< 0.0010	< 0.0050	**0.018**	--	< 0.80 J,UJ	**0.0030**	**0.21**	< 0.00020	**0.021**	< 0.0060	< 0.0010	< 0.7
W-305	Downgradient	Alluvial	2/15/2019	--	--	--	< 0.40	--	--	--	< 0.0010	**0.00087 J**	--	**0.011 J**	< 0.0010	< 0.00010	**0.0017**	**0.018**	--	< 0.40	**0.0018 J**	**0.22**	< 0.00020	**0.020 J**	< 0.00050	< 0.00010	**0.8**
W-305	Downgradient	Alluvial	4/17/2019	--	--	--	< 0.80	--	--	--	--	**0.00083**	--	**0.012**	--	< 0.00010	**0.0015**	**0.018**	--	< 0.80	**0.0020**	**0.20**	--	**0.022**	**0.00067**	< 0.00010	< 0.7
W-305	Downgradient	Alluvial	8/1/2019	**0.33**	**670**	**2,400**	< 0.8	**7.3 J**	**2,300**	**7,000**	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	10/23/2019	**0.48**	**85**	**1,400**	**1.3**	**7.8 J**	**350**	**7,100**	< 0.0020	**0.0015**	--	**0.013**	< 0.0010	**0.00021**	< 0.0020	**0.018**	--	**1.3**	**0.0025**	**0.20**	< 0.00020	**0.022**	< 0.0010	< 0.00020	--
W-305	Downgradient	Alluvial	10/23/2019	**0.34**	**690**	**2,400**	< 0.80	**7.3 J**	**2,300**	**7,000**	< 0.0020	**0.0019**	--	**0.014**	< 0.0010	**0.00022**	< 0.0020	**0.018**	--	< 0.80	**0.0026**	**0.20**	< 0.00020	**0.023**	< 0.0010	**0.00024**	--
W-305	Downgradient	Alluvial	4/18/2020	**0.41**	**680**	**2,400**	< 0.8	**7.4 J**	**2,300**	**7,600**	--	< 0.0025	< 0.0025	**0.014**	< 0.0005	< 0.0005	**0.0069**	**0.020**	**0.020**	< 0.8	**0.0024**	**0.30 J**	--	**0.021**	< 0.0025	< 0.0001	--
W-306	Downgradient	Alluvial	12/2/2015	**0.32**	**550**	**2,400**	**0.75**	**7.02**	**3,600**	**8,900**	< 0.0025	**0.0019**	--	**0.014**	< 0.0010	**0.0015**	**0.00073**	**0.030**	--	**0.75**	**0.00066**	**0.43**	< 0.00020	**0.032**	**0.0016**	< 0.00010	< 0.7
W-306	Downgradient	Alluvial	3/9/2016	**0.46**	**460**	**2,200**	**1.4**	**7.82**	**7,100**	**13,000**	< 0.015	< 0.0049	--	**0.013**	< 0.0010	< 0.00046	< 0.0087	**0.0099 J**	--	**1.4**	< 0.0044	**0.51**	< 0.00020	**0.020**	**0.0020 J**	< 0.00026	< 0.6
W-306	Downgradient	Alluvial	5/11/2016	**0.56**	**430**	**1,900**	< 2.0	--	**8,000**	**15,000**	**0.00024**	**0.0039**	--	**0.014**	< 0.0010	< 0.00020	< 0.0010	**0.0082**	--	< 2.0	< 0.0010	**0.56**	< 0.00020	**0.020**	**0.0037**	< 0.00020	< 0.4
W-306	Downgradient	Alluvial	8/26/2016	**1.1**	**440**	**1,800**	**1.4**	**7.7**	**11,000**	**19,000**	**0.00024**	**0.0051**	--	**0.015**	< 0.0010	< 0.00010	**0.00093**	**0.0043**	--	**1.4**	< 0.00050	**0.67**	< 0.00020	**0.057**	**0.0047**	< 0.00010	**0.5**
W-306	Downgradient	Alluvial	9/22/2016	**1.1**	**430**	**4,900**	< 0.40	**7.9**	**11,000**	**20,000**	< 0.0010	**0.0042**	--	**0.013**	< 0.0010	< 0.00020	< 0.0010	**0.0038**	--	< 0.40	< 0.00020	**0.72**	< 0.00020	**0.032**	**0.0039**	< 0.00020	< 0.7
W-306	Downgradient	Alluvial	2/21/2017	**1.1**	**430**	**1,800**	**1.5**	**7.9**	**12,000**	**18,000**	< 0.0010	**0.0048**	--	**0.012**	< 0.0010	< 0.00010	**0.00087**	**0.0021**	--	**1.5**	< 0.00050	**0.78**	< 0.00020	**0.033**	**0.0042**	< 0.00010	< 0.6
W-306	Downgradient	Alluvial	4/12/2017	**1.0**	**410**	**1,800**	**1.4**	**8.2**	**12,000**	**20,000**	< 0.0010	**0.0050**	--	**0.012**	< 0.0010	< 0.00010	< 0.00050	**0.0021**	--	**1.4**	< 0.00050	**0.70**	< 0.00020	**0.035**	**0.0039**	< 0.00010	< 0.6
W-306	Downgradient	Alluvial	4/25/2017	**1.1**	**410**	**1,900**	**1.5**	**7.9**	**13,000**	**20,000**	< 0.0010	**0.0048**	--	**0.012**	< 0.0010	< 0.00010	**0.00050**	**0.0020**	--	**1.5**	< 0.0010	**0.71**	< 0.00020	**0.032**	**0.0039**	< 0.00020	< 0.6
W-306	Downgradient	Alluvial	5/22/2017	**1.0**	**420**	**1,800**	**1.1**	**7.9**	**12,000**	**20,000**	< 0.0010	**0.0042**	--	**0.010**	< 0.0010	< 0.00010	< 0.00050	**0.0018**	--	**1.1**	< 0.00050	**0.65**	< 0.00020	**0.026**	**0.0030**	< 0.00010	< 0.6
W-306	Downgradient	Alluvial	5/24/2017	**1.0**	**420**	**1,800**	**1.0**	**7.9**	**12,000**	**18,000**	< 0.0040	**0.0046**	--	**0.013**	< 0.0010	< 0.00040	< 0.0020	**0.0022**	--	**1.0**	< 0.0020	**0.74**	< 0.00020	**0.029**	**0.0030**	< 0.00040	< 0.6
W-306	Downgradient	Alluvial	7/1/2017	**0.95**	**380**	**2,100**	**1.3**	**7.8**	**13,000**	**19,000**	< 0.0010	**0.0046**	--	**0.011**	< 0.0010	**0.00010**	< 0.00050	**0.0023**	--	**1.3**	< 0.00050	**0.64**	< 0.00020	**0.028**	**0.0031**	< 0.00010	< 0.7
W-306	Downgradient	Alluvial	7/28/2017	**0.99**	**410**	**2,100**	**1.2**	**7.8**	**12,000**	**18,000**	< 0.0010	**0.0044**	--	**0.0094**	< 0.0010	< 0.00040	< 0.00050	**0.0024**	--	**1.2**	< 0.0020	**0.64**	< 0.00020	**0.027**	**0.0027**	< 0.00040	**1.1**
W-306	Downgradient	Alluvial	9/6/2017	**0.97**	**430**	**1,800**	**1.4**	**7.8**	**11,000**	**17,000**	< 0.0010	**0.0047**	--	**0.010**	< 0.0010	< 0.00010	< 0.0010	**0.0023**	--	**1.4**	< 0.00050	**0.62**	< 0.00020	**0.028**	**0.0029**	< 0.00010	< 0.7
W-306	Downgradient	Alluvial	12/7/2017	**1.0**	**440**	**1,900**	**1.4**	**7.9**	**12,000**	**18,000**	--	--	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
W-306	Downgradient	Alluvial	2/15/2018	--	--	--	**1.3**	--	--	--	< 0.0010	**0.0048**	--	**0.010**	< 0.0010	< 0.00010	< 0.0010	**0.0014**	--	**1.3**	< 0.00050	**0.69**	< 0.00020	**0.028**	**0.0021**	< 0.00010	**0.4**
W-306	Downgradient	Alluvial	2/15/2018	--	--	--	**1.3**	--	--	--	< 0.0020	**0.0049**	--	**0.011**	< 0.0010	< 0.00020	< 0.0010	**0.0015**	--	**1.3**	< 0.0010	**0.70**	< 0.00020	**0.030**	**0.0022**	< 0.00020	**0.3**
W-306	Downgradient	Alluvial	5/19/2018	**1.0**	**390**	**2,000**	**1.6**	**7.8**	**13,000**	**18,000**	< 0.0020	**0.0052**	--	**0.010**	--	< 0.00020	< 0.0020	**0.0014**	--	**1.6**	< 0.0010	**0.68**	--	**0.031**	**0.0016**	< 0.00020	**0.8**
W-306	Downgradient	Alluvial	10/26/2018	**1.0**	**420**	**1,800**	**1.4**	**7.9**	**12,000**	**18,000**	--	**0.0052**	--	**0.010**	--	**0.00011**	< 0.0010	**0.0012**	--	**1.4**	< 0.00050	**0.68**	--	**0.032**	**0.0021**	< 0.00010	--
W-306	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
W-306	Downgradient	Alluvial	12/7/2018	**1.1**	**410**	**1,900**	**1.4 J,UJ**	**7.9 J**	**12,000**	**19,000**	< 0.0050	**0.0041**	--	**0.010**	--	< 0.0010	< 0.0050	< 0.0020	--	**1.4 J,UJ**	< 0.0010	**0.73**	< 0.00020	**0.028**	< 0.0060	< 0.0010	< 0.7

Groundwater Sampling Results for the BAP Monitoring Wells

			Constituent:	Boron	Calcium	Chloride	Fluoride	Ph (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
				Appendix III Constituents							Appendix IV Constituents																
			Filtered:	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			BAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
W-306	Downgradient	Alluvial	2/15/2019	--	--	--	1.2	--	--	--	< 0.0010	0.0053	--	0.011	< 0.0010	< 0.00010	< 0.0010	0.00097	--	1.2	< 0.00050	0.80	< 0.00020	0.031	0.0021	< 0.00010	< 0.6
W-306	Downgradient	Alluvial	4/16/2019	--	--	--	1.0	--	--	--	--	0.0052	--	0.011	--	0.00013	< 0.0010	0.00094	--	1.0	< 0.00050	0.68	--	0.033	0.0016	< 0.00010	< 0.7
W-306	Downgradient	Alluvial	8/1/2019	1.1	390	1,900	0.99	7.9 J	12,000	19,000	--	--	--	--	--	--	--	--	--	0.99	--	--	--	--	--	--	--
W-306	Downgradient	Alluvial	10/23/2019	1.0	380	1,900	1.0	7.9 J	13,000	19,000	< 0.0020	0.0060	--	0.013	< 0.0010	0.00021	< 0.0040	0.0029	--	1.0	< 0.0010	0.70	< 0.00020	0.039	0.0023	< 0.00020	--
W-306	Downgradient	Alluvial	4/19/2020	1.1	400	1,800	1.5	7.9 J	12,000	19,000	--	0.0048	0.0051	0.011	0.0017	< 0.0005	< 0.005	< 0.0025	< 0.0025	1.5	< 0.0025	1.2	--	0.039	< 0.0025	< 0.0005	--
W-306	Downgradient	Alluvial	4/19/2020	1.2	400	2,000	1.1	7.8 J	13,000	19,000	--	0.0050	0.0055	0.012	0.0017	< 0.0005	< 0.005	< 0.0025	< 0.0025	1.1	< 0.0025	1.3	--	0.042	< 0.0025	< 0.0005	--
W-307	Supplementary	Alluvial	12/8/2018	2.4	790	2,700	< 0.80 J,UJ	7.2 J	2,600	7,800	< 0.0050	< 0.0020	--	0.012	--	< 0.0010	< 0.0050	0.076	--	< 0.80 J,UJ	0.0020	0.24	< 0.00020	0.0044	< 0.0060	< 0.0010	< 0.7
W-307	Supplementary	Alluvial	2/15/2019	--	--	--	< 0.80	--	--	--	< 0.0010	0.00088	--	0.012	< 0.0010	0.00028	< 0.0010	0.073	--	< 0.80	0.00085	0.26	< 0.00020	0.0045	0.00063	< 0.00010	< 0.6
W-307	Supplementary	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	0.0011	--	0.012	--	0.00062	< 0.0010	0.080	--	< 0.80	0.0018	0.22	--	0.0068	0.00064	< 0.00010	--
W-307	Supplementary	Alluvial	6/25/2019	2.3	790	2,500	< 0.40	7.3	2,500	8,300	--	--	--	--	< 0.0010	--	0.0069	--	--	< 0.40	--	--	--	--	--	< 0.00010	--
W-307	Supplementary	Alluvial	8/8/2019	2.6	850	2,600	< 0.8	7.2 J	2,600	7,800	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
W-307	Supplementary	Alluvial	10/24/2019	2.3	750	2,800	< 0.80	7.4 J	2,700	8,100	< 0.0020	< 0.0020	--	0.013	< 0.0010	0.00049	0.016	0.082	--	< 0.80	0.0011	0.23	< 0.00020	0.011	< 0.0010	< 0.00020	--
W-307	Supplementary	Alluvial	4/17/2020	2.7	710	2,600	< 0.8	7.3 J	2,500	8,000	--	< 0.0025	< 0.0025	0.012	< 0.0005	< 0.0005	0.013	0.084	0.085	< 0.8	0.0011	0.29 J	--	0.011	< 0.0025	< 0.0001	--
W-308	Supplementary	Alluvial	12/8/2018	0.45	730	2,900	< 0.80 J,UJ	7.1 J	3,000	8,300	< 0.0050	0.0023	--	0.0082	--	< 0.0010	< 0.0050	0.0033	--	< 0.80 J,UJ	< 0.0010	0.37	< 0.00020	0.032	< 0.0060	< 0.0010	< 0.7
W-308	Supplementary	Alluvial	2/15/2019	--	--	--	< 0.80	--	--	--	< 0.0010	0.0019	--	0.0066	< 0.0010	< 0.00010	< 0.0010	0.00079	--	< 0.80	< 0.00050	0.39	< 0.00020	0.0020	0.074	< 0.00010	< 0.7
W-308	Supplementary	Alluvial	4/16/2019	--	--	--	< 0.80	--	--	--	--	0.00083	--	0.0067	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	0.35	--	0.010	0.053 J	< 0.00010	--
W-308	Supplementary	Alluvial	6/25/2019	0.45	780	2,900	< 0.40	7.3	2,800	8,800	--	--	--	--	< 0.0010	--	0.0061	--	--	< 0.40	--	--	--	--	--	< 0.00010	--
W-308	Supplementary	Alluvial	8/8/2019	0.48	850	3,000	< 0.8	7.2 J	2,700	8,700	--	--	--	--	--	--	--	--	--	< 0.8	--	--	--	--	--	--	--
W-308	Supplementary	Alluvial	10/24/2019	0.45	780	3,100 J	< 0.80 UJ	7.3 J	2,800 J	8,900 J	< 0.0020	< 0.0020	--	0.0078	< 0.0010	< 0.00020	0.010	< 0.0020	--	< 0.80 UJ	< 0.0010	0.37	< 0.00020	0.0025	0.022	< 0.00020	--
W-308	Supplementary	Alluvial	4/17/2020	0.50	760	2,900	< 0.8	7.3 J	2,500	8,600	--	< 0.0025	0.0025	0.0072	< 0.0005	< 0.0005	0.077	< 0.0025	< 0.0025	< 0.8	< 0.0025	0.46 J	--	0.0052	0.020	< 0.0005	--
W-309	Supplementary	Alluvial	12/8/2018	0.42	280	1,300	1.0 J,UJ	8.1 J	2,900	6,500	< 0.0050	0.0044	--	0.011	--	< 0.0010	< 0.0050	< 0.0020	--	1.0 J,UJ	< 0.0010	< 0.20	< 0.00020	0.024	< 0.0060	< 0.0010	< 0.7
W-309	Supplementary	Alluvial	2/15/2019	--	--	--	1.1	--	--	--	< 0.0010	0.0047	--	0.0083	< 0.0010	< 0.00010	< 0.0010	< 0.00050	--	1.1	< 0.00050	0.35	< 0.00020	0.028	0.19	< 0.00010	--
W-309	Supplementary	Alluvial	4/16/2019	--	--	--	1.0	--	--	--	--	0.0051	--	0.0062	--	< 0.00010	< 0.0010	< 0.00050	--	1.0	< 0.00050	0.30	--	0.061	0.22 J	< 0.00010	--
W-309	Supplementary	Alluvial	6/25/2019	0.46	450	1,600	1.2	7.5	3,000	7,100	--	--	--	--	< 0.0010	--	0.0033	--	--	1.2	--	--	--	--	--	< 0.00010	--
W-309	Supplementary	Alluvial	8/8/2019	0.50	470	1,600	1.1	7.5 J	3,200	7,300	--	--	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--
W-309	Supplementary	Alluvial	10/24/2019	0.45	430	1,600 J	1.1 J	7.5 J	3,300 J	7,100 J	< 0.0020	0.0066	--	0.0079	< 0.0010	< 0.00020	0.0020	< 0.0010	--	1.1 J	< 0.0010	0.31	< 0.00020	0.011	0.18	< 0.00020	--
W-309	Supplementary	Alluvial	5/4/2020	0.46	440	1,500	1.2	7.5 J	3,200	7,200	< 0.001	0.0047	0.0038	0.0070	< 0.001	< 0.0001	0.0052	< 0.0005	< 0.0005	1.2	0.023	0.50	--	0.010	0.20	< 0.0001	< 0.8
W-314	Downgradient	Alluvial	12/2/2015	0.98	780	2,900	1.2	7.62	2,200	7,400	< 0.0025	< 0.00050	--	0.016	< 0.0010	0.00022	0.00078	0.016	--	1.2	0.00067	0.35	< 0.00020	0.0066	0.00040	< 0.00010	< 0.7
W-314	Downgradient	Alluvial	3/10/2016	0.96	760	3,000	< 0.80	7.35	2,300	7,200	< 0.015	< 0.0049	--	0.013	< 0.0010	< 0.00046	< 0.0087	0.018	--	< 0.80	< 0.0044	0.32	< 0.00020	0.0072 J	< 0.0015	< 0.00026	< 0.5
W-314	Downgradient	Alluvial	5/11/2016	0.97	780	2,600	< 2.0	--	2,100	7,400	< 0.00020	< 0.0010	--	0.012	< 0.0010	< 0.00020	< 0.0010	0.015	--	< 2.0	< 0.0010	0.33	< 0.00020	0.0073	< 0.0010	< 0.00020	< 0.5
W-314	Downgradient	Alluvial	8/26/2016	1.1	820	2,600	0.93	7.3	2,200	8,000	0.00014	0.00056	--	0.013	< 0.0010	0.00017	0.00078	0.015	--	0.93	< 0.00050	0.32	< 0.00020	0.013	< 0.00050	< 0.00010	< 0.6
W-314	Downgradient	Alluvial	9/22/2016	1.1	800	2,700	1.1	7.6	2,300	8,100	< 0.00050	0.00060	--	0.012	< 0.0010	0.00015	0.00073	0.013	--	1.1	0.00041	0.34	< 0.00020	0.0082	0.00064	< 0.00010	< 0.7
W-314	Downgradient	Alluvial	2/21/2017	1.1	810	2,600	0.97	7.5	2,100	7,200	< 0.0010	0.00054	--	0.011	< 0.0010	0.00016	0.0010	0.013	--	0.97	< 0.00050	0.35	< 0.00020	0.0077	< 0.00050	< 0.00010	< 0.6
W-314	Downgradient	Alluvial	4/11/2017	1.1	780	2,800	0.91	7.7	2,200	7,700	< 0.0010	< 0.00050	--	0.012	< 0.0010	0.00019	0.0012	0.014	--	0.91	< 0.00050	0.31	< 0.00020	0.0086	< 0.00050	< 0.00010	< 0.6
W-314	Downgradient	Alluvial	4/25/2017	1.1	810	2,800	0.80	7.5	2,300	7,500	< 0.0010	< 0.00050	--	0.011	< 0.0010	0.00017	0.0017	0.013	--	0.80	0.0023	0.33	< 0.00020	0.0079	< 0.00050	< 0.00010	0.5
W-314	Downgradient	Alluvial	5/22/2017	1.1	840	2,800	0.90	7.5	2,300	7,600	< 0.0010	< 0.00050	--	0.0097	< 0.0010	0.00016	0.0020	0.011	--	0.90	< 0.00050	0.32	< 0.00020	0.0070	< 0.00050	< 0.00010	< 0.6
W-314	Downgradient	Alluvial	5/24/2017	1.1	840	2,800	0.90	7.4	2,300	7,400	< 0.0040	< 0.0020	--	0.013	< 0.0010	< 0.00040	< 0.0020	0.014	--	0.90	< 0.0020	0.34	< 0.00020	0.0085	< 0.0020	< 0.00040	< 0.6
W-314	Downgradient	Alluvial	6/30/2017	1.1	770	2,900	1.1	7.4	2,500	7,900	< 0.0010	0.00069	--	0.011	< 0.0010	0.00020	0.00098	0.012	--	1.1	< 0.00050	0.30	< 0.00020	0.0080	< 0.00050	< 0.00010	< 0.7
W-314	Downgradient	Alluvial	7/28/2017	1.1	800	2,800	0.90	7.3	2,200	7,600	< 0.0010	0.00053	--	0.0093	< 0.0010	0.00018	0.00087	0.012	--	0.90	< 0.00050	0.30	< 0.00020	0.0071	< 0.00050	< 0.00010	< 0.6
W-314	Downgradient	Alluvial	9/7/2017	1.1	860	2,800	0.90	7.3	2,200	7,700	< 0.0010	0.00091	--	0.011	< 0.0010	0.00018	0.0012	0.013	--	0.90	< 0.00050	0.31	< 0.00020	0.0080	< 0.00050	< 0.00010	< 0.7
W-314	Downgradient	Alluvial	12/7/2017	1.1	830	2,900	0.85	7.4	2,200	7,500	--	--	--	--	--	--	--	--	--	0.85	--	--	--	--	--	--	--
W-314	Downgradient	Alluvial	2/15/2018	--	--	--	1.1	--	--	--	< 0.0010	0.00060	--	0.012	< 0.0010	0.00019	< 0.0010	0.013	--	1.1	< 0.00050	0.32	< 0.00020	0.0085	< 0.00050	< 0.00010	0.2
W-314	Downgradient	Alluvial	5/20/2018	1.1	790	2,900	1.3	7.3	2,400	7,500	< 0.0020	< 0.0010	--	0.011	--	< 0.00020	< 0.0020	0.013	--	1.3	< 0.0010	0.32	--	0.0093	< 0.0010	< 0.00020	< 0.7
W-314	Downgradient	Alluvial	10/24/2018	1.1	800	2,600	0.83	7.5	2,200	7,400	--	0.00073	--	0.011	--	0.00019	0.0013	0.015	--	0.83	< 0.00050	0.30	--	0.0087	< 0.00050	< 0.00010	--
W-314	Downgradient	Alluvial	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
W-314	Downgradient	Alluvial	12/8/2018	1.1	800	2,700	0.89 J,UJ	7.3 J	2,100	7,700	< 0.0050	< 0.0020	--	0.013	--	< 0.0010	0.014	0.014	--	0.89 J,UJ	< 0.0010	0.32	< 0.00020	0.0087	< 0.0060	< 0.0010	0.7
W-314	Downgradient	Alluvial	2/15/2019	--	--	--	0.82	--	--	--	< 0.0010	0.0011	--	0.011	< 0.0010	0.00017	0.046	0.016	--	0.82	< 0.00050	0.34	< 0.00020	0.012	< 0.00050	< 0.00010	--
W-314	Downgradient	Alluvial	4/16/2019	--	--	--	0.87	--	--	--	--	< 0.00050	--	0.012	--	0.00021	0.094	0.016	--	0.87	< 0.00050	0.29	--	0.026	< 0.00050	< 0.00010	< 0.7
W-314	Downgradient	Alluvial	8/1/2019	1.2	740	2,700	0.84	7.4 J	2,200	7,600	--	--	--	--	--	--	--	--	--	0.84	--	--	--	--	--	--	--
W-314	Downgradient	Alluvial	10/24/2019	1.2	750	2,700 J	< 0.80 UJ	7.4 J	2,200 J	7,400 J	< 0.0020	0.0015	--	0.013	< 0.0010	0.00036	0.0081	0.019	--	< 0.80 UJ	< 0.0010	0.30	< 0.00020	0.011	< 0.0010	< 0.00020	--
W-314	Downgradient	Alluvial	4/19/2020	1.4	790	2,900	0.84	7.5 J	2,300	7,600	--	< 0.0025	< 0.0025	0.011	< 0.0005	< 0.0005	0.010	0.022	0.023	0.84	< 0.0025	0.44 J	--	0.010	< 0.0025	< 0.0005	--
W-317	Supplementary	Alluvial	3/30/2019	0.20	320	1,400	< 0.40	7.5 J	670	3,300	< 0.0010	0.0036	--	0.039	< 0.0010	< 0.00010	0.0035	0.00085	--	< 0.40	< 0.00050	< 0.20	< 0.00020	0.064	< 0.00050	< 0.00010	--
W-317	Supplementary	Alluvial	4/17/2019	--	--	--	< 0.80	--	--	--	--	0.0039	--	0.033	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	< 0.20	--	0.0028	< 0.00050	< 0.00010	--
W-317	Supplementary	Alluvial	4/17/2019	--	--	--	< 0.80	--	--	--	--	0.0035	--	0.032	--	< 0.00010	< 0.0010	< 0.00050	--	< 0.80	< 0.00050	< 0.20	--	0.0028	< 0.00050	< 0.00010	--
W-317	Supplementary	Alluvial	8/8/2019	0.48	450	1,600	1.0	7.5 J	3,200	7,200	--	--	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	8/9/2019	0.22	360	1,500	< 0.4	7.4 J	700	3,400	--	--	--	--	--	--	--	--	--	< 0.4	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	10/24/2019	0.21	340	1,400 J	< 0.40 UJ	7.5 J	680 J	3,400 J	< 0.0010	0.0043	--	0.036	< 0.0010	< 0.00010	0.0012	< 0.00050	--	< 0.40 UJ	< 0.00050	< 0.20	< 0.00020	0.0046	< 0.00050	< 0.00010	--

Groundwater Sampling Results for the BAP Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents																	
			Constituent:	**Boron**	**Calcium**	**Chloride**	**Fluoride**	**Ph (Laboratory Measurement)**	**Sulfate**	**Total Dissolved Solids**	**Antimony**	**Arsenic**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Cobalt**	**Fluoride**	**Lead**	**Lithium**	**Mercury**	**Molybdenum**	**Selenium**	**Thallium**	**Total Radium**
			Filtered:	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
			Units:	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**su**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**pCi/L**
			BAP BTV	*1.3*	*740*	*5,700*	*0.8*	*7.4*	*5,100*	*15,000*	*0.004*	*0.004*	*0.004*	*0.05*	*0.001*	*0.0004*	*0.004*	*0.002*	*0.002*	*0.8*	*0.002*	*0.31*	*0.0002*	*0.0061*	*0.002*	*0.0014*	*1.6*
			BAP GWPS	--	--	--	--	--	--	--	*0.006*	*0.01*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.006*	*0.006*	*4*	*0.015*	*0.31*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
W-317	Supplementary	Alluvial	4/16/2020	**0.21**	**350**	**1,500**	< 0.8	**7.5 J**	**730**	**3,700**	**--**	**0.0038**	**--**	**0.031**	< 0.0005	< 0.0005	< 0.005	< 0.0025	**--**	< 0.8	< 0.0005	**0.042 J**	**--**	**0.0037**	< 0.0025	< 0.0001	**--**

Groundwater Sampling Results for the BAP Monitoring Wells

				Additional Analyses																					
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nickel	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			BAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	2/20/2017	**520**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**17**	**0.8**	< 0.6	--	**3,600**	
M-64A	Background	Alluvial	2/20/2017	**520**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**17**	< 0.4	< 0.6	--	**3,600**	
M-64A	Background	Alluvial	4/12/2017	**520**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**14**	< 0.4	**0.8**	--	**3,700**	
M-64A	Background	Alluvial	4/12/2017	**520**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**14**	< 0.5	< 0.6	--	**3,800**	
M-64A	Background	Alluvial	4/25/2017	**530**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**14**	**0.8**	**0.8**	--	**3,600**	
M-64A	Background	Alluvial	5/18/2017	**530**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**14**	< 0.5	**1.3**	--	**3,600**	
M-64A	Background	Alluvial	5/24/2017	**530**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**13**	< 0.3	**1.1**	--	**3,600**	
M-64A	Background	Alluvial	5/24/2017	**530**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**14**	**0.4**	< 0.6	--	**3,700**	
M-64A	Background	Alluvial	6/30/2017	**450**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**14**	< 0.4	< 0.7	--	**3,700**	
M-64A	Background	Alluvial	7/27/2017	**470**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**14**	< 0.4	< 0.7	--	**3,600**	
M-64A	Background	Alluvial	7/27/2017	**470**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**15**	< 0.4	< 0.7	--	**3,700**	
M-64A	Background	Alluvial	9/7/2017	**460**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**14**	< 0.5	< 0.7	--	**3,700**	
M-64A	Background	Alluvial	12/8/2017	**540**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**14**	--	--	--	**3,000**	
M-64A	Background	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.3**	**0.7**	--	--	
M-64A	Background	Alluvial	5/19/2018	**520**	< 6.0	< 6.0	--	--	--	--	**200**	--	--	--	--	--	--	--	--	**13**	< 0.5	< 0.7	--	**4,000**	
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/22/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-64A	Background	Alluvial	2/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.6	--	--	--
M-64A	Background	Alluvial	4/11/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-64A	Background	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-64A	Background	Alluvial	5/6/2020	**470**	< 6	< 6	**0.75**	**5.5**	**5.5**	**4.8**	**220**	**2.3**	**1.9**	--	--	< 0.5	--	--	--	**19**	< 0.4	< 0.8	--	**3,800**	**5.5**
M-64A	Background	Alluvial	5/6/2020	**490**	< 6	< 6	**0.73**	**5.0**	**5.5**	**5.0**	**230**	**2.2**	**1.9**	--	--	< 0.5	--	--	--	**20**	< 0.4	< 0.8	--	**3,400**	**5.1**
M-52A	Downgradient	Alluvial/Moqui	12/1/2015	**190**	< 6.0	< 6.0	--	--	--	--	**280**	--	--	--	--	--	--	--	--	**6.4**	**0.4**	< 0.7	**15**	**2,200**	
M-52A	Downgradient	Alluvial/Moqui	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.6	--	--	
M-52A	Downgradient	Alluvial/Moqui	5/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.4	--	--	
M-52A	Downgradient	Alluvial/Moqui	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.6**	< 0.6	--	--	
M-52A	Downgradient	Alluvial/Moqui	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.6**	< 0.7	--	--	
M-52A	Downgradient	Alluvial/Moqui	2/21/2017	**220**	< 6.0	< 6.0	--	--	--	--	**250**	--	--	--	--	--	--	--	--	**6.9**	< 0.5	< 0.6	--	**2,400**	
M-52A	Downgradient	Alluvial/Moqui	2/21/2017	**220**	< 6.0	< 6.0	--	--	--	--	**260**	--	--	--	--	--	--	--	--	**7.1**	< 0.4	< 0.6	--	**2,600**	
M-52A	Downgradient	Alluvial/Moqui	4/11/2017	**240**	< 6.0	< 6.0	--	--	--	--	**250**	--	--	--	--	--	--	--	--	**6.5**	< 0.6	< 0.6	--	**2,400**	
M-52A	Downgradient	Alluvial/Moqui	4/25/2017	**240**	< 6.0	< 6.0	--	--	--	--	**260**	--	--	--	--	--	--	--	--	**6.6**	**0.9**	< 0.6	--	**2,400**	
M-52A	Downgradient	Alluvial/Moqui	5/18/2017	**250**	< 6.0	< 6.0	--	--	--	--	**270**	--	--	--	--	--	--	--	--	**6.9**	< 0.4	**0.6**	--	**2,400**	
M-52A	Downgradient	Alluvial/Moqui	5/24/2017	**250**	< 6.0	< 6.0	--	--	--	--	**280**	--	--	--	--	--	--	--	--	**7.2**	< 0.4	< 0.6	--	**2,500**	
M-52A	Downgradient	Alluvial/Moqui	6/30/2017	**190**	< 6.0	< 6.0	--	--	--	--	**250**	--	--	--	--	--	--	--	--	**5.6**	< 0.5	< 0.7	--	**2,200**	
M-52A	Downgradient	Alluvial/Moqui	7/28/2017	**150**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**4.7**	< 0.4	< 0.7	--	**2,000**	
M-52A	Downgradient	Alluvial/Moqui	9/7/2017	**140**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	--	**4.6**	**0.6**	< 0.6	--	**2,000**	
M-52A	Downgradient	Alluvial/Moqui	12/7/2017	**150**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	--	**5.2**	--	--	--	**2,000**	
M-52A	Downgradient	Alluvial/Moqui	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.2**	**0.7**	--	--	
M-52A	Downgradient	Alluvial/Moqui	5/20/2018	**230**	< 6.0	< 6.0	--	--	--	--	**280**	--	--	--	--	--	--	--	--	**6.6**	--	--	--	**2,500**	
M-52A	Downgradient	Alluvial/Moqui	6/7/2018	**220**	< 6.0	< 6.0	--	--	--	--	**260**	--	--	--	--	--	--	--	--	**5.6**	< 0.4	**0.7**	--	**2,200**	
M-52A	Downgradient	Alluvial/Moqui	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-52A	Downgradient	Alluvial/Moqui	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-52A	Downgradient	Alluvial/Moqui	12/8/2018	**230**	< 6.0	< 6.0	--	--	--	--	**300**	--	--	--	--	--	--	--	--	**7.1**	< 0.5	< 0.7	**14**	**2,600**	--
M-52A	Downgradient	Alluvial/Moqui	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-52A	Downgradient	Alluvial/Moqui	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
M-52A	Downgradient	Alluvial/Moqui	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-52A	Downgradient	Alluvial/Moqui	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-52A	Downgradient	Alluvial/Moqui	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-52A	Downgradient	Alluvial/Moqui	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-52A	Downgradient	Alluvial/Moqui	4/19/2020	**210 J**	< 6	< 6	< 0.5	**1.4 J**	**5.0**	**2.9**	**250**	**1.2**	**1.1**	--	--	< 0.5	--	--	--	**8.9**	--	--	--	**2,500**	**1.5**
M-53A	Downgradient	Alluvial	12/1/2015	**100**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	--	**8.4**	< 0.4	< 0.7	**13**	**1,700**	
M-53A	Downgradient	Alluvial	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	**0.5**	--	--	

Groundwater Sampling Results for the BAP Monitoring Wells

				Additional Analyses																					
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nickel	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			BAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-53A	Downgradient	Alluvial	5/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.5	--	--	
M-53A	Downgradient	Alluvial	5/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.4	--	--	
M-53A	Downgradient	Alluvial	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	
M-53A	Downgradient	Alluvial	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.6**	--	--	
M-53A	Downgradient	Alluvial	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	
M-53A	Downgradient	Alluvial	2/21/2017	**96**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**14**	< 0.4	< 0.6	--	**1,700**	
M-53A	Downgradient	Alluvial	4/12/2017	**110**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**12**	< 0.5	**0.6**	--	**1,700**	
M-53A	Downgradient	Alluvial	4/25/2017	**120**	< 6.0	< 6.0	--	--	--	--	**190**	--	--	--	--	--	--	--	--	**6.5**	< 0.4	< 0.6	--	**1,700**	
M-53A	Downgradient	Alluvial	5/18/2017	**98**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**14**	< 0.4	< 0.6	--	**1,700**	
M-53A	Downgradient	Alluvial	5/24/2017	**98**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	--	**15**	< 0.4	< 0.4	--	**1,700**	
M-53A	Downgradient	Alluvial	7/1/2017	**97**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**13**	< 0.5	< 0.7	--	**1,700**	
M-53A	Downgradient	Alluvial	7/28/2017	**110**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**14**	< 0.4	< 0.7	--	**1,700**	
M-53A	Downgradient	Alluvial	9/7/2017	**170**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**14**	< 0.4	< 0.6	--	**1,700**	
M-53A	Downgradient	Alluvial	12/7/2017	**98**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**13**	--	--	--	**1,600**	
M-53A	Downgradient	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**	**0.3**	--	--	
M-53A	Downgradient	Alluvial	5/20/2018	**99**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**13**	< 0.6	< 0.7	--	**1,600**	
M-53A	Downgradient	Alluvial	5/20/2018	**99**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**13**	< 0.6	< 0.7	--	**1,600**	
M-53A	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-53A	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-53A	Downgradient	Alluvial	12/7/2018	**91**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**13**	< 0.5	**0.9**	**8.9**	**1,500**	--
M-53A	Downgradient	Alluvial	12/7/2018	**92**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**13**	< 0.5	**1.1**	**9.4**	**1,600**	--
M-53A	Downgradient	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.8**	--	--	--
M-53A	Downgradient	Alluvial	4/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-53A	Downgradient	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-53A	Downgradient	Alluvial	10/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-53A	Downgradient	Alluvial	4/19/2020	**96**	< 6	< 6	< 0.5	**1.3**	< 0.03	< 0.1	**210**	**5.0**	**5.0**	--	--	< 0.5	--	--	--	**12 J**	--	--	--	**1,600**	**1.2**
M-53A	Downgradient	Alluvial	4/19/2020	**96**	< 6	< 6	< 0.5	**1.2**	< 0.03	< 0.1	**210**	**5.2**	**4.8**	--	--	< 0.5	--	--	--	**15 J**	--	--	--	**1,600**	**1.2**
M-55A	Supplementary	Alluvial	12/1/2015	**180**	< 6.0	< 6.0	--	--	--	--	**140**	--	--	--	--	--	--	--	--	**3.3**	< 0.5	< 0.9	**22**	**2,200**	
M-55A	Supplementary	Alluvial	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.2**	< 0.6	--	--	
M-55A	Supplementary	Alluvial	5/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.5	--	--	
M-55A	Supplementary	Alluvial	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	
M-55A	Supplementary	Alluvial	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.8**	--	--	
M-55A	Supplementary	Alluvial	2/21/2017	**200**	< 6.0	< 6.0	--	--	--	--	**150**	--	--	--	--	--	--	--	--	**3.6**	< 0.4	< 0.6	--	**2,900**	
M-55A	Supplementary	Alluvial	4/12/2017	**200**	< 6.0	< 6.0	--	--	--	--	**140**	--	--	--	--	--	--	--	--	**3.1**	< 0.5	**1.4**	--	**2,800**	
M-55A	Supplementary	Alluvial	4/25/2017	**210**	< 6.0	< 6.0	--	--	--	--	**150**	--	--	--	--	--	--	--	--	**3.2**	< 0.4	**1.0**	--	**2,900**	
M-55A	Supplementary	Alluvial	5/18/2017	**210**	< 6.0	< 6.0	--	--	--	--	**150**	--	--	--	--	--	--	--	--	**3.2**	< 0.4	**1.1**	--	**2,800**	
M-55A	Supplementary	Alluvial	5/24/2017	**210**	< 6.0	< 6.0	--	--	--	--	**150**	--	--	--	--	--	--	--	--	**3.1**	< 0.4	**1.5**	--	**2,900**	
M-55A	Supplementary	Alluvial	7/1/2017	**210**	< 6.0	< 6.0	--	--	--	--	**150**	--	--	--	--	--	--	--	--	**2.9**	< 0.5	**0.9**	--	**2,800**	
M-55A	Supplementary	Alluvial	7/28/2017	**200**	< 6.0	< 6.0	--	--	--	--	**160**	--	--	--	--	--	--	--	--	**2.9**	< 0.4	< 0.7	--	**3,000**	
M-55A	Supplementary	Alluvial	9/7/2017	**210**	< 6.0	< 6.0	--	--	--	--	**160**	--	--	--	--	--	--	--	--	**3.1**	< 0.4	**1.2**	--	**2,900**	
M-55A	Supplementary	Alluvial	12/8/2018	**190**	< 6.0	< 6.0	--	--	--	--	**160**	--	--	--	--	--	--	--	--	**3.0**	< 0.5	**0.9**	**12**	**2,900**	--
M-55A	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**1.2**	--	--	--
M-55A	Supplementary	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-55A	Supplementary	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-55A	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-55A	Supplementary	Alluvial	4/17/2020	**190**	< 6	< 6	< 0.5	**3.4**	**0.04 J**	< 0.1	**160**	< 0.015	< 0.01	--	--	**0.52**	--	--	--	**6.5**	--	--	--	**2,900**	**3.2**
MW-69A	Supplementary	Alluvial	4/19/2020	**140**	< 6	< 6	< 0.5	**1.7**	**0.21**	< 0.1	**170**	**8.6**	**8.2**	--	--	< 0.5	--	--	--	**10**	--	--	--	**1,800**	**1.7**
MW-70M	Supplementary	Moqui	4/19/2020	**85**	< 6	< 6	< 0.5	**1.7**	**0.072 J**	< 0.1	**160**	**1.8**	**1.8**	--	--	< 0.5	--	--	--	**11**	--	--	--	**1,500**	**1.3**
W-301	Supplementary	Alluvial	12/7/2018	**180**	< 6.0	< 6.0	--	--	--	--	**170**	--	--	--	--	--	--	--	--	**4.6**	< 0.6	< 0.7	**14**	**2,600**	--
W-301	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.7**	--	--	--
W-301	Supplementary	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-301	Supplementary	Alluvial	8/9/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-301	Supplementary	Alluvial	10/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-301	Supplementary	Alluvial	4/18/2020	**150**	< 6	< 6	< 0.5	**3.1**	< 0.03	< 0.1	**160**	**1.8**	**1.7**	--	--	**17**	--	--	--	**9.6**	--	--	--	**4,100**	**2.9**
W-302	Supplementary	Alluvial	12/7/2018	**140**	< 6.0	< 6.0	--	--	--	--	**120**	--	--	--	--	--	--	--	--	**5.5**	< 0.6	< 0.7	**12**	**1,800**	--
W-302	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.7**	--	--	--
W-302	Supplementary	Alluvial	4/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Groundwater Sampling Results for the BAP Monitoring Wells

				Additional Analyses																					
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nickel	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			BAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-302	Supplementary	Alluvial	8/9/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-302	Supplementary	Alluvial	10/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-302	Supplementary	Alluvial	4/17/2020	**130**	< 6.0	< 6.0	< 0.5	**1.2 J**	**0.40**	**0.14**	**120**	**0.022 J**	**0.027**	--	--	< 0.5	--	--	--	**6.5**	--	--	--	**1,800**	**0.64 J**
W-303	Supplementary	Moenkopi - Moqui	4/18/2020	**150**	< 6.0	< 6.0	--	**1.4**	--	< 0.1	**190**	< 0.50	**0.023**	--	--	< 0.5	--	--	--	**6.8**	--	--	--	**2,100**	**1.4**
W-304	Supplementary	Alluvial	12/7/2018	**140**	< 6.0	< 6.0	--	--	--	--	**100**	--	--	--	--	--	--	--	--	**5.8**	< 0.5	< 0.7	**9.6**	**2,100**	--
W-304	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
W-304	Supplementary	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-304	Supplementary	Alluvial	8/8/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-304	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-304	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-304	Supplementary	Alluvial	4/17/2020	**140**	< 6	< 6	< 0.5	**0.97**	**0.11**	< 0.1	**94**	**0.89**	**0.82**	--	--	< 0.5	--	--	--	**5.0**	--	--	--	**2,100**	**0.70**
W-305	Downgradient	Alluvial	12/2/2015	**110**	< 6	< 6	--	--	--	--	**120**	--	--	--	--	--	--	--	--	**3.8**	--	--	**0.0047**	**1,600**	--
W-305	Downgradient	Alluvial	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	5/11/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	8/27/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	2/21/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.2**	--	--	--	**1,600**	--
W-305	Downgradient	Alluvial	4/11/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.0**	--	--	--	**1,500**	--
W-305	Downgradient	Alluvial	4/24/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.0**	--	--	--	**1,600**	--
W-305	Downgradient	Alluvial	5/22/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.1**	--	--	--	**1,600**	--
W-305	Downgradient	Alluvial	5/24/2017	**110**	< 6	< 6	--	--	--	--	**120**	--	--	--	--	--	--	--	--	**3.2**	--	--	--	**1,700**	--
W-305	Downgradient	Alluvial	6/29/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**2.8**	--	--	--	**1,500**	--
W-305	Downgradient	Alluvial	7/28/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.1**	--	--	--	**1,500**	--
W-305	Downgradient	Alluvial	9/6/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**2.8**	--	--	--	**1,500**	--
W-305	Downgradient	Alluvial	12/7/2017	**110**	< 6	< 6	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.2**	--	--	--	**1,500**	--
W-305	Downgradient	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.295**	**0.347**	--	--	--
W-305	Downgradient	Alluvial	5/19/2018	**110**	< 6.0	< 6.0	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.0**	< 0.5	< 0.7	--	**1,500**	--
W-305	Downgradient	Alluvial	5/19/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.6	< 0.7	--	--	--
W-305	Downgradient	Alluvial	12/7/2018	**99**	< 6.0	< 6.0	--	--	--	--	**110**	--	--	--	--	--	--	--	--	**3.0**	< 0.5	< 0.7	**11**	**1,500**	--
W-305	Downgradient	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.8**	--	--	--
W-305	Downgradient	Alluvial	4/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
W-305	Downgradient	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	10/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	10/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-305	Downgradient	Alluvial	4/18/2020	**100**	< 6	< 6	< 0.5	**1.7**	**0.48**	**0.28**	**110**	**8.1**	**7.3**	--	--	< 0.5	--	--	--	**1.4 J**	--	--	--	**1,600**	**1.8**
W-306	Downgradient	Alluvial	12/2/2015	**100**	< 6.0	< 6.0	--	--	--	--	**120**	--	--	--	--	--	--	--	--	**5.6**	< 0.4	< 0.7	**11**	**2,500**	
W-306	Downgradient	Alluvial	3/9/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.6	--	--	
W-306	Downgradient	Alluvial	5/11/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.4	--	--	
W-306	Downgradient	Alluvial	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	< 0.6	--	--	
W-306	Downgradient	Alluvial	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.7	--	--	
W-306	Downgradient	Alluvial	2/21/2017	**150**	< 6.0	< 6.0	--	--	--	--	**240**	--	--	--	--	--	--	--	--	**3.3**	< 0.4	< 0.6	--	**6,100**	
W-306	Downgradient	Alluvial	4/12/2017	**150**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**3.2**	< 0.4	< 0.6	--	**5,600**	
W-306	Downgradient	Alluvial	4/25/2017	**150**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**2.8**	< 0.4	< 0.6	--	**5,800**	
W-306	Downgradient	Alluvial	5/22/2017	**160**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**2.9**	< 0.4	< 0.6	--	**5,700**	
W-306	Downgradient	Alluvial	5/24/2017	**150**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**2.8**	< 0.5	< 0.6	--	**5,700**	
W-306	Downgradient	Alluvial	7/1/2017	**140**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**2.7**	< 0.4	< 0.7	--	**6,000**	
W-306	Downgradient	Alluvial	7/28/2017	**140**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**2.4**	< 0.4	**1.1**	--	**5,400**	
W-306	Downgradient	Alluvial	9/6/2017	**140**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**2.2**	< 0.5	< 0.7	--	**5,700**	
W-306	Downgradient	Alluvial	12/7/2017	**140**	< 6.0	< 6.0	--	--	--	--	**220**	--	--	--	--	--	--	--	--	**3.1**	--	--	--	**5,100**	
W-306	Downgradient	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**	**0.3**	--	--	
W-306	Downgradient	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**	**0.2**	--	--	
W-306	Downgradient	Alluvial	5/19/2018	**140**	< 6.0	< 6.0	--	--	--	--	**210**	--	--	--	--	--	--	--	--	**2.5**	< 0.5	**0.8**	--	**5,900**	
W-306	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-306	Downgradient	Alluvial	10/26/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
W-306	Downgradient	Alluvial	12/7/2018	**130**	< 6.0	< 6.0	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**2.6**	< 0.5	< 0.7	**12**	**5,700**	--

Groundwater Sampling Results for the BAP Monitoring Wells

				Additional Analyses																					
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nickel	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			BAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-306	Downgradient	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
W-306	Downgradient	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
W-306	Downgradient	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-306	Downgradient	Alluvial	10/23/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-306	Downgradient	Alluvial	4/19/2020	130	< 6	< 6	< 0.5	2.7	< 0.03	< 0.1	230	< 0.003	< 0.01	--	--	< 0.5	--	--	--	9.7 J	--	--	--	5,500	2.5
W-306	Downgradient	Alluvial	4/19/2020	130	< 6	< 6	< 0.5	2.6	< 0.03	< 0.1	230	< 0.015	< 0.01	--	--	< 0.5	--	--	--	3.6 J	--	--	--	5,700	2.4
W-307	Supplementary	Alluvial	12/8/2018	100	< 6.0	< 6.0	--	--	--	--	150	--	--	--	--	--	--	--	--	5.4	< 0.5	< 0.7	13	1,700	--
W-307	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
W-307	Supplementary	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-307	Supplementary	Alluvial	6/25/2019	--	--	--	--	--	--	--	140	--	--	--	< 0.10	< 0.10	< 0.10	< 0.10	< 0.50	--	--	--	--	1,700	--
W-307	Supplementary	Alluvial	8/8/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-307	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-307	Supplementary	Alluvial	4/17/2020	110	< 6	< 6	< 0.5	1.6	0.16	< 0.1	130	0.030 J	0.027	--	--	< 0.5	--	--	--	4.2	--	--	--	1,600	1.3
W-308	Supplementary	Alluvial	12/8/2018	160	< 6.0	< 6.0	--	--	--	--	120	--	--	--	--	--	--	--	--	7.7	< 0.5	< 0.7	12	1,900	--
W-308	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.6	< 0.7	--	--	--
W-308	Supplementary	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-308	Supplementary	Alluvial	6/25/2019	--	--	--	--	--	--	--	120	--	--	--	0.20	0.20	< 0.10	0.20	< 0.50	--	--	--	--	2,100	--
W-308	Supplementary	Alluvial	8/8/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-308	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-308	Supplementary	Alluvial	4/17/2020	170	< 6	< 6	< 0.5	1.2	0.031 J	< 0.1	120	0.072	0.073	--	--	< 0.5	--	--	--	6.4	--	--	--	2,100	1.0
W-309	Supplementary	Alluvial	12/8/2018	55	< 6.0	< 6.0	--	--	--	--	34	--	--	--	--	--	--	--	--	12	< 0.5	< 0.7	22	1,700	--
W-309	Supplementary	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-309	Supplementary	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-309	Supplementary	Alluvial	6/25/2019	--	--	--	--	--	--	--	88	--	--	--	2.7	2.7	< 0.10	2.7	< 0.50	--	--	--	--	1,900	--
W-309	Supplementary	Alluvial	8/8/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-309	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-309	Supplementary	Alluvial	5/4/2020	160	< 6	< 6	< 0.5	< 1	< 0.1	< 0.1	86	0.83	0.83	--	--	2.6	--	--	--	8.9	< 0.4	< 0.8	--	1,800	< 1
W-314	Downgradient	Alluvial	12/2/2015	99	< 6.0	< 6.0	--	--	--	--	150	--	--	--	--	--	--	--	--	2.4	< 0.4	< 0.7	9.2	1,500	
W-314	Downgradient	Alluvial	3/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.5	--	--	
W-314	Downgradient	Alluvial	5/11/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	< 0.5	--	--	
W-314	Downgradient	Alluvial	8/26/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	
W-314	Downgradient	Alluvial	9/22/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	
W-314	Downgradient	Alluvial	2/21/2017	100	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	2.1	< 0.4	< 0.6	--	1,600	
W-314	Downgradient	Alluvial	4/11/2017	100	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	1.9	< 0.4	< 0.6	--	1,500	
W-314	Downgradient	Alluvial	4/25/2017	100	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	1.8	0.5	< 0.6	--	1,600	
W-314	Downgradient	Alluvial	5/22/2017	100	< 6.0	< 6.0	--	--	--	--	170	--	--	--	--	--	--	--	--	1.9	< 0.4	< 0.6	--	1,600	
W-314	Downgradient	Alluvial	5/24/2017	100	< 6.0	< 6.0	--	--	--	--	170	--	--	--	--	--	--	--	--	1.9	< 0.5	< 0.6	--	1,600	
W-314	Downgradient	Alluvial	6/30/2017	100	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	1.6	< 0.4	< 0.7	--	1,500	
W-314	Downgradient	Alluvial	7/28/2017	100	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	1.7	< 0.4	< 0.6	--	1,500	
W-314	Downgradient	Alluvial	9/7/2017	110	< 6.0	< 6.0	--	--	--	--	170	--	--	--	--	--	--	--	--	1.7	< 0.5	< 0.7	--	1,500	
W-314	Downgradient	Alluvial	12/7/2017	100	< 6.0	< 6.0	--	--	--	--	170	--	--	--	--	--	--	--	--	2.0	--	--	--	1,500	
W-314	Downgradient	Alluvial	2/15/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.2	--	--	
W-314	Downgradient	Alluvial	5/20/2018	100	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	1.9	< 0.5	< 0.7	--	1,500	
W-314	Downgradient	Alluvial	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-314	Downgradient	Alluvial	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
W-314	Downgradient	Alluvial	12/8/2018	94	< 6.0	< 6.0	--	--	--	--	160	--	--	--	--	--	--	--	--	1.8	< 0.5	0.7	8.9	1,500	--
W-314	Downgradient	Alluvial	2/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-314	Downgradient	Alluvial	4/16/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
W-314	Downgradient	Alluvial	8/1/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-314	Downgradient	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-314	Downgradient	Alluvial	4/19/2020	98	< 6	< 6	< 0.5	1.0	< 0.03	< 0.1	170	0.063	0.057	--	--	< 0.5	--	--	--	< 0.73	--	--	--	1,500	0.97
W-317	Supplementary	Alluvial	3/30/2019	190	< 6.0	< 6.0	--	--	--	--	110	--	--	--	--	--	--	--	--	7.1	--	--	--	650	--
W-317	Supplementary	Alluvial	4/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	4/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	8/8/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	8/9/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	10/24/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Groundwater Sampling Results for the BAP Monitoring Wells

				Additional Analyses																			
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Ammonia (as N)	Dissolved Organic Carbon	Iron	Iron	Magnesium	Manganese	Manganese	Nickel	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BAP BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			BAP GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-317	Supplementary	Alluvial	4/16/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

BTV exceedances are shown in grey shaded cells. GWPS exceedence are shown in red text.

*Background well for the FAP and BAP.

Duplicate sample dates under the same locations are either field duplicates or are instances of samples with multiple filed/lab sample IDs on the same date.

Abbreviations and Data Qualifiers:

< = less than

BAP = Bottom Ash Pond

BTV = Background Threshold Value

degrees C = degrees Celsius

GWPS = Groundwater Protection Standard

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/L = milligrams per liter

pCi/L = Picocuries per liter

su = standard units

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

umhos/cm = micromhos per centimeter

uS/cm = microsiemens per centimeter

Groundwater Sampling Results for the BAM Monitoring Wells

			Constituent:	Boron	Calcium	Chloride	Fluoride	pH (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Fluoride	Lead	Lithium	Molybdenum	Mercury	Selenium	Thallium	Total Radium
				Appendix III Constituents							Appendix IV Constituents														
			Filtered:	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BTV	*0.55*	*100*	*1,600*	*1.4 / 1.5**	*7.3 - 7.8*	*380*	*3,200*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	12/03/2015	0.52	100	1,500	1.2	7.34	380	3,000	< 0.0025	0.0041	0.052	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.2	< 0.00050	< 0.20	0.0086	< 0.00020	0.00018	< 0.00010	4.0
M-54	Background	Coconino Sandstone	03/10/2016	0.53	100	1,600	1.3	7.56	360	2,900	< 0.015	0.0073 j	0.045	< 0.0010	< 0.00046	< 0.0087	0.0013 j	1.3	< 0.0044	< 0.20	0.0067 j	< 0.00020	< 0.0015	< 0.00026	5.5
M-54	Background	Coconino Sandstone	05/20/2016	0.51	100	1,500	1.4	--	350	3,000	0.00015	0.0067	0.032	< 0.0010	< 0.00010	< 0.00050	0.00058	1.4	0.00065	< 0.20	0.0055	< 0.00020	< 0.00050	< 0.00010	6.3
M-54	Background	Coconino Sandstone	08/27/2016	0.53	110	1,600	1.4	7.5	370	3,100	< 0.00010	0.0077	0.032	< 0.0010	< 0.00010	0.00056	0.00057	1.4	< 0.00050	< 0.20	0.0060	< 0.00020	< 0.00050	< 0.00010	7.5
M-54	Background	Coconino Sandstone	09/22/2016	0.52	99	1,400	1.3	7.7	350	3,200	< 0.00050	0.0074	0.030	< 0.0010	< 0.00010	< 0.00050	0.00055	1.3	< 0.00010	< 0.20	0.0064	< 0.00020	< 0.00060	< 0.00010	6.3
M-54	Background	Coconino Sandstone	02/21/2017	0.52	100	1,300	1.3	7.7	350	2,900	< 0.0010	0.0072	0.027	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.3	< 0.00050	< 0.20	0.0056	< 0.00020	< 0.00050	< 0.00010	6.6
M-54	Background	Coconino Sandstone	04/11/2017	0.51	100	1,500	1.3	7.7	360	3,100	< 0.0010	0.0077	0.028	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.3	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	8.1
M-54	Background	Coconino Sandstone	04/24/2017	0.53	95	1,500	1.3	7.6	370	3,000	< 0.0010	0.0075	0.027	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.3	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	5.6
M-54	Background	Coconino Sandstone	05/19/2017	0.50	99	1,600	1.3	7.8	380	3,200	< 0.0010	0.0068	0.026	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.3	< 0.00050	< 0.20	0.0054	< 0.00020	< 0.00050	< 0.00010	8.4
M-54	Background	Coconino Sandstone	05/25/2017	0.52	100	1,500	1.4	7.7	370	3,200	< 0.0010	0.0079	0.026	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0056	< 0.00020	< 0.00050	< 0.00010	9.6
M-54	Background	Coconino Sandstone	06/29/2017	0.51	97	1,600	1.4	7.6	380	2,900	< 0.0010	0.0074	0.027	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0059	< 0.00020	< 0.00050	< 0.00010	9.0
M-54	Background	Coconino Sandstone	07/29/2017	0.56	100	1,500	1.4	7.4	350	3,100	< 0.0020	0.0074	0.027	< 0.0010	< 0.00020	< 0.0010	< 0.0010	1.4	< 0.0010	< 0.20	0.0057	< 0.00020	< 0.0010	< 0.00020	6.5
M-54	Background	Coconino Sandstone	09/05/2017	0.55	100	1,500	1.4	7.5	370	3,100	< 0.0040	0.0076	0.028	< 0.0010	< 0.00040	< 0.0040	< 0.0020	1.4	< 0.0020	< 0.20	0.0059	< 0.00020	< 0.0020	< 0.00040	6.4
M-54	Background	Coconino Sandstone	12/07/2017	0.51	97	1,600	1.4	7.6	360	3,000	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	05/25/2018	0.50	96	1,500	1.4	7.4	350	3,000	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	10/26/2018	0.50	100	1,500	1.4	7.5	360	2,900	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	04/09/2019	0.53	98	1,400	1.3	7.7	340	3,100	--	--	--	--	--	--	--	1.3	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	10/22/2019	0.49	95	1,500	1.3	7.4 J	350	2,900	--	--	--	--	--	--	--	1.3	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	05/07/2020	0.51	98	1,400	1.8	7.6 J	360	3,100	--	--	--	--	--	--	--	1.8	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	12/03/2015	0.50	87	1,300	1.3	7.53	340	2,700	< 0.0025	0.0049	0.051	< 0.0010	< 0.00010	< 0.00050	0.0013	1.3	< 0.00050	< 0.20	0.0063	< 0.00020	0.00013	< 0.00010	5.4
M-59	Downgradient	Coconino Sandstone	03/10/2016	0.48	85	1,400	1.3	7.57	350	2,700	< 0.015	0.0069 j	0.032	< 0.0010	< 0.00046	< 0.0087	< 0.0013	1.3	< 0.0044	< 0.20	0.0058 j	< 0.00020	< 0.0015	< 0.00026	5.4
M-59	Downgradient	Coconino Sandstone	05/20/2016	0.49	86	1,400	1.4	--	340	2,700	< 0.00010	0.0073	0.031	< 0.0010	< 0.00010	0.00063	0.00085	1.4	0.00068	< 0.20	0.0059	< 0.00020	< 0.00050	< 0.00010	7.4
M-59	Downgradient	Coconino Sandstone	08/27/2016	0.50	89	1,400	1.4	7.6	350	2,700	< 0.00010	0.0082	0.030	< 0.0010	< 0.00010	< 0.00050	0.00062	1.4	< 0.00050	< 0.20	0.0065	< 0.00020	< 0.00050	< 0.00010	8.1
M-59	Downgradient	Coconino Sandstone	09/22/2016	0.50	88	1,300	1.4	7.8	340	2,900	< 0.00050	0.0085	0.028	< 0.0010	< 0.00010	< 0.00050	0.00055	1.4	< 0.00010	< 0.20	0.0063	< 0.00020	< 0.00060	< 0.00010	7.2
M-59	Downgradient	Coconino Sandstone	02/22/2017	0.48	86	1,200	1.3	7.8	330	2,800	< 0.0010	0.0081	0.025	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.3	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	7.7
M-59	Downgradient	Coconino Sandstone	04/11/2017	0.49	90	1,400	1.3	8.1	350	2,800	< 0.0010	0.0083	0.025	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.3	< 0.00050	< 0.20	0.0063	< 0.00020	< 0.00050	< 0.00010	7.7
M-59	Downgradient	Coconino Sandstone	04/24/2017	0.52	89	1,300	1.4	7.7	350	2,800	< 0.0010	0.0082	0.025	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	8.0
M-59	Downgradient	Coconino Sandstone	05/19/2017	0.50	93	1,400	1.4	7.8	360	2,700	< 0.0010	0.0077	0.023	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0056	< 0.00020	< 0.00050	< 0.00010	7.1
M-59	Downgradient	Coconino Sandstone	05/25/2017	0.50	88	1,300	1.4	7.6	350	2,700	< 0.0010	0.0073	0.024	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	0.00061	< 0.20	0.0059	< 0.00020	< 0.00050	< 0.00010	8.0
M-59	Downgradient	Coconino Sandstone	06/29/2017	0.49	84	1,400	1.5	7.8	370	2,500	< 0.0010	0.0086	0.025	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.5	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	9.0
M-59	Downgradient	Coconino Sandstone	07/29/2017	0.53	92	1,300	1.5	7.6	340	2,800	< 0.0020	0.0085	0.025	< 0.0010	< 0.00020	< 0.0010	< 0.0010	1.5	< 0.0010	< 0.20	0.0058	< 0.00020	< 0.0010	< 0.00020	7.9
M-59	Downgradient	Coconino Sandstone	09/05/2017	0.51	90	1,300	1.4	7.7	360	2,700	< 0.0040	0.0085	0.027	< 0.0010	< 0.00040	< 0.0040	< 0.0020	1.4	< 0.0020	< 0.20	0.0062	< 0.00020	< 0.0020	< 0.00040	7.6
M-59	Downgradient	Coconino Sandstone	12/07/2017	0.49	86	1,400	1.4	7.7	350	2,700	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	05/25/2018	0.49	85	1,400	1.4	7.5	350	2,700	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	10/26/2018	0.48	88	1,400	1.4	7.6	360	2,500	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	04/09/2019	0.50	86	1,200	1.4	7.9 J	330	2,700	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	10/23/2019	0.48	84	1,400	1.3	7.5 J	350	2,800	--	--	--	--	--	--	--	1.3	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	05/07/2020	0.50	89	1,200	1.8	7.7 J	350	2,800	--	--	--	--	--	--	--	1.8	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	12/03/2015	0.54	88	1,400	1.3	7.56	350	2,800	< 0.0025	0.0078	0.031	< 0.0010	< 0.00010	< 0.00050	0.00074	1.3	< 0.00050	< 0.20	0.0058	< 0.00020	0.00016	< 0.00010	7.8
M-60	Downgradient	Coconino Sandstone	03/09/2016	0.50	86	1,400	1.4	7.83	350	2,800	< 0.015	0.0084 j	0.025	< 0.0010	< 0.00046	< 0.0087	< 0.0013	1.4	< 0.0044	< 0.20	0.0058 j	< 0.00020	< 0.0015	< 0.00026	2.6
M-60	Downgradient	Coconino Sandstone	05/20/2016	0.50	89	1,400	1.5	--	350	2,800	< 0.00010	0.0077	0.023	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.5	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	7.9
M-60	Downgradient	Coconino Sandstone	08/27/2016	0.52	90	1,400	1.5	7.5	360	2,800	< 0.00010	0.0091	0.025	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.5	< 0.00050	< 0.20	0.0061	< 0.00020	< 0.00050	< 0.00010	8.7
M-60	Downgradient	Coconino Sandstone	09/22/2016	0.51	88	1,300	1.4	7.8	350	3,000	< 0.00050	0.0088	0.023	< 0.0010	< 0.00010	< 0.00050	0.00034	1.4	0.00011	< 0.20	0.0066	< 0.00020	< 0.00060	0.00010	8.3
M-60	Downgradient	Coconino Sandstone	02/22/2017	0.52	91	1,300	1.4	7.8	340	2,800	< 0.0010	0.0084	0.022	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0058	< 0.00020	< 0.00050	< 0.00010	8.2
M-60	Downgradient	Coconino Sandstone	04/11/2017	0.48	90	1,400	1.4	8.0	360	2,900	< 0.0010	0.0087	0.021	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0061	< 0.00020	< 0.00050	< 0.00010	6.9
M-60	Downgradient	Coconino Sandstone	04/11/2017	0.47	84	1,300	1.4	7.8	370	2,900	< 0.0010	0.0084	0.021	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0059	< 0.00020	< 0.00050	< 0.00010	8.8
M-60	Downgradient	Coconino Sandstone	04/24/2017	0.53	86	1,400	1.4	7.8	350	2,700	< 0.0010	0.0087	0.022	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0059	< 0.00020	< 0.00050	< 0.00010	7.2
M-60	Downgradient	Coconino Sandstone	05/19/2017	0.53	92	1,400	1.4	7.7	360	2,800	< 0.0010	0.0079	0.020	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0054	< 0.00020	< 0.00050	< 0.00010	8.6
M-60	Downgradient	Coconino Sandstone	05/25/2017	0.51	86	1,300	1.4	7.7	350	2,800	< 0.0010	0.0097	0.022	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.4	< 0.00050	< 0.20	0.0060	< 0.00020	< 0.00050	< 0.00010	10.2
M-60	Downgradient	Coconino Sandstone	06/29/2017	0.51	84	1,500	1.5	7.7	440	2,500	< 0.0010	0.0086	0.022	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.5	< 0.00050	< 0.20	0.0064	< 0.00020	< 0.00050	< 0.00010	8.1
M-60	Downgradient	Coconino Sandstone	06/29/2017	0.50	84	1,500	1.5	7.8	380	2,700	< 0.0010	0.0086	0.021	< 0.0010	< 0.00010	< 0.00050	< 0.00050	1.5	0.00090	< 0.20	0.0063	< 0.00020	< 0.00050	< 0.00010	9.0
M-60	Downgradient	Coconino Sandstone	07/29/2017	0.53	89	1,400	1.5	7.6	370	2,800	< 0.0020	0.010	0.027	< 0.0010	0.00037	< 0.0010	< 0.0010	1.5	< 0.0010	< 0.20	0.0075	< 0.00020	< 0.0010	< 0.00020	8.4
M-60	Downgradient	Coconino Sandstone	09/05/2017	0.53	90	1,400	1.5	7.6	360	2,800	< 0.0040	0.0097	0.024	< 0.0010	< 0.00040	< 0.0040	< 0.0020	1.5	< 0.0020	< 0.20	0.0065	< 0.00020	< 0.0020	< 0.00040	8.5
M-60	Downgradient	Coconino Sandstone	09/05/2017	0.52	89	1,400	1.5	7.6	360	2,700	< 0.0040	0.0095	0.023	< 0.0010	< 0.00040	< 0.0040	< 0.0020	1.5	< 0.0020	< 0.20	0.0063	< 0.00020	< 0.0020	< 0.00040	7.6
M-60	Downgradient	Coconino Sandstone	12/07/2017	0.50	85	1,500	1.4	7.6	360	2,900	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--

Groundwater Sampling Results for the BAM Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents														
			Constituent:	Boron	Calcium	Chloride	Fluoride	pH (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Fluoride	Lead	Lithium	Molybdenum	Mercury	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BTV	*0.55*	*100*	*1,600*	*1.4 / 1.5**	*7.3 - 7.8*	*380*	*3,200*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	12/07/2017	**0.51**	**86**	**1,400**	**1.4**	**7.6**	**350**	**2,900**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	05/25/2018	**0.50**	**83**	**1,400**	**1.5**	**7.5**	**350**	**2,800**	--	--	--	--	--	--	--	**1.5**	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	10/26/2018	**0.49**	**88**	**1,400**	**1.4**	**7.7**	**350**	**2,600**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	04/09/2019	**0.51**	**84**	**1,300**	**1.4**	**7.7 J**	**350**	**2,800**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	10/22/2019	**0.50**	**85**	**1,400**	**1.4**	**7.6 J**	**360**	**2,800**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	05/07/2020	**0.50**	**88**	**1,200**	**1.7**	**7.7 J**	**350**	**2,900**	--	--	--	--	--	--	--	**1.7**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	12/03/2015	**0.51**	**90**	**1,400**	**1.3**	**7.22**	**350**	**2,800**	< 0.0025	**0.0063**	**0.039**	< 0.0010	< 0.00010	**0.00093**	**0.00098**	**1.3**	< 0.00050	< 0.20	**0.0064**	< 0.00020	**0.00019**	< 0.00010	**7.1**
M-61	Downgradient	Coconino Sandstone	03/10/2016	**0.49**	**90**	**1,400**	**1.4**	**7.59**	**340**	**2,800**	< 0.015	**0.010**	**0.030**	< 0.0010	< 0.00046	< 0.0087	< 0.0013	**1.4**	< 0.0044	< 0.20	**0.0063 j**	< 0.00020	< 0.0015	< 0.00026	**7.3**
M-61	Downgradient	Coconino Sandstone	05/20/2016	**0.49**	**89**	**1,400**	**1.4**	--	**350**	**2,800**	< 0.00010	**0.0081**	**0.025**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.4**	< 0.00050	< 0.20	**0.0053**	< 0.00020	< 0.00050	< 0.00010	**7.7**
M-61	Downgradient	Coconino Sandstone	08/27/2016	**0.50**	**90**	**1,400**	**1.5**	**7.5**	**360**	**2,900**	< 0.00010	**0.0091**	**0.027**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.5**	< 0.00050	< 0.20	**0.0061**	< 0.00020	< 0.00050	< 0.00010	**9.8**
M-61	Downgradient	Coconino Sandstone	09/22/2016	**0.50**	**90**	**1,300**	**1.4**	**7.9**	**350**	**3,000**	< 0.00050	**0.0086**	**0.023**	< 0.0010	< 0.00010	< 0.00050	**0.00037**	**1.4**	< 0.00010	< 0.20	**0.0059**	< 0.00020	< 0.00060	< 0.00010	**8.3**
M-61	Downgradient	Coconino Sandstone	02/22/2017	**0.50**	**92**	**1,100**	**1.4**	**7.8**	**340**	**2,700**	< 0.0010	**0.0079**	**0.023**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.4**	< 0.00050	< 0.20	**0.0057**	< 0.00020	< 0.00050	< 0.00010	**7.5**
M-61	Downgradient	Coconino Sandstone	04/11/2017	**0.50**	**93**	**1,700**	**1.4**	**8.0**	**420**	**3,000**	< 0.0010	**0.012**	**0.023**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.4**	< 0.00050	< 0.20	**0.0059**	< 0.00020	< 0.00050	< 0.00010	**7.8**
M-61	Downgradient	Coconino Sandstone	04/24/2017	**0.52**	**88**	**1,400**	**1.4**	**7.7**	**360**	**2,700**	< 0.0010	**0.0084**	**0.022**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.4**	< 0.00050	< 0.20	**0.0056**	< 0.00020	< 0.00050	< 0.00010	**8.6**
M-61	Downgradient	Coconino Sandstone	05/19/2017	**0.50**	**92**	**1,400**	**1.3**	**7.8**	**370**	**2,800**	< 0.0010	**0.0077**	**0.020**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.3**	< 0.00050	< 0.20	**0.0052**	< 0.00020	< 0.00050	< 0.00010	**8.6**
M-61	Downgradient	Coconino Sandstone	05/25/2017	**0.51**	**92**	**1,400**	**1.4**	**7.7**	**370**	**2,800**	< 0.0010	**0.0098**	**0.023**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.4**	< 0.00050	< 0.20	**0.0062**	< 0.00020	< 0.00050	< 0.00010	**8.7**
M-61	Downgradient	Coconino Sandstone	06/29/2017	**0.50**	**86**	**1,500**	**1.5**	**7.8**	**380**	**2,700**	< 0.0010	**0.0086**	**0.022**	< 0.0010	< 0.00010	< 0.00050	< 0.00050	**1.5**	< 0.00050	< 0.20	**0.0056**	< 0.00020	< 0.00050	< 0.00010	**8.1**
M-61	Downgradient	Coconino Sandstone	07/29/2017	**0.52**	**94**	**1,300**	**1.5**	**7.6**	**360**	**2,900**	< 0.0020	**0.0086**	**0.022**	< 0.0010	< 0.00020	< 0.0010	< 0.0010	**1.5**	< 0.0010	< 0.20	**0.0056**	< 0.00020	< 0.0010	< 0.00020	**8.0**
M-61	Downgradient	Coconino Sandstone	09/05/2017	**0.50**	**91**	**1,400**	**1.5**	**7.6**	**360**	**2,800**	< 0.0040	**0.0096**	**0.026**	< 0.0010	< 0.00040	< 0.0040	< 0.0020	**1.5**	< 0.0020	< 0.20	**0.0064**	< 0.00020	< 0.0020	< 0.00040	**8.3**
M-61	Downgradient	Coconino Sandstone	12/07/2017	**0.49**	**88**	**1,500**	**1.4**	**7.6**	**360**	**2,900**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	05/25/2018	**0.48**	**87**	**1,400**	**1.5**	**7.5**	**390**	**2,800**	--	--	--	--	--	--	--	**1.5**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	10/26/2018	**0.48**	**91**	**1,400**	**1.4**	**7.5**	**360**	**2,600**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	04/09/2019	**0.50**	**88**	**1,300**	**1.4**	**7.7 J**	**340**	**2,800**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	10/22/2019	**0.48**	**87**	**1,400**	**1.4**	**7.8 J**	**350**	**2,700**	--	--	--	--	--	--	--	**1.4**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	05/07/2020	**0.51**	**93**	**1,300**	**1.6**	**7.7 J**	**350**	**3,000**	--	--	--	--	--	--	--	**1.6**	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	05/07/2020	**0.51**	**93**	**1,200**	**1.7**	**7.6 J**	**350**	**2,900**	--	--	--	--	--	--	--	**1.7**	--	--	--	--	--	--	--

Groundwater Sampling Results for the BAM Monitoring Wells

				Additional Analyses								
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Magnesium	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium
			Filtered:	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L
			BTV	--	--	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	12/03/2015	**220**	< 6.0	< 6.0	**36**	**4.5**	**2.6**	**1.4**	**10**	**1,000**
M-54	Background	Coconino Sandstone	03/10/2016	--	--	--	--	--	**3.6**	**1.9**	--	--
M-54	Background	Coconino Sandstone	05/20/2016	**210**	< 6.0	< 6.0	**34**	**4.1**	**3.6**	**2.7**	**8.8**	**990**
M-54	Background	Coconino Sandstone	08/27/2016	--	--	--	--	--	**4.3**	**3.2**	--	--
M-54	Background	Coconino Sandstone	09/22/2016	--	--	--	--	--	**3.7**	**2.6**	--	--
M-54	Background	Coconino Sandstone	02/21/2017	**210**	< 6.0	< 6.0	**36**	**4.4**	**4.1**	**2.5**	--	**1,000**
M-54	Background	Coconino Sandstone	04/11/2017	**220**	< 6.0	< 6.0	**34**	**4.1**	**5.1**	**3.0**	--	**950**
M-54	Background	Coconino Sandstone	04/24/2017	**220**	< 6.0	< 6.0	**35**	**4.3**	**3.3**	**2.3**	--	**1,000**
M-54	Background	Coconino Sandstone	05/19/2017	**220**	< 6.0	< 6.0	**35**	**4.0**	**5.7**	**2.7**	--	**950**
M-54	Background	Coconino Sandstone	05/25/2017	**220**	< 6.0	< 6.0	**36**	**4.2**	**5.9**	**3.7**	--	**1,000**
M-54	Background	Coconino Sandstone	06/29/2017	**220**	< 6.0	< 6.0	**35**	**4.1**	**6.1**	**2.9**	--	**970**
M-54	Background	Coconino Sandstone	07/29/2017	**220**	< 6.0	< 6.0	**37**	**4.2**	**3.8**	**2.7**	--	**990**
M-54	Background	Coconino Sandstone	09/05/2017	**220**	< 6.0	< 6.0	**36**	**4.2**	**3.9**	**2.5**	--	**1,000**
M-54	Background	Coconino Sandstone	12/07/2017	**220**	< 6.0	< 6.0	**33**	**4.1**	--	--	--	**940**
M-54	Background	Coconino Sandstone	05/25/2018	**220**	< 6.0	< 6.0	**33**	**3.9**	--	--	--	**920**
M-54	Background	Coconino Sandstone	10/26/2018	--	--	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	04/09/2019	--	--	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	10/22/2019	--	--	--	--	--	--	--	--	--
M-54	Background	Coconino Sandstone	05/07/2020	--	--	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	12/03/2015	**210**	< 6.0	< 6.0	**32**	**4.3**	**3.2**	**2.2**	**9.5**	**910**
M-59	Downgradient	Coconino Sandstone	03/10/2016	--	--	--	--	--	**3.1**	**2.3**	--	--
M-59	Downgradient	Coconino Sandstone	05/20/2016	**210**	< 6.0	< 6.0	**31**	**4.0**	**4.6**	**2.8**	**8.9**	**870**
M-59	Downgradient	Coconino Sandstone	08/27/2016	--	--	--	--	--	**5.2**	**2.9**	--	--
M-59	Downgradient	Coconino Sandstone	09/22/2016	--	--	--	--	--	**4.2**	**3.0**	--	--
M-59	Downgradient	Coconino Sandstone	02/22/2017	**210**	< 6.0	< 6.0	**31**	**4.1**	**5.2**	**2.5**	--	**880**
M-59	Downgradient	Coconino Sandstone	04/11/2017	**220**	< 6.0	< 6.0	**31**	**4.0**	**5.4**	**2.3**	--	**870**
M-59	Downgradient	Coconino Sandstone	04/24/2017	**220**	< 6.0	< 6.0	**32**	**4.2**	**4.6**	**3.4**	--	**950**
M-59	Downgradient	Coconino Sandstone	05/19/2017	**220**	< 6.0	< 6.0	**32**	**4.2**	**5.1**	**2.0**	--	**920**
M-59	Downgradient	Coconino Sandstone	05/25/2017	**220**	< 6.0	< 6.0	**32**	**4.1**	**4.9**	**3.1**	--	**910**
M-59	Downgradient	Coconino Sandstone	06/29/2017	**220**	< 6.0	< 6.0	**31**	**3.9**	**5.2**	**3.8**	--	**860**
M-59	Downgradient	Coconino Sandstone	07/29/2017	**220**	< 6.0	< 6.0	**33**	**4.1**	**4.5**	**3.4**	--	**900**
M-59	Downgradient	Coconino Sandstone	09/05/2017	**220**	< 6.0	< 6.0	**32**	**4.1**	**4.6**	**3.0**	--	**910**
M-59	Downgradient	Coconino Sandstone	12/07/2017	**220**	< 6.0	< 6.0	**30**	**3.9**	--	--	--	**860**
M-59	Downgradient	Coconino Sandstone	05/25/2018	**220**	< 6.0	< 6.0	**30**	**3.9**	--	--	--	**850**
M-59	Downgradient	Coconino Sandstone	10/26/2018	--	--	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	04/09/2019	--	--	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	10/23/2019	--	--	--	--	--	--	--	--	--
M-59	Downgradient	Coconino Sandstone	05/07/2020	--	--	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	12/03/2015	**210**	< 6.0	< 6.0	**32**	**4.2**	**4.0**	**3.8**	**9.4**	**960**
M-60	Downgradient	Coconino Sandstone	03/09/2016	--	--	--	--	--	< 0.2	**2.6**	--	--
M-60	Downgradient	Coconino Sandstone	05/20/2016	**210**	< 6.0	< 6.0	**30**	**3.9**	**4.2**	**3.7**	**8.7**	**950**
M-60	Downgradient	Coconino Sandstone	08/27/2016	--	--	--	--	--	**5.4**	**3.3**	--	--
M-60	Downgradient	Coconino Sandstone	09/22/2016	--	--	--	--	--	**5.2**	**3.1**	--	--
M-60	Downgradient	Coconino Sandstone	02/22/2017	**210**	< 6.0	< 6.0	**31**	**4.2**	**4.3**	**3.9**	--	**960**
M-60	Downgradient	Coconino Sandstone	04/11/2017	**220**	< 6.0	< 6.0	**29**	**3.8**	**4.4**	**2.5**	--	**890**
M-60	Downgradient	Coconino Sandstone	04/11/2017	**220**	< 6.0	< 6.0	**29**	**3.7**	**4.8**	**4.0**	--	**880**
M-60	Downgradient	Coconino Sandstone	04/24/2017	**220**	< 6.0	< 6.0	**32**	**4.1**	**4.8**	**2.4**	--	**970**
M-60	Downgradient	Coconino Sandstone	05/19/2017	**220**	< 6.0	< 6.0	**32**	**4.0**	**6.1**	**2.5**	--	**950**
M-60	Downgradient	Coconino Sandstone	05/25/2017	**220**	< 6.0	< 6.0	**31**	**3.9**	**4.8**	**5.4**	--	**950**
M-60	Downgradient	Coconino Sandstone	06/29/2017	**220**	< 6.0	< 6.0	**31**	**3.8**	**5.0**	**3.1**	--	**910**
M-60	Downgradient	Coconino Sandstone	06/29/2017	**220**	< 6.0	< 6.0	**30**	**3.9**	**4.8**	**4.2**	--	**930**
M-60	Downgradient	Coconino Sandstone	07/29/2017	**220**	< 6.0	< 6.0	**31**	**3.8**	**5.0**	**3.4**	--	**900**
M-60	Downgradient	Coconino Sandstone	09/05/2017	**220**	< 6.0	< 6.0	**32**	**4.2**	**4.9**	**3.6**	--	**970**
M-60	Downgradient	Coconino Sandstone	09/05/2017	**220**	< 6.0	< 6.0	**31**	**4.0**	**4.4**	**3.2**	--	**930**
M-60	Downgradient	Coconino Sandstone	12/07/2017	**220**	< 6.0	< 6.0	**29**	**3.8**	--	--	--	**890**

Groundwater Sampling Results for the BAM Monitoring Wells

				Additional Analyses								
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Magnesium	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium
			Filtered:	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L
			BTV	--	--	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	12/07/2017	**220**	< 6.0	< 6.0	**29**	**3.9**	--	--	--	**900**
M-60	Downgradient	Coconino Sandstone	05/25/2018	**230**	< 6.0	< 6.0	**29**	**3.6**	--	--	--	**870**
M-60	Downgradient	Coconino Sandstone	10/26/2018	--	--	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	04/09/2019	--	--	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	10/22/2019	--	--	--	--	--	--	--	--	--
M-60	Downgradient	Coconino Sandstone	05/07/2020	--	--	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	12/03/2015	**210**	< 6.0	< 6.0	**33**	**4.0**	**3.8**	**3.3**	**9.3**	**950**
M-61	Downgradient	Coconino Sandstone	03/10/2016	--	--	--	--	--	**4.5**	**2.8**	--	--
M-61	Downgradient	Coconino Sandstone	05/20/2016	**210**	< 6.0	< 6.0	**31**	**3.7**	**4.3**	**3.4**	**8.8**	**890**
M-61	Downgradient	Coconino Sandstone	08/27/2016	--	--	--	--	--	**5.7**	**4.1**	--	--
M-61	Downgradient	Coconino Sandstone	09/22/2016	--	--	--	--	--	**5.2**	**3.1**	--	--
M-61	Downgradient	Coconino Sandstone	02/22/2017	**210**	< 6.0	< 6.0	**32**	**4.2**	**4.2**	**3.3**	--	**930**
M-61	Downgradient	Coconino Sandstone	04/11/2017	**220**	< 6.0	< 6.0	**32**	**3.8**	**5.4**	**2.4**	--	**910**
M-61	Downgradient	Coconino Sandstone	04/24/2017	**220**	< 6.0	< 6.0	**33**	**4.0**	**5.0**	**3.6**	--	**960**
M-61	Downgradient	Coconino Sandstone	05/19/2017	**220**	< 6.0	< 6.0	**32**	**3.8**	**4.9**	**3.7**	--	**910**
M-61	Downgradient	Coconino Sandstone	05/25/2017	**220**	< 6.0	< 6.0	**33**	**3.9**	**5.2**	**3.5**	--	**960**
M-61	Downgradient	Coconino Sandstone	06/29/2017	**220**	< 6.0	< 6.0	**32**	**3.8**	**4.6**	**3.5**	--	**910**
M-61	Downgradient	Coconino Sandstone	07/29/2017	**220**	< 6.0	< 6.0	**33**	**3.9**	**4.8**	**3.2**	--	**920**
M-61	Downgradient	Coconino Sandstone	09/05/2017	**220**	< 6.0	< 6.0	**32**	**3.9**	**4.9**	**3.4**	--	**910**
M-61	Downgradient	Coconino Sandstone	12/07/2017	**220**	< 6.0	< 6.0	**31**	**3.9**	--	--	--	**910**
M-61	Downgradient	Coconino Sandstone	05/25/2018	**230**	< 6.0	< 6.0	**30**	**3.6**	--	--	--	**860**
M-61	Downgradient	Coconino Sandstone	10/26/2018	--	--	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	04/09/2019	--	--	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	10/22/2019	--	--	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	05/07/2020	--	--	--	--	--	--	--	--	--
M-61	Downgradient	Coconino Sandstone	05/07/2020	--	--	--	--	--	--	--	--	--

Notes:

BTV exceedances are shown in grey shaded cells.

Duplicate sample dates under the same locations are either field duplicates or are instances of samples with multiple filed/lab sample IDs on the same date.

*Fluoride BTV for M-60 and M-61 is 1.5 mg/L

Abbreviations and Data Qualifiers:

< = less than

BTV = Background Threshold Value

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/L = milligrams per liter

pCi/L = Picocuries per liter

su = standard units

Groundwater Sampling Results for the SEDI Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents															
			Constituent:	Boron	Calcium	Chloride	Fluoride	pH (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BTV	*0.23*	*600*	*3,700*	*0.8*	*7.5*	*630*	*7,800*	*0.05*	*0.004*	*0.08*	*0.001*	*0.002*	*0.004*	*0.004*	*0.002*	*0.8*	*0.01*	*0.2*	*0.002*	*0.011*	*0.01*	*0.0004*	*1.1*
			GWPS	--	--	--	--	--	--	--	*0.05*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.1*	*0.006*	*4*	*0.015*	*0.2*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-62A	Background	LCR Alluvium	11/30/2015	**0.14**	**280**	**2,000**	< 0.40	**7.68**	**610**	**4,300**	< 0.0025	**0.0020**	**0.082**	< 0.0010	< 0.00010	**0.00078**	--	**0.00054**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.011**	**0.00071**	< 0.00010	< 0.7
M-62A	Background	LCR Alluvium	03/08/2016	**0.20**	**380**	**2,500**	< 0.80	**7.6**	**510**	**5,100**	< 0.015	< 0.0049	**0.16**	< 0.0010	< 0.00046	< 0.0087	--	**0.0022 j**	< 0.80	< 0.0044	< 0.20	< 0.00020	**0.0044 j**	< 0.0015	**0.00050 j**	**1.0**
M-62A	Background	LCR Alluvium	03/08/2016	**0.20**	**380**	**2,500**	< 0.80	**7.59**	**520**	**5,100**	< 0.015	< 0.0049	**0.15**	< 0.0010	< 0.00046	< 0.0087	--	**0.0020 j**	< 0.80	< 0.0044	< 0.20	< 0.00020	**0.0040 j**	< 0.0015	**0.00028 j**	**1.2**
M-62A	Background	LCR Alluvium	05/05/2016	**0.22**	**420**	**2,600**	< 0.40	--	**510**	**5,100**	< 0.00010	**0.0030**	**0.084**	< 0.0010	< 0.00010	**0.0014**	--	**0.0012**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0026**	< 0.00050	< 0.00010	**0.5**
M-62A	Background	LCR Alluvium	08/29/2016	**0.21**	**410**	**2,500**	< 0.80	**7.4**	**550**	**6,100**	< 0.00010	**0.0031**	**0.082**	< 0.0010	< 0.00010	< 0.00050	--	< 0.00050	< 0.80	< 0.00050	< 0.20	< 0.00020	**0.0023**	< 0.00050	< 0.00010	**0.9**
M-62A	Background	LCR Alluvium	09/21/2016	**0.21**	**400**	**2,600**	< 0.80	**7.6**	**520**	**4,300**	< 0.00050	**0.0028**	**0.075**	< 0.0010	< 0.00010	**0.00099**	--	**0.00046**	< 0.80	< 0.00010	< 0.20	< 0.00020	**0.0022**	**0.00078**	< 0.00010	**2.0**
M-62A	Background	LCR Alluvium	02/20/2017	**0.22**	**420**	**2,800**	< 0.40	**7.4**	**570**	**5,100**	< 0.0010	**0.0029**	**0.064**	< 0.0010	< 0.00010	**0.0020**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0019**	< 0.00050	< 0.00010	**1.4**
M-62A	Background	LCR Alluvium	04/13/2017	**0.21**	**460**	**3,000**	< 0.40	**7.8**	**540**	**5,600**	< 0.0010	**0.0021**	**0.074**	< 0.0010	< 0.00010	**0.0015**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0023**	< 0.00050	< 0.00010	**1.2**
M-62A	Background	LCR Alluvium	04/25/2017	**0.22**	**450**	**2,800**	< 0.80	**7.4**	**550**	**5,800**	< 0.0010	**0.0017**	**0.079**	< 0.0010	< 0.00010	**0.0017**	--	< 0.00050	< 0.80	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**0.9**
M-62A	Background	LCR Alluvium	04/25/2017	**0.22**	**450**	**2,800**	< 0.80	**7.5**	**540**	**5,600**	< 0.0010	**0.0018**	**0.080**	< 0.0010	< 0.00010	**0.0010**	--	< 0.00050	< 0.80	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**2.6**
M-62A	Background	LCR Alluvium	05/18/2017	**0.21**	**490**	**3,000**	< 0.40	**7.6**	**550**	**5,500**	< 0.0010	**0.0016**	**0.072**	< 0.0010	< 0.00010	**0.00063**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0020**	< 0.00050	< 0.00010	**1.2**
M-62A	Background	LCR Alluvium	05/25/2017	**0.22**	**500**	**3,100**	< 0.40	**7.5**	**550**	**6,100**	< 0.0010	**0.0019**	**0.077**	< 0.0010	< 0.00010	**0.00096**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**1.5**
M-62A	Background	LCR Alluvium	07/01/2017	**0.23**	**450**	**3,100**	< 0.40	**7.4**	**580**	**6,400**	< 0.0010	**0.0026**	**0.076**	< 0.0010	< 0.00010	**0.0011**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	< 0.7
M-62A	Background	LCR Alluvium	07/26/2017	**0.23**	**480**	**3,000**	< 0.40	**7.5**	**580**	**6,800**	< 0.0020	**0.0024**	**0.075**	< 0.0010	< 0.00020	< 0.0010	--	< 0.0010	< 0.40	< 0.0010	< 0.20	< 0.00020	**0.0021**	< 0.0010	< 0.00020	**1.3**
M-62A	Background	LCR Alluvium	09/07/2017	**0.22**	**480**	**3,000**	< 0.40	**7.4**	**560**	**6,500**	< 0.0040	**0.0031**	**0.079**	< 0.0010	< 0.00040	< 0.0040	--	< 0.0020	< 0.40	< 0.0020	< 0.20	< 0.00020	**0.003**	< 0.0020	< 0.00040	**0.9**
M-62A	Background	LCR Alluvium	12/08/2017	**0.22**	**460**	**3,000**	< 0.40	**7.4**	**550**	**5,400**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	05/21/2018	**0.22**	**450**	**3,000**	< 0.40	**7.4**	**560**	**5,500**	< 0.0020	**0.0029**	**0.072**	< 0.0010	< 0.00020	< 0.0020	--	< 0.0010	< 0.40	< 0.0010	< 0.20	< 0.00020	**0.0024**	< 0.0010	< 0.00020	**0.7**
M-62A	Background	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	**0.0029**	**0.074**	--	--	< 0.0010	--	< 0.00050	--	--	--	--	**0.0023**	--	< 0.00010	**0.5**
M-62A	Background	LCR Alluvium	10/24/2018	**0.21**	**460**	**2,900**	< 0.40	**7.5**	**570**	**5,300**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	02/15/2019	**0.23**	**490**	**2,900**	< 0.40	**7.3 J**	**560**	--	--	**0.0030**	**0.068**	--	--	< 0.0010	--	< 0.00050	< 0.40	--	--	--	**0.0024**	--	< 0.00010	< 0.7
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	**0.47**	--	--	--	< 0.0010	**0.0033**	**0.068**	< 0.0010	< 0.00010	< 0.0010	--	< 0.00050	**0.47**	< 0.00050	< 0.20	< 0.00020	**0.0026**	< 0.00050	< 0.00010	--
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	< 0.40	--	--	--	< 0.0010	**0.0031**	**0.068**	< 0.0010	< 0.00010	< 0.0010	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0025**	< 0.00050	< 0.00010	--
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-62A	Background	LCR Alluvium	08/05/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	08/09/2019	**0.21**	**450**	**2,900**	< 0.4	**7.3 J**	**590**	**5,300**	--	**0.0031**	**0.067**	--	--	**0.0037**	--	< 0.0005	< 0.4	--	< 0.2	--	**0.0028**	--	< 0.0001	**0.8**
M-62A	Background	LCR Alluvium	08/09/2019	**0.55**	**450**	**1,900**	< 0.4	**7.0 J**	**1,300**	**5,000**	--	**0.0021**	**0.040**	--	--	**0.043**	--	**0.0039**	< 0.4	--	< 0.2	--	**0.0071**	--	< 0.0001	< 0.7
M-62A	Background	LCR Alluvium	11/25/2019	**0.22**	**450**	**2,800**	< 0.4	**7.3 J**	**590**	**5,900**	--	**0.0048**	**0.15 J**	--	--	**0.0044**	--	**0.0012**	< 0.4	--	--	--	**0.0091**	--	**0.00016**	--
M-62A	Background	LCR Alluvium	02/25/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	04/16/2020	< 0.25	**430**	**3,000**	< 0.8	**7.4 J**	**650**	**5,400**	< 0.005	**0.0043**	**0.078**	< 0.001	< 0.0005	**0.0053**	--	< 0.0025	< 0.8	< 0.0025	< 1	< 0.0002	**0.0040**	< 0.0025	< 0.0005	--
M-62A	Background	LCR Alluvium	09/08/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	11/30/2015	**0.18**	**260**	**1,900**	< 0.40	**7.58**	**590**	**4,000**	< 0.0025	**0.0019**	**0.081**	< 0.0010	< 0.00010	**0.00051**	--	**0.0012**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0096**	**0.00033**	< 0.00010	< 0.9
M-56A	Downgradient	LCR Alluvium	03/08/2016	**0.25**	**200**	**1,700**	**0.43**	**7.68**	**570**	**3,600**	< 0.015	< 0.0049	**0.084**	< 0.0010	< 0.00046	< 0.0087	--	**0.0020 j**	**0.43**	< 0.0044	< 0.20	< 0.00020	**0.029**	< 0.0015	< 0.00026	< 0.4
M-56A	Downgradient	LCR Alluvium	05/10/2016	**0.24**	**200**	**1,700**	**0.42**	--	**560**	**3,700**	< 0.00010	**0.00093**	**0.075**	< 0.0010	< 0.00010	< 0.00050	--	**0.0013**	**0.42**	< 0.00050	< 0.20	< 0.00020	**0.023**	< 0.00050	< 0.00010	**0.6**
M-56A	Downgradient	LCR Alluvium	08/29/2016	**0.26**	**220**	**1,800**	**0.46**	**7.5**	**570**	**3,900**	**0.00013**	**0.00082**	**0.082**	< 0.0010	< 0.00010	< 0.00050	--	**0.0013**	**0.46**	< 0.00050	< 0.20	< 0.00020	**0.021**	< 0.00050	< 0.00010	**1.6**
M-56A	Downgradient	LCR Alluvium	09/21/2016	**0.26**	**220**	**1,700**	**0.40**	**7.8**	**580**	**3,900**	< 0.00050	**0.00083**	**0.076**	< 0.0010	< 0.00010	**0.0012**	--	**0.0012**	**0.40**	< 0.00010	< 0.20	< 0.00020	**0.016**	< 0.00060	< 0.00010	**0.6**
M-56A	Downgradient	LCR Alluvium	09/21/2016	**0.27**	**230**	**1,700**	**0.40**	**7.9**	**600**	**4,500**	< 0.00050	**0.00089**	**0.076**	< 0.0010	< 0.00010	**0.0013**	--	**0.0011**	**0.40**	**0.00012**	< 0.20	< 0.00020	**0.015**	< 0.00060	< 0.00010	**1.6**
M-56A	Downgradient	LCR Alluvium	02/20/2017	**0.27**	**240**	**2,000**	**0.40**	**7.6**	**640**	**3,700**	< 0.0010	**0.00068**	**0.071**	< 0.0010	< 0.00010	**0.0093**	--	**0.00077**	**0.40**	< 0.00050	< 0.20	< 0.00020	**0.013**	< 0.00050	< 0.00010	**1.8**
M-56A	Downgradient	LCR Alluvium	04/13/2017	**0.26**	**260**	**2,000**	< 0.40	**7.7**	**630**	**3,900**	< 0.0010	**0.00076**	**0.070**	< 0.0010	< 0.00010	**0.0091**	--	**0.00065**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.011**	< 0.00050	< 0.00010	**1.2**
M-56A	Downgradient	LCR Alluvium	04/25/2017	**0.27**	**250**	**1,800**	< 0.80	**7.6**	**630**	**3,800**	< 0.0010	**0.00075**	**0.086**	< 0.0010	< 0.00010	**0.0067**	--	**0.00061**	< 0.80	< 0.00050	< 0.20	< 0.00020	**0.013**	**0.00056**	< 0.00010	**1.9**
M-56A	Downgradient	LCR Alluvium	05/18/2017	**0.26**	**260**	**2,000**	< 0.40	**7.7**	**680**	**4,100**	< 0.0010	**0.00060**	**0.062**	< 0.0010	< 0.00010	**0.0063**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0095**	< 0.00050	< 0.00010	< 1.2
M-56A	Downgradient	LCR Alluvium	05/18/2017	**0.26**	**270**	**2,000**	< 0.40	**7.7**	**670**	**4,000**	< 0.0010	**0.00058**	**0.063**	< 0.0010	< 0.00010	**0.0059**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0095**	< 0.00050	< 0.00010	**1.7**
M-56A	Downgradient	LCR Alluvium	05/25/2017	**0.25**	**250**	**1,900**	< 0.40	**7.6**	**660**	**3,900**	< 0.0010	**0.00070**	**0.073**	< 0.0010	< 0.00010	**0.020**	--	**0.00075**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.011**	**0.00057**	< 0.00010	**1.5**
M-56A	Downgradient	LCR Alluvium	07/01/2017	**0.27**	**260**	**2,000**	**0.41**	**7.5**	**690**	**4,000**	< 0.0010	**0.00065**	**0.068**	< 0.0010	< 0.00010	**0.0034**	--	< 0.00050	**0.41**	< 0.00050	< 0.20	< 0.00020	**0.0098**	< 0.00050	< 0.00010	< 0.7
M-56A	Downgradient	LCR Alluvium	07/26/2017	**0.27**	**270**	**1,900**	< 0.40	**7.5**	**690**	**4,300**	< 0.0020	< 0.0010	**0.066**	< 0.0010	< 0.00020	**0.0028**	--	< 0.0010	< 0.40	< 0.0010	< 0.20	< 0.00020	**0.0090**	< 0.0010	< 0.00020	**1.7**
M-56A	Downgradient	LCR Alluvium	09/08/2017	**0.27**	**270**	**2,000**	**0.47**	**7.4**	**680**	**4,100**	< 0.0040	< 0.0020	**0.070**	< 0.0010	< 0.00040	< 0.0040	--	< 0.0020	**0.47**	< 0.0020	< 0.20	< 0.00020	**0.0093**	< 0.0020	< 0.00040	**0.5**
M-56A	Downgradient	LCR Alluvium	12/08/2017	**0.24**	**260**	**2,000**	**0.49**	**7.6**	**630**	**4,000**	--	--	--	--	--	--	--	--	**0.49**	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	05/21/2018	**0.25**	**270**	**1,900**	< 0.40	**7.4**	**710**	**4,100**	< 0.0010	**0.00081**	**0.061**	< 0.0010	< 0.00010	**0.0046**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0079**	< 0.00050	**0.00012**	**1.4**
M-56A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	**0.0013**	**0.065**	--	--	**0.0042**	--	< 0.00050	--	--	--	--	**0.0057**	--	< 0.00010	**0.5**
M-56A	Downgradient	LCR Alluvium	10/24/2018	**0.24**	**280**	**2,000**	< 0.40	**7.5**	**630**	**4,100**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	02/15/2019	**0.30**	**300**	**2,000**	< 0.40	**7.3 J**	**850**	--	--	**0.0082**	**0.067**	--	--	**0.0052**	--	**0.00073**	< 0.40	--	--	--	**0.0074**	--	< 0.00010	**0.9**

Groundwater Sampling Results for the SEDI Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents															
			Constituent:	Boron	Calcium	Chloride	Fluoride	pH (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BTV	*0.23*	*600*	*3,700*	*0.8*	*7.5*	*630*	*7,800*	*0.05*	*0.004*	*0.08*	*0.001*	*0.002*	*0.004*	*0.004*	*0.002*	*0.8*	*0.01*	*0.2*	*0.002*	*0.011*	*0.01*	*0.0004*	*1.1*
			GWPS	--	--	--	--	--	--	--	*0.05*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.1*	*0.006*	*4*	*0.015*	*0.2*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-56A	Downgradient	LCR Alluvium	02/15/2019	**0.23**	**490**	**3,000**	< 0.40	**7.3 J**	**590**	--	--	**0.0032**	**0.071**	--	--	< 0.0010	--	< 0.00050	< 0.40	--	--	--	**0.0025**	--	< 0.00010	--
M-56A	Downgradient	LCR Alluvium	04/18/2019	--	--	--	< 0.40	--	--	--	< 0.0010	**0.0011**	**0.055**	< 0.0010	< 0.00010	**0.076**	--	**0.0013**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.014**	**0.00062**	< 0.00010	--
M-56A	Downgradient	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-56A	Downgradient	LCR Alluvium	08/09/2019	**0.33**	**300**	**1,700**	< 0.8	**7.3 J**	**1,100**	**4,200**	--	**0.0085**	**0.078**	--	--	**0.023**	--	**0.0012**	< 0.8	--	< 0.2	--	**0.011**	--	< 0.0001	**0.6**
M-56A	Downgradient	LCR Alluvium	11/25/2019	**0.32**	**300**	**1,700**	< 0.4	**7.3 J**	**880**	**4,500**	--	**0.0088**	**0.063**	--	--	**0.0086**	--	**0.00064**	< 0.4	--	--	--	**0.0087**	--	< 0.0001	--
M-56A	Downgradient	LCR Alluvium	04/16/2020	**0.38**	**300**	**1,800**	< 0.8	**7.5 J**	**1,000**	**4,600**	< 0.005	< 0.0025	**0.052**	< 0.001	< 0.0005	**0.034**	--	< 0.0025	< 0.8	< 0.0025	< 1	< 0.0002	**0.012**	< 0.0025	< 0.0005	--
M-56A	Downgradient	LCR Alluvium	04/16/2020	**0.37**	**290**	**1,800**	< 0.8	**7.4 J**	**1,000**	**4,500**	< 0.005	< 0.0025	**0.052**	< 0.001	< 0.0005	**0.028**	--	< 0.0025	< 0.8	< 0.0025	< 1	< 0.0002	**0.012**	< 0.0025	< 0.0005	--
M-57A	Downgradient	LCR Alluvium	11/30/2015	**0.42**	**280**	**1,500**	< 0.40	**7.39**	**1,000**	**3,900**	< 0.0025	**0.0048**	**0.072**	< 0.0010	< 0.00010	**0.00074**	--	**0.0077**	< 0.40	**0.00086**	< 0.20	< 0.00020	**0.008**	**0.00029**	< 0.00010	< 0.9
M-57A	Downgradient	LCR Alluvium	11/30/2015	**0.42**	**280**	**1,500**	< 0.40	**7.35**	**1,000**	**3,800**	< 0.0025	**0.0047**	**0.078**	< 0.0010	< 0.00010	**0.00077**	--	**0.0079**	< 0.40	**0.00095**	< 0.20	< 0.00020	**0.0079**	**0.00035**	< 0.00010	**1.0**
M-57A	Downgradient	LCR Alluvium	03/08/2016	**0.42**	**290**	**1,600**	< 0.40	**7.56**	**1,000**	**4,200**	< 0.015	**0.0064 j**	**0.063**	< 0.0010	< 0.00046	< 0.0087	--	**0.0082 j**	< 0.40	< 0.0044	< 0.20	< 0.00020	**0.0040 j**	< 0.0015	< 0.00026	< 0.4
M-57A	Downgradient	LCR Alluvium	05/11/2016	**0.46**	**320**	**1,600**	< 0.40	--	**1,000**	**4,100**	< 0.00010	**0.0027**	**0.047**	< 0.0010	< 0.00010	< 0.00050	--	**0.0065**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0011**	< 0.00050	< 0.00010	< 0.6
M-57A	Downgradient	LCR Alluvium	08/25/2016	**0.49**	**340**	**1,600**	< 0.40	**7.2**	**1,100**	**4,400**	**0.00012**	**0.0042**	**0.055**	< 0.0010	< 0.00010	**0.00066**	--	**0.0078**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.022**	< 0.00050	< 0.00010	< 0.6
M-57A	Downgradient	LCR Alluvium	09/21/2016	**0.51**	**340**	**1,600**	< 0.40	**7.6**	**1,100**	**3,900**	< 0.00050	**0.0019**	**0.051**	< 0.0010	< 0.00010	**0.016**	--	**0.0067**	< 0.40	**0.00021**	< 0.20	< 0.00020	**0.0029**	< 0.00060	< 0.00010	< 0.7
M-57A	Downgradient	LCR Alluvium	09/21/2016	**0.52**	**340**	**1,600**	< 0.40	**7.5**	**1,100**	--	< 0.0025	**0.0019**	**0.051**	< 0.0010	< 0.00050	**0.030**	--	**0.0071**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0028**	< 0.0030	< 0.00050	< 0.7
M-57A	Downgradient	LCR Alluvium	02/20/2017	**0.60**	**380**	**1,700**	< 0.40	**7.1**	**1,400**	**4,400**	< 0.0010	**0.0051**	**0.041**	< 0.0010	< 0.00010	**0.042**	--	**0.0086**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0048**	< 0.00050	< 0.00010	**1.1**
M-57A	Downgradient	LCR Alluvium	04/12/2017	**0.60**	**410**	**1,800**	< 0.40	**7.4**	**1,400**	**4,800**	< 0.0010	**0.0042**	**0.042**	< 0.0010	< 0.00010	**0.031**	--	**0.0087**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0047**	< 0.00050	< 0.00010	< 0.6
M-57A	Downgradient	LCR Alluvium	04/25/2017	**0.60**	**380**	**1,600**	< 0.40	**7.1**	**1,300**	**4,600**	< 0.0010	**0.0039**	**0.042**	< 0.0010	< 0.00010	**0.019**	--	**0.0077**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0042**	< 0.00050	< 0.00010	< 0.6
M-57A	Downgradient	LCR Alluvium	05/18/2017	**0.62**	**410**	**1,800**	< 0.40	**7.4**	**1,400**	**4,800**	< 0.0010	**0.0098**	**0.038**	< 0.0010	< 0.00010	**0.024**	--	**0.0076**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0041**	< 0.00050	< 0.00010	**1.5**
M-57A	Downgradient	LCR Alluvium	05/25/2017	**0.59**	**400**	**1,700**	< 0.40	**7.3**	**1,400**	**4,900**	< 0.0010	**0.0066**	**0.044**	< 0.0010	< 0.00010	**0.035**	--	**0.0083**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0063**	< 0.00050	< 0.00010	**0.5**
M-57A	Downgradient	LCR Alluvium	07/01/2017	**0.57**	**380**	**1,800**	**0.42**	**7.1**	**1,400**	**4,500**	< 0.0010	**0.0038**	**0.043**	< 0.0010	< 0.00010	**0.012**	--	**0.0075**	**0.42**	< 0.00050	< 0.20	< 0.00020	**0.0037**	< 0.00050	< 0.00010	< 0.7
M-57A	Downgradient	LCR Alluvium	07/26/2017	**0.64**	**420**	**1,800**	< 0.40	**7.1**	**1,600**	**5,000**	< 0.0020	**0.0027**	**0.042**	< 0.0010	< 0.00020	**0.028**	--	**0.0088**	< 0.40	< 0.0010	< 0.20	< 0.00020	**0.0058**	< 0.0010	< 0.00020	< 0.7
M-57A	Downgradient	LCR Alluvium	09/08/2017	**0.63**	**420**	**1,800**	< 0.40	**7.1**	**1,400**	**4,800**	< 0.0040	**0.0027**	**0.045**	< 0.0010	< 0.00040	**0.015**	--	**0.0082**	< 0.40	< 0.0020	< 0.20	< 0.00020	**0.0046**	< 0.0020	< 0.00040	**0.6**
M-57A	Downgradient	LCR Alluvium	12/08/2017	**0.63**	**420**	**1,900**	< 0.40	**7.2**	**1,300**	**4,800**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	05/21/2018	**0.59**	**410**	**1,900**	< 0.40	**7.0**	**1,200**	**4,800**	< 0.0020	**0.0022**	**0.043**	< 0.0010	< 0.00020	**0.0023**	--	**0.0058**	< 0.40	< 0.0010	< 0.20	< 0.00020	**0.0026**	< 0.0010	< 0.00020	< 0.7
M-57A	Downgradient	LCR Alluvium	05/21/2018	**0.60**	**430**	**1,900**	< 0.80	**7.1**	**1,200**	**4,900**	< 0.0020	**0.0028**	**0.043**	< 0.0010	< 0.00020	**0.0031**	--	**0.0058**	< 0.80	< 0.0010	< 0.20	< 0.00020	**0.0026**	< 0.0010	< 0.00020	< 0.6
M-57A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	**0.0021**	**0.045**	--	--	**0.0067**	--	**0.0057**	--	--	--	--	**0.003**	--	< 0.00010	**0.7**
M-57A	Downgradient	LCR Alluvium	10/24/2018	**0.60**	**470**	**2,100**	< 0.40	**7.1**	**1,300**	**5,000**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	02/15/2019	**0.63**	**490**	**2,100**	< 0.40	**7.1 J**	**1,300**	--	--	**0.0017**	**0.041**	--	--	**0.0074**	--	**0.0049**	< 0.40	--	--	--	**0.0029**	--	< 0.00010	< 0.7
M-57A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	**0.53**	--	--	--	< 0.0010	**0.0026**	**0.041**	< 0.0010	< 0.00010	**0.045**	--	**0.0050**	**0.53**	< 0.00050	< 0.20	< 0.00020	**0.0078**	**0.00069**	< 0.00010	--
M-57A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-57A	Downgradient	LCR Alluvium	08/09/2019	**0.56**	**470**	**1,900**	< 0.8	**7.0 J**	**1,300**	**4,700**	--	**0.0019**	**0.039**	--	--	**0.038**	--	**0.0040**	< 0.8	--	< 0.2	--	**0.0068**	--	< 0.0001	< 0.7
M-57A	Downgradient	LCR Alluvium	11/25/2019	**0.54**	**440**	**1,900**	< 0.4	**7.0 J**	**1,400**	**4,900**	--	**0.021**	**0.047**	--	--	**0.0038**	--	**0.0044**	< 0.4	--	--	--	**0.012**	--	< 0.0001	--
M-57A	Downgradient	LCR Alluvium	11/25/2019	**0.58**	**480**	**1,800**	< 0.4	**7.0 J**	**1,400**	**4,800**	--	**0.021**	**0.047**	--	--	**0.0035**	--	**0.0046**	< 0.4	--	--	--	**0.012**	--	< 0.0001	--
M-57A	Downgradient	LCR Alluvium	04/16/2020	**0.48**	**360**	**1,800**	< 0.8	**7.2 J**	**1,100**	**4,600**	< 0.005	**0.0037**	**0.042**	< 0.001	< 0.0005	< 0.005	--	**0.0028**	< 0.8	< 0.0025	< 1	< 0.0002	< 0.0025	< 0.0025	< 0.0005	--
M-58A	Downgradient	LCR Alluvium	11/30/2015	**0.19**	**250**	**1,900**	**0.43**	**7.6**	**570**	**3,700**	< 0.0025	**0.0032**	**0.10**	< 0.0010	< 0.00010	< 0.00050	--	**0.0011**	**0.43**	**0.00056**	< 0.20	< 0.00020	**0.0047**	**0.00024**	< 0.00010	< 0.9
M-58A	Downgradient	LCR Alluvium	03/08/2016	**0.19**	**250**	**1,800**	< 0.40	**7.74**	**520**	**3,700**	< 0.015	< 0.0049	**0.081**	< 0.0010	< 0.00046	< 0.0087	--	< 0.0013	< 0.40	< 0.0044	< 0.20	< 0.00020	< 0.0040	< 0.0015	< 0.00026	< 0.6
M-58A	Downgradient	LCR Alluvium	05/11/2016	**0.21**	**250**	**1,800**	< 0.40	--	**540**	**3,700**	< 0.00010	**0.0025**	**0.055**	< 0.0010	< 0.00010	< 0.00050	--	**0.00051**	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0018**	< 0.00050	< 0.00010	**0.9**
M-58A	Downgradient	LCR Alluvium	08/25/2016	**0.20**	**270**	**1,900**	< 0.40	**7.5**	**490**	**4,200**	< 0.00010	**0.0045**	**0.097**	< 0.0010	< 0.00010	**0.00097**	--	**0.00079**	< 0.40	**0.00059**	< 0.20	< 0.00020	**0.020**	< 0.00050	< 0.00010	**2.6**
M-58A	Downgradient	LCR Alluvium	09/21/2016	**0.21**	**280**	**1,800**	< 0.40	**7.8**	**510**	**4,500**	< 0.00050	**0.0039**	**0.076**	< 0.0010	< 0.00010	**0.0018**	--	**0.00057**	< 0.40	< 0.00010	< 0.20	< 0.00020	**0.0025**	< 0.00060	< 0.00010	**1.2**
M-58A	Downgradient	LCR Alluvium	02/20/2017	**0.23**	**260**	**2,000**	< 0.40	**7.5**	**580**	**3,700**	< 0.0010	**0.0027**	**0.064**	< 0.0010	< 0.00010	**0.0033**	--	**0.00097**	< 0.40	**0.00078**	< 0.20	< 0.00020	**0.0022**	< 0.00050	< 0.00010	**0.8**
M-58A	Downgradient	LCR Alluvium	04/12/2017	**0.21**	**280**	**1,900**	< 0.40	**8.0**	**570**	**3,900**	< 0.0010	**0.0037**	**0.048**	< 0.0010	< 0.00010	**0.00091**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0017**	< 0.00050	< 0.00010	**1.9**
M-58A	Downgradient	LCR Alluvium	04/25/2017	**0.21**	**270**	**1,700**	< 0.80	**7.5**	**550**	**3,600**	< 0.0010	**0.0040**	**0.049**	< 0.0010	< 0.00010	**0.0010**	--	< 0.00050	< 0.80	< 0.00050	< 0.20	< 0.00020	**0.0015**	< 0.00050	< 0.00010	**0.9**
M-58A	Downgradient	LCR Alluvium	05/18/2017	**0.21**	**260**	**1,900**	< 0.40	**7.7**	**600**	**3,700**	< 0.0010	**0.0030**	**0.043**	< 0.0010	< 0.00010	**0.00052**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0014**	< 0.00050	< 0.00010	< 0.6
M-58A	Downgradient	LCR Alluvium	05/25/2017	**0.21**	**270**	**1,800**	< 0.40	**7.7**	**550**	**3,700**	< 0.0010	**0.0051**	**0.055**	< 0.0010	< 0.00010	**0.00055**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0016**	< 0.00050	< 0.00010	**2.2**
M-58A	Downgradient	LCR Alluvium	05/25/2017	**0.21**	**280**	**1,800**	< 0.40	**7.7**	**540**	**3,700**	< 0.0010	**0.0050**	**0.052**	< 0.0010	< 0.00010	**0.00054**	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0016**	< 0.00050	< 0.00010	< 0.6
M-58A	Downgradient	LCR Alluvium	07/01/2017	**0.28**	**270**	**2,000**	< 0.40	**7.5**	**540**	**4,100**	< 0.0010	**0.0047**	**0.063**	< 0.0010	< 0.00010	< 0.00050	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0018**	< 0.00050	< 0.00010	< 0.7
M-58A	Downgradient	LCR Alluvium	07/26/2017	**0.23**	**300**	**1,900**	< 0.40	**7.6**	**560**	**4,100**	< 0.0020	**0.0057**	**0.11**	< 0.0010	< 0.00020	**0.0030**	--	**0.0010**	< 0.40	**0.0011**	< 0.20	< 0.00020	**0.0021**	< 0.0010	< 0.00020	< 0.7
M-58A	Downgradient	LCR Alluvium	09/08/2017	**0.22**	**300**	**2,000**	< 0.40	**7.5**	**520**	**4,300**	< 0.0040	**0.0048**	**0.080**	< 0.0010	< 0.00040	< 0.0040	--	< 0.0020	< 0.40	< 0.0020	< 0.20	< 0.00020	**0.0022**	< 0.0020	< 0.00040	< 0.7
M-58A	Downgradient	LCR Alluvium	12/08/2017	**0.21**	**290**	**2,100**	< 0.40	**7.6**	**530**	**4,000**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	12/08/2017	**0.20**	**280**	**2,100**	< 0.40	**7.6**	**530**	**3,900**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	05/21/2018	**0.21**	**290**	**2,000**	< 0.40	**7.4**	**520**	**3,900**	< 0.0020	**0.0042**	**0.071**	< 0.0010	< 0.00020	< 0.0020	--	< 0.0010	< 0.40	< 0.0010	< 0.20	< 0.00020	**0.0018**	< 0.0010	< 0.00020	**0.7**

Groundwater Sampling Results for the SEDI Monitoring Wells

				Appendix III Constituents							Appendix IV Constituents															
			Constituent:	Boron	Calcium	Chloride	Fluoride	pH (Laboratory Measurement)	Sulfate	Total Dissolved Solids	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Total Radium
			Filtered:	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	su	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L
			BTV	*0.23*	*600*	*3,700*	*0.8*	*7.5*	*630*	*7,800*	*0.05*	*0.004*	*0.08*	*0.001*	*0.002*	*0.004*	*0.004*	*0.002*	*0.8*	*0.01*	*0.2*	*0.002*	*0.011*	*0.01*	*0.0004*	*1.1*
			GWPS	--	--	--	--	--	--	--	*0.05*	*0.01*	*2*	*0.004*	*0.005*	*0.1*	*0.1*	*0.006*	*4*	*0.015*	*0.2*	*0.002*	*0.1*	*0.05*	*0.002*	*5*
M-58A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	**0.0037**	**0.075**	--	--	< 0.0010	--	< 0.00050	--	--	--	--	**0.0017**	--	< 0.00010	< 0.6
M-58A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	**0.0037**	**0.076**	--	--	< 0.0010	--	< 0.00050	--	--	--	--	**0.0017**	--	< 0.00010	< 0.6
M-58A	Downgradient	LCR Alluvium	10/24/2018	**0.21**	**290**	**2,000**	< 0.40	**7.5**	**530**	**3,900**	--	--	--	--	--	--	--	--	< 0.40	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	02/15/2019	**0.23**	**310**	**2,100**	< 0.40	**7.5 J**	**540**	--	--	**0.0043**	**0.063**	--	--	< 0.0010	--	< 0.00050	< 0.40	--	--	--	**0.0018**	--	< 0.00010	< 0.7
M-58A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	< 0.40	--	--	--	< 0.0010	**0.0039**	**0.059**	< 0.0010	< 0.00010	< 0.0010	--	< 0.00050	< 0.40	< 0.00050	< 0.20	< 0.00020	**0.0018**	< 0.00050	< 0.00010	--
M-58A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.7
M-58A	Downgradient	LCR Alluvium	08/09/2019	**0.22**	**300**	**2,100**	< 0.8	**7.4 J**	**530**	**4,200**	--	**0.0038**	**0.066**	--	--	< 0.001	--	< 0.0005	< 0.8	--	< 0.2	--	**0.0018**	--	< 0.0001	< 0.7
M-58A	Downgradient	LCR Alluvium	11/25/2019	**0.22**	**300**	**2,000**	< 0.4	**7.4 J**	**530**	**4,000**	--	**0.0046**	**0.079**	--	--	< 0.001	--	< 0.0005	< 0.4	--	--	--	**0.0018**	--	< 0.0001	--
M-58A	Downgradient	LCR Alluvium	04/16/2020	< 0.25	**280**	**2,100**	< 0.8	**7.5 J**	**590**	**4,300**	< 0.005	**0.0042**	**0.069**	< 0.001	< 0.0005	< 0.005	--	< 0.0025	< 0.8	< 0.0025	< 1	< 0.0002	< 0.0025	< 0.0025	< 0.0005	--
CR-1	Supplementary	LCR Alluvium	03/12/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.010	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	**0.146**	**225**	--	--	**7.42**	--	**2,890**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	--	--	**1,100**	**0.80**	--	**270**	--	--	--	--	--	--	--	--	--	**0.80**	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	--	--	**1,300**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	11/14/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	03/11/2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/04/2013	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.010	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/04/2013	**0.139**	**215**	--	**0.43**	**7.32**	--	**2,380**	--	--	--	--	--	--	--	--	**0.43**	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/04/2013	--	--	**1,100**	--	--	**250**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	09/16/2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	03/18/2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/10/2014	**0.128**	**229**	**1,100**	**0.48**	**7.79**	**240**	**2,960**	--	--	--	--	--	--	< 0.01	--	**0.48**	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/30/2014	--	--	--	--	--	**262**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/16/2015	**0.157**	**214**	**1,110**	**0.46**	**7.59**	**211**	**2,490**	--	--	--	--	--	--	< 0.01	--	**0.46**	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/25/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/17/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	11/30/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/02/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/04/2016	**0.18**	--	**1,400**	**0.68**	**7.5**	**300**	**3,100**	--	--	--	--	--	--	< 0.010	--	**0.68**	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/24/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	11/01/2016	--	--	**1,300**	--	**7.4**	--	**3,300**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	05/03/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/06/2017	**0.16**	--	**1,300**	< 0.40	**7.6**	**280**	**2,600**	--	--	--	--	--	< 0.010	< 0.010	--	< 0.40	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/31/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/30/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/05/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	09/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.010	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	02/26/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	09/08/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Groundwater Sampling Results for the SEDI Monitoring Wells

				Additional Analyses																	
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Iron	Magnesium	Manganese	Methane	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	11/30/2015	**140**	< 6.0	< 6.0	--	**130**	--	--	--	--	--	--	--	**9.5**	< 0.4	< 0.7	**10**	**1,200**	--
M-62A	Background	LCR Alluvium	03/08/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.4**	**0.6**	--	--	--
M-62A	Background	LCR Alluvium	03/08/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	**0.7**	--	--	--
M-62A	Background	LCR Alluvium	05/05/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	< 0.8	--	--	--
M-62A	Background	LCR Alluvium	08/29/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.9**	--	--	--
M-62A	Background	LCR Alluvium	09/21/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	**1.5**	--	--	--
M-62A	Background	LCR Alluvium	02/20/2017	**190**	< 6.0	< 6.0	--	**150**	--	--	--	--	--	--	--	**7.9**	**0.7**	**0.7**	--	**1,200**	--
M-62A	Background	LCR Alluvium	04/13/2017	**190**	< 6.0	< 6.0	--	**150**	--	--	--	--	--	--	--	**7.7**	< 0.5	**1.2**	--	**1,200**	--
M-62A	Background	LCR Alluvium	04/25/2017	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**8.4**	< 0.4	**0.9**	--	**1,300**	--
M-62A	Background	LCR Alluvium	04/25/2017	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**8.5**	**1.0**	**1.6**	--	**1,300**	--
M-62A	Background	LCR Alluvium	05/18/2017	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**8.5**	< 0.5	**1.2**	--	**1,300**	--
M-62A	Background	LCR Alluvium	05/25/2017	**190**	< 6.0	< 6.0	--	**170**	--	--	--	--	--	--	--	**8.6**	**0.4**	**1.1**	--	**1,400**	--
M-62A	Background	LCR Alluvium	07/01/2017	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**8.1**	< 0.5	< 0.7	--	**1,300**	--
M-62A	Background	LCR Alluvium	07/26/2017	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**8.3**	< 0.4	**1.3**	--	**1,300**	--
M-62A	Background	LCR Alluvium	09/07/2017	**210**	< 6.0	< 6.0	--	**170**	--	--	--	--	--	--	--	**8.7**	< 0.5	**0.9**	--	**1,400**	--
M-62A	Background	LCR Alluvium	12/08/2017	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**8.2**	--	--	--	**1,200**	--
M-62A	Background	LCR Alluvium	05/21/2018	**190**	< 6.0	< 6.0	--	**160**	--	--	--	--	--	--	--	**7.9**	< 0.4	**0.7**	--	**1,200**	--
M-62A	Background	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	< 0.6	--	--	--
M-62A	Background	LCR Alluvium	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	02/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-62A	Background	LCR Alluvium	08/05/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	08/09/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.8**	< 0.7	--	--	--
M-62A	Background	LCR Alluvium	08/09/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--
M-62A	Background	LCR Alluvium	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	02/25/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	04/16/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-62A	Background	LCR Alluvium	09/08/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	11/30/2015	**160**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**10**	< 0.5	< 0.9	**16**	**1,100**	--
M-56A	Downgradient	LCR Alluvium	03/08/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.4	--	--	--
M-56A	Downgradient	LCR Alluvium	05/10/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	**0.6**	--	--	--
M-56A	Downgradient	LCR Alluvium	08/29/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**1.6**	--	--	--
M-56A	Downgradient	LCR Alluvium	09/21/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.6**	< 0.7	--	--	--
M-56A	Downgradient	LCR Alluvium	09/21/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**1.6**	--	--	--
M-56A	Downgradient	LCR Alluvium	02/20/2017	**180**	< 6.0	< 6.0	--	**71**	--	--	--	--	--	--	--	**7.1**	**0.7**	**1.1**	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	04/13/2017	**190**	< 6.0	< 6.0	--	**74**	--	--	--	--	--	--	--	**7.3**	< 0.5	**1.2**	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	04/25/2017	**190**	< 6.0	< 6.0	--	**76**	--	--	--	--	--	--	--	**7.7**	< 0.4	**1.9**	--	**1,200**	--
M-56A	Downgradient	LCR Alluvium	05/18/2017	**200**	< 6.0	< 6.0	--	**77**	--	--	--	--	--	--	--	**7.6**	< 0.8	< 1.2	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	05/18/2017	**190**	< 6.0	< 6.0	--	**78**	--	--	--	--	--	--	--	**7.6**	**0.6**	**1.1**	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	05/25/2017	**200**	< 6.0	< 6.0	--	**74**	--	--	--	--	--	--	--	**7.2**	**0.4**	**1.1**	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	07/01/2017	**200**	< 6.0	< 6.0	--	**79**	--	--	--	--	--	--	--	**7.6**	< 0.5	< 0.7	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	07/26/2017	**190**	< 6.0	< 6.0	--	**81**	--	--	--	--	--	--	--	**7.5**	**0.7**	**1.0**	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	09/08/2017	**200**	< 6.0	< 6.0	--	**82**	--	--	--	--	--	--	--	**7.8**	**0.5**	< 0.6	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	12/08/2017	**190**	< 6.0	< 6.0	--	**79**	--	--	--	--	--	--	--	**7.3**	--	--	--	**1,000**	--
M-56A	Downgradient	LCR Alluvium	05/21/2018	**200**	< 6.0	< 6.0	--	**87**	--	--	--	--	--	--	--	**7.4**	< 0.4	**1.4**	--	**1,100**	--
M-56A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.5**	< 0.6	--	--	--
M-56A	Downgradient	LCR Alluvium	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	02/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.9**	--	--	--

Groundwater Sampling Results for the SEDI Monitoring Wells

				Additional Analyses																	
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Iron	Magnesium	Manganese	Methane	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	02/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	04/18/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-56A	Downgradient	LCR Alluvium	08/09/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.6**	< 0.7	--	--	--
M-56A	Downgradient	LCR Alluvium	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	04/16/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-56A	Downgradient	LCR Alluvium	04/16/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	11/30/2015	**230**	< 6.0	< 6.0	--	**96**	--	--	--	--	--	--	--	**7.5**	< 0.5	< 0.9	**19**	**1,100**	--
M-57A	Downgradient	LCR Alluvium	11/30/2015	**230**	< 6.0	< 6.0	--	**97**	--	--	--	--	--	--	--	**7.8**	< 0.5	**1.0**	**19**	**1,000**	--
M-57A	Downgradient	LCR Alluvium	03/08/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.4	--	--	--
M-57A	Downgradient	LCR Alluvium	05/11/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.6	--	--	--
M-57A	Downgradient	LCR Alluvium	08/25/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
M-57A	Downgradient	LCR Alluvium	09/21/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--
M-57A	Downgradient	LCR Alluvium	09/21/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--
M-57A	Downgradient	LCR Alluvium	02/20/2017	**260**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**6.3**	< 0.4	**1.1**	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	04/12/2017	**260**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**6.0**	< 0.5	< 0.6	--	**1,000**	--
M-57A	Downgradient	LCR Alluvium	04/25/2017	**260**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**6.5**	< 0.4	< 0.6	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	05/18/2017	**270**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.3**	**0.8**	**0.7**	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	05/25/2017	**260**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.3**	**0.5**	< 0.6	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	07/01/2017	**270**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**6.2**	< 0.5	< 0.7	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	07/26/2017	**270**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.0**	< 0.4	< 0.7	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	09/08/2017	**270**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.4**	**0.6**	< 0.6	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	12/08/2017	**270**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**6.2**	--	--	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	05/21/2018	**270**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.2**	< 0.4	< 0.7	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	05/21/2018	**270**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.3**	< 0.4	< 0.6	--	**1,100**	--
M-57A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**0.7**	--	--	--
M-57A	Downgradient	LCR Alluvium	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	02/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-57A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-57A	Downgradient	LCR Alluvium	08/09/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--
M-57A	Downgradient	LCR Alluvium	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-57A	Downgradient	LCR Alluvium	04/16/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	11/30/2015	**190**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**9.7**	< 0.5	< 0.9	**15**	**1,000**	--
M-58A	Downgradient	LCR Alluvium	03/08/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	< 0.6	--	--	--
M-58A	Downgradient	LCR Alluvium	05/11/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2	**0.9**	--	--	--
M-58A	Downgradient	LCR Alluvium	08/25/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.2**	**1.4**	--	--	--
M-58A	Downgradient	LCR Alluvium	09/21/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	**1.2**	--	--	--
M-58A	Downgradient	LCR Alluvium	02/20/2017	**210**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**7.5**	< 0.4	**0.8**	--	**1,000**	--
M-58A	Downgradient	LCR Alluvium	04/12/2017	**210**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**7.1**	**0.6**	**1.3**	--	**880**	--
M-58A	Downgradient	LCR Alluvium	04/25/2017	**210**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**7.4**	< 0.4	**0.9**	--	**930**	--
M-58A	Downgradient	LCR Alluvium	05/18/2017	**210**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**6.9**	< 0.5	< 0.6	--	**900**	--
M-58A	Downgradient	LCR Alluvium	05/25/2017	**200**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**7.4**	**0.6**	**1.6**	--	**920**	--
M-58A	Downgradient	LCR Alluvium	05/25/2017	**200**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**7.4**	< 0.4	< 0.6	--	**940**	--
M-58A	Downgradient	LCR Alluvium	07/01/2017	**190**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**7.5**	< 0.4	< 0.7	--	**900**	--
M-58A	Downgradient	LCR Alluvium	07/26/2017	**190**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**8.4**	< 0.4	< 0.7	--	**940**	--
M-58A	Downgradient	LCR Alluvium	09/08/2017	**190**	< 6.0	< 6.0	--	**120**	--	--	--	--	--	--	--	**7.9**	< 0.6	< 0.7	--	**960**	--
M-58A	Downgradient	LCR Alluvium	12/08/2017	**190**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**7.6**	--	--	--	**930**	--
M-58A	Downgradient	LCR Alluvium	12/08/2017	**190**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**7.3**	--	--	--	**920**	--
M-58A	Downgradient	LCR Alluvium	05/21/2018	**190**	< 6.0	< 6.0	--	**110**	--	--	--	--	--	--	--	**7.3**	< 0.4	**0.7**	--	**940**	--

Groundwater Sampling Results for the SEDI Monitoring Wells

				Additional Analyses																	
			Constituent:	Alkalinity Bicarbonate	Alkalinity Carbonate	Alkalinity Hydroxide	Iron	Magnesium	Manganese	Methane	Nitrate as N	Nitrate-Nitrite as N	Nitrite (as N)	Nitrogen	Nitrogen, Kjeldahl, Total	Potassium	Radium 226	Radium 228	SIO2, Silica	Sodium	Total Organic Carbon
			Filtered:	N	N	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
			Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	mg/L	mg/L	mg/L
			BTV	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			GWPS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
M-58A	Downgradient	LCR Alluvium	08/28/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.6	--	--	--
M-58A	Downgradient	LCR Alluvium	10/24/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	02/15/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-58A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	04/17/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5	< 0.7	--	--	--
M-58A	Downgradient	LCR Alluvium	08/09/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.4	< 0.7	--	--	--
M-58A	Downgradient	LCR Alluvium	11/25/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M-58A	Downgradient	LCR Alluvium	04/16/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	03/12/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	**190**	< 5.0	< 5.0	--	**88.9**	--	--	--	--	--	--	--	< 10	--	--	--	**547**	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	--	--	--	--	--	--	--	< 0.8	--	< 0.8	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/09/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	11/14/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	03/11/2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/04/2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/04/2013	**170**	< 5.0	< 5.0	--	**78.3**	--	--	--	--	--	--	--	< 10	--	--	--	**510**	--
CR-1	Supplementary	LCR Alluvium	06/04/2013	--	--	--	--	--	--	--	**0.90**	--	< 0.8	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	09/16/2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	03/18/2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/10/2014	**180**	< 5.0	--	--	**88.1**	--	--	< 0.8	--	< 0.8	--	--	< 10	--	--	--	**496**	--
CR-1	Supplementary	LCR Alluvium	10/30/2014	--	--	--	**0.585**	--	**1.39**	**0.34 J**	--	< 0.10 U	--	--	--	--	--	--	--	--	< 1.0 U
CR-1	Supplementary	LCR Alluvium	06/16/2015	**176**	< 5.0	< 5.0	--	**85.5**	--	--	< 0.10	--	< 0.50	--	--	< 10	--	--	--	**520**	--
CR-1	Supplementary	LCR Alluvium	06/25/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/17/2015	--	--	--	--	--	--	--	--	--	< 1.0	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	11/30/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/02/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/04/2016	--	--	--	--	--	--	--	< 0.10	--	< 0.10	< 0.10	< 0.50	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/24/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	11/01/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	05/03/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	06/06/2017	--	--	--	--	--	--	--	< 0.10	< 0.10	< 0.10	**0.66**	**0.66**	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	10/31/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/30/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	08/05/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	09/13/2019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	02/26/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-1	Supplementary	LCR Alluvium	09/08/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

BTV exceedances are shown in grey shaded cells. GWPS exceedence are shown in red text.

Duplicate sample dates under the same locations are either field duplicates or are instances of samples with multiple filed/lab sample IDs on the same date.

Abbreviations and Data Qualifiers:

< = less than

BTV = Background Threshold Value

GWPS = Groundwater Protection Standard

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/L = milligrams per liter

pCi/L = Picocuries per liter

su = standard units

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

wood.

SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI
ARIZONA PUBLIC SERVICE COMPANY CHOLLA POWER PLANT
NAVAJO COUNTY, ARIZONA

Coal Combustion Residuals Rule Compliance

Submitted to:

Arizona Public Service Company
400 North 5th Street
Phoenix, Arizona 85004

Submitted by:

Wood Environment & Infrastructure Solutions, Inc.
Phoenix, Arizona

November 30, 2020

Wood Project No. 14-2018-2040

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1.0 INTRODUCTION

The following provides a summary of the hydrogeologic conditions at the Fly Ash Pond (FAP), the Bottom Ash Pond (BAP), the Bottom Ash Monofill (BAM), and the Sedimentation Pond (SEDI), (collectively referred to as Coal Combustion Residuals [CCR] units) located at the Arizona Public Service Company Cholla Power Plant (Cholla or the Site) in Navajo County, Arizona. A detailed description of the site geology, environmental setting, and applicable hydrostratigraphy is provided in the *Assessment of Corrective Measures For the Fly Ash Pond and the Bottom Ash Pond, Coal Combustion Residuals Rule and Aquifer Protection Permit Compliance* (Wood, 2019) and *Annual Groundwater Monitoring and Corrective Action Report for 2019* (Wood, 2020). This summary includes a geologic map and cross-sections illustrating the lateral and vertical extent of the various lithostratigraphic units in the vicinity of the site CCR units.

2.0 REGIONAL GEOLOGIC SETTING

Cholla is located at an elevation of approximately 5,025 ft above mean sea level (amsl) in the Navajo Section of the Colorado Plateau physiographic province of northeastern Arizona. Rolling terrain, open vistas, and incised drainages/arroyos characterize the general topography of the area. Surface water features near Cholla include the Little Colorado River (LCR), which is a meandering intermittent stream with a large alluvial floodplain. The Colorado Plateau, on which Cholla is located, is characterized by sub-horizontal layered sequences of sedimentary rock, which consist primarily of sandstones, siltstones, and claystones. A regional geologic map depicting the predominant rock units near the Site is presented in Figure 1.

3.0 SITE GEOLOGY

The primary geologic units at the Site include the LCR and Tanner Wash Alluviums, the Triassic Chinle Formation, the Triassic Moenkopi Formation, and the Permian Coconino Sandstone.

The LCR and Tanner Wash Alluviums overlie the bedrock formations in localized areas and consist of unconsolidated, heterogeneous sequences of clay, silt, sand, and gravel. In general, the Tanner Wash alluvium is finer grained than the LCR Alluvium. The alluvium ranges in thickness from non-existent to approximately 200 ft thick in the vicinity of the Site.

An outcrop of the Triassic Chinle Formation is present in the vicinity of the BAP and BAM and consists of the Shinarump and Petrified Forest Members. The Shinarump member consists primarily of a yellowish-orange to yellowish-gray sandstone that is composed of very fine to very coarse quartz grains and rounded to well-rounded pebbles. This unit is weakly cemented and forms slopes in the vicinity of the BAP and BAM. The Petrified Forest member consists of reddish mudstone and brown sandstone and contains petrified wood.

Directly underlying the LCR and Tanner Wash Alluviums is the Moenkopi Formation. The thickness of the Moenkopi Formation near Cholla ranges from being non-existent to over 300 feet (ft) thick and consists of three members (in descending order): the Holbrook Member, the Moqui Member, and the Wupatki Member. The Holbrook Member ranges between 30 to 50 ft thick and consists primarily of medium to very-fine grained and poorly sorted (silty) sandstone. The Moqui Member ranges from non-existent to 300 ft thick and is primarily comprised of pale to reddish-brown gypsiferous mudstone and siltstone beds. The Wupatki Member ranges from 30 to 50 ft thick and generally consists of siltstone and fine-grained sandstone.

Underlying the Moenkopi Formation is the Permian Coconino Sandstone, a very fine- to medium-grained sandstone comprised of well-sorted, rounded to subangular quartz grains commonly cemented with silicious cement. It is the principal lithologic unit of the C-aquifer, a regionally important aquifer for water supply, and is approximately 375 to 400 ft thick in the vicinity of Cholla. This unit is overlain by the Permian Kaibab Limestone, which does not outcrop near the Site.

4.0 SITE HYDROGEOLOGY

Two hydrostratigraphic units are conceptualized beneath the site CCR units. These form the basis of the hydrogeologic Conceptual Site Model (CSM) developed by Montgomery & Associates (2011 and 2017).

The first hydrogeologic unit, the LCR and Tanner Wash Alluvial Aquifers, is present in the LCR and Tanner Wash drainage channels adjacent to the FAP, BAP and BAM, respectively. The alluvial aquifer in this area receives recharge from the LCR and any leakage through anthropogenic features such as the reservoir and the nearby Joseph City Canal. Regionally, the alluvial aquifer is not used as a drinking water supply due to poor water quality (i.e., high levels of total dissolved solids). Depth to water in the alluvial aquifers ranges from several ft to several tens of ft below land surface in the Cholla area, varying spatially based on proximity to recharge sources and topography and seasonally based on rainfall-runoff patterns. Where present, groundwater flows generally in the downstream direction of the drainages under which it is present, that is, east to west in the LCR alluvium and north to south in the Tanner Wash alluvium. Groundwater flow in the LCR alluvial aquifer is also influenced by deeper paleochannels that may not coincide with the present river channel.

The second hydrogeologic unit is the C-aquifer, which consists of the Coconino Sandstone and Schnebly Hill Formation in the vicinity of the plant. Groundwater in this aquifer is under confined conditions in areas north of the LCR where the Moqui member of the Moenkopi Formation acts as a confining unit. Groundwater movement in the C-aquifer is generally to the north. However, the Cholla well field (southwest of the plant) has created a cone of depression that has made the localized groundwater flow in a westerly direction in that area. Near the FAP, the inferred flow of the groundwater in the C-aquifer is to the west or northwest, possibly due to the broad, northwest-trending anticline that extends from the vicinity of the FAP to near Joseph City.

The alluvial aquifer and the C-aquifer are separated by the Moenkopi Formation, a regional aquitard that creates a barrier between the two aquifers in the vicinity of Cholla where the unit is sufficiently thick. In areas where the C-aquifer in the Coconino Sandstone is confined (primarily north of the Little Colorado River), the Wupatki member of the Moenkopi has been observed to be water-bearing; however, the Moqui member prevents hydraulic connection between the alluvial aquifer and the C-aquifer and is effectively bedrock when considering water quality conditions and groundwater movement in a significant portion of the alluvial aquifer.

Cross sections outlining the lateral and vertical extent of the above-mentioned stratigraphic units are presented as Figures 2A, 2B, 2C, 2D, 3A, 3B, and 3C. These cross sections also depict groundwater elevations measured in April 2020 at monitoring wells installed in the alluvial aquifer, the C-aquifer, and the Moenkopi Formation. The (inferred) approximate extents of groundwater impacts resulting from the FAP and the BAP are also shown (as dashed area in blue) on the cross-sections.

Figure 2 shows a plan view of cross sections A, B, C, and D (Figures 2A, 2B, 2C, and 2D). Cross section A (Figure 2A) cuts across the BAM to the north and the BAP to the south, while cross Section B (Figure 2B) cuts from the northwest to the southeast across the BAP. Cross section C (Figure 2C) runs east of the BAP with a northeast to southwest trend. Cross section D (Figure 2D) runs east to west through the SEDI. Figure

3 depicts a plan view of cross section E (Figure 3A) which runs south of the FAP, and cross sections F and G (Figure 3B, 3C) which cut across the FAP.

The uppermost aquifer underlying each CCR unit is depicted on the cross sections discussed above and described as follows:

- FAP (Little Colorado River Alluvium): The FAP is constructed primarily on the relatively impermeable Moenkopi Formation; however, alluvial sediments are present in the vicinity of the FAP while the dam itself extends to bedrock. Groundwater at the toe of the FAP dam flows west-southwest through localized shallow alluvial sediments (which are fairly fine grained) and then merges with the Little Colorado River Alluvium where the predominant direction of groundwater flow is to the west. Near the FAP, the inferred flow of the groundwater in the Coconino Sandstone is to the west or southwest, possibly due to the broad, northwest-trending anticline that extends from the vicinity of the FAP to near Joseph City.
- BAP (Tanner Wash Alluvium): The BAP is located in the Tanner Wash drainage area. The northern and western edges of the BAP are constructed on the Moenkopi Formation, whereas the southern edge rests primarily on alluvial material. The BAP dams have a clay core that extend through the alluvium to bedrock where the alluvium was less than 20 ft thick at the time of dam construction. In regions where the alluvium was greater than 20 ft thick, a cutoff wall was constructed that generally extended to bedrock. Due to the depths involved, the cutoff wall does not extend to bedrock in the middle of the channel underlying the southern dam. There is an approximately 10 to 20-ft thick layer of alluvium below the base of the cutoff wall in this region (at an elevation of 4,980 ft above mean sea level). Groundwater near the BAP flows south-southwest through the Tanner Wash Alluvium to its confluence with the Little Colorado River Alluvium. The results of a recent investigation conducted in 2019 indicates the Moenkopi Moqui is saturated downgradient of the BAP; the extent of saturation is currently unknown but may impact the CSM for this unit in the future.
- BAM (Coconino Sandstone): The BAM is a CCR landfill constructed in the Tanner Wash watershed. It is constructed on the Moenkopi Formation where no saturated alluvium is present; water levels from nearby wells indicate that the Moenkopi is unsaturated beneath the BAM. Therefore, the uppermost hydrogeologic unit at the BAM is the Coconino Sandstone Aquifer which exists under confined conditions more than 300 ft bgs in the vicinity of the BAM. Groundwater in the Coconino Aquifer beneath the BAM flows to the north-northwest.
- SEDI (Little Colorado River Alluvium): The SEDI is constructed on the Little Colorado River Alluvium. Groundwater near the SEDI flows parallel to the direction of Little Colorado River surface flows, approximately to the southwest.

5.0 REFERENCES

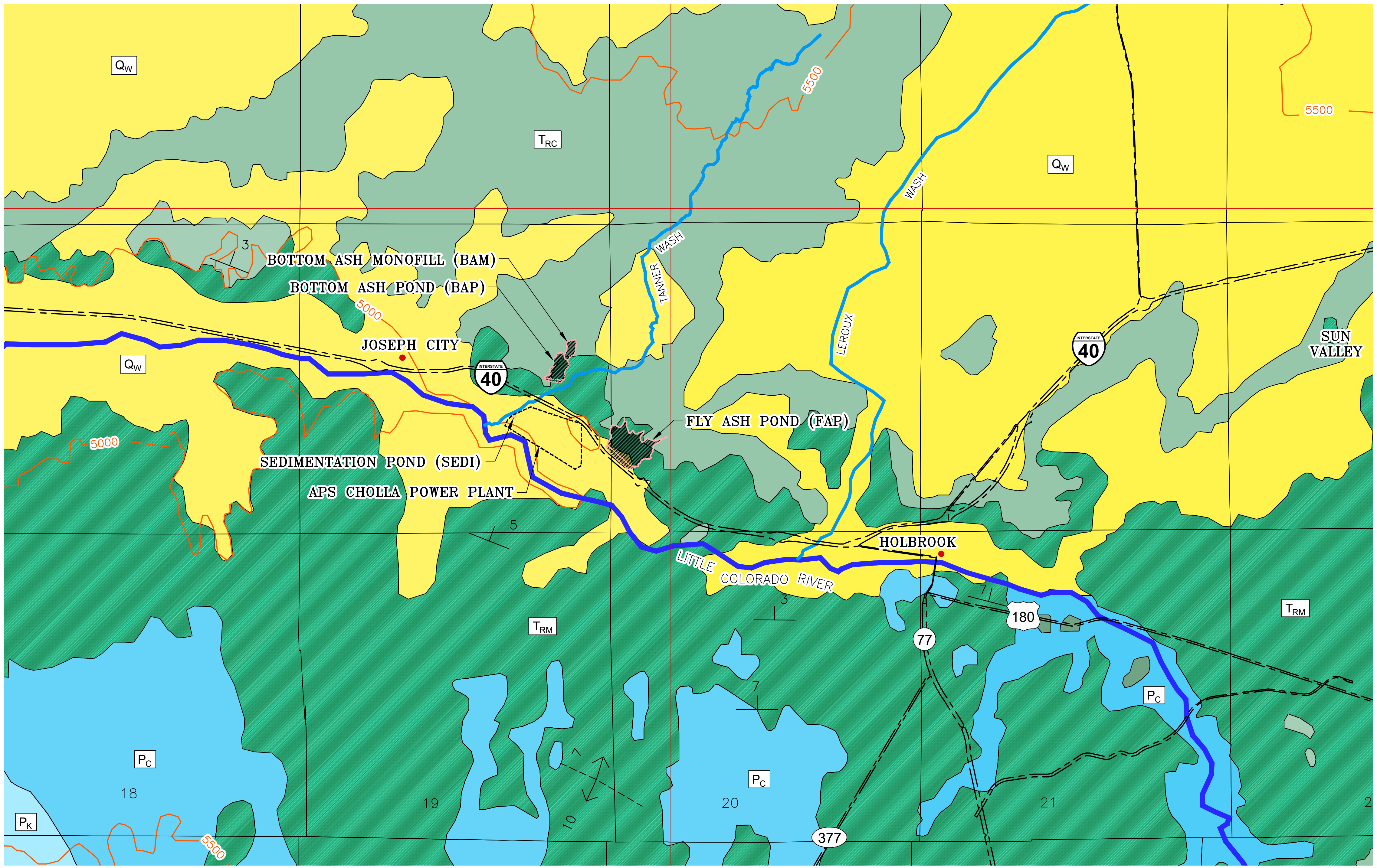
Montgomery & Associates, 2011. Arizona Public Service Cholla Power Plant Point of Compliance Evaluation. Prepared for APS. January 26, 2011.

Montgomery & Associates, 2017. *Cholla Power Plant Coal Combustion Residuals Program – Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks*. Navajo County, Arizona. Document #CH_GW_SystemCert_020_20170919. September 19, 2017.

Wood Environment & Infrastructure Solutions, Inc. (Wood), 2019. *Assessment of Corrective Measures for the Fly Ash Pond and the Bottom Ash Pond.* Coal Combustion Residual Rule and Aquifer Protection Permit Compliance, Arizona Public Service Company, Cholla Power Plant, Navajo County, Arizona. Prepared on behalf of APS. June 14, 2019.

Wood, 2020. *Annual Groundwater Monitoring and Corrective Action Report for 2019*. Coal Combustion Residual Rule Groundwater Monitoring System Compliance, Cholla Power Plant, Navajo County, Arizona. Prepared on behalf of APS. January 31, 2020.

FIGURES



LEGEND:

- CONTACT BETWEEN UNITS
- ORIGINAL GROUND SURFACE DASHED WHERE APPROXIMATELY LOCATED U, UPTHROWN SIDE; D DOWNTHROWN SIDE
- AXIS OF ANTICLINE SHOWING DIRECTION OF PLUNGE
- STRIKE AND DIP
- 5500 ELEVATION CONTOURS (FEET)
- ADOT ROW
- RIVER
- WASH
- Qw QUATERNARY ALLUVIUM
- TRC TRIASSIC CHINLE FORMATION
- TRM TRIASSIC MOENKOPI FORMATION
- PK PERMIAN KAIBAB LIMESTONE
- PC COCONINO SANDSTONE

NOTE:

GEOLOGIC MAP REFERENCE: WILSON, E.D., MOORE, R.T., AND O'HAIRE, R.T., 1960, GEOLOGIC MAP OF NAVAJO AND APACHE COUNTIES, ARIZONA. ARIZONA BUREAU OF MINES - UNIVERSITY OF ARIZONA, ARIZONA COUNTY MAP SERIES 03-07.

6000 0 6000 12000 FT

CLIENT: aps

PROJECT: CHOLLA COMPLIANCE SUPPORT

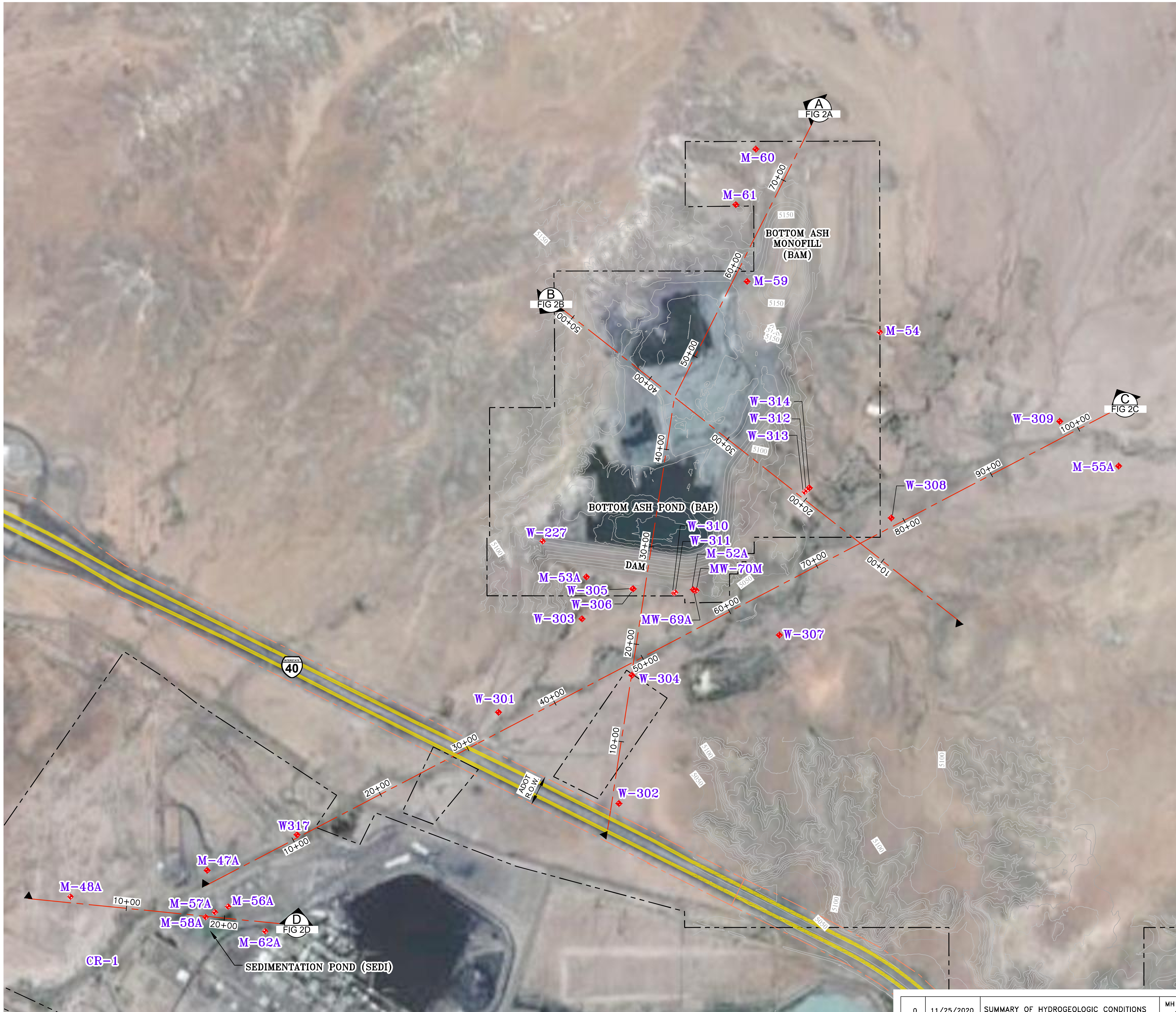
TITLE: GEOLOGY SITE PLAN

DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL

					FILENAME	FIGURE No.	REV	PROJECT NO.
0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH	PM	2040–Geological Map	1	0	14–2018–2040

wood.

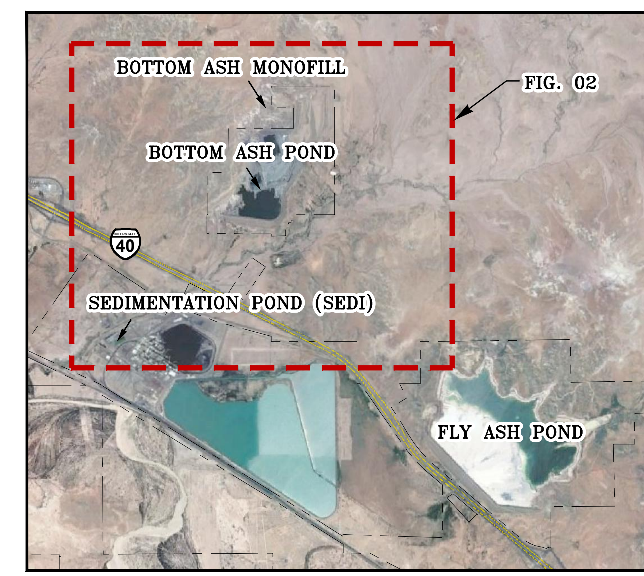
\\phx4-fs1\data\Environmental-Development\2018 Projects\14-2018-2040 APS Cholla Compliance Support\5.0_Technical\5.6_GIS_CADD\CADD\Figures\FAP\2040-Geological Map.dwg-11/27/2020 1:48 PM



LEGEND:

- EXISTING GROUND SURFACE CONTOUR EL, FEET
- MONITORING WELLS
- EXISTING FENCE
- PROPERTY BOUNDARY
- ADOT RIGHT-OF-WAY

500 0 500 1000 FT

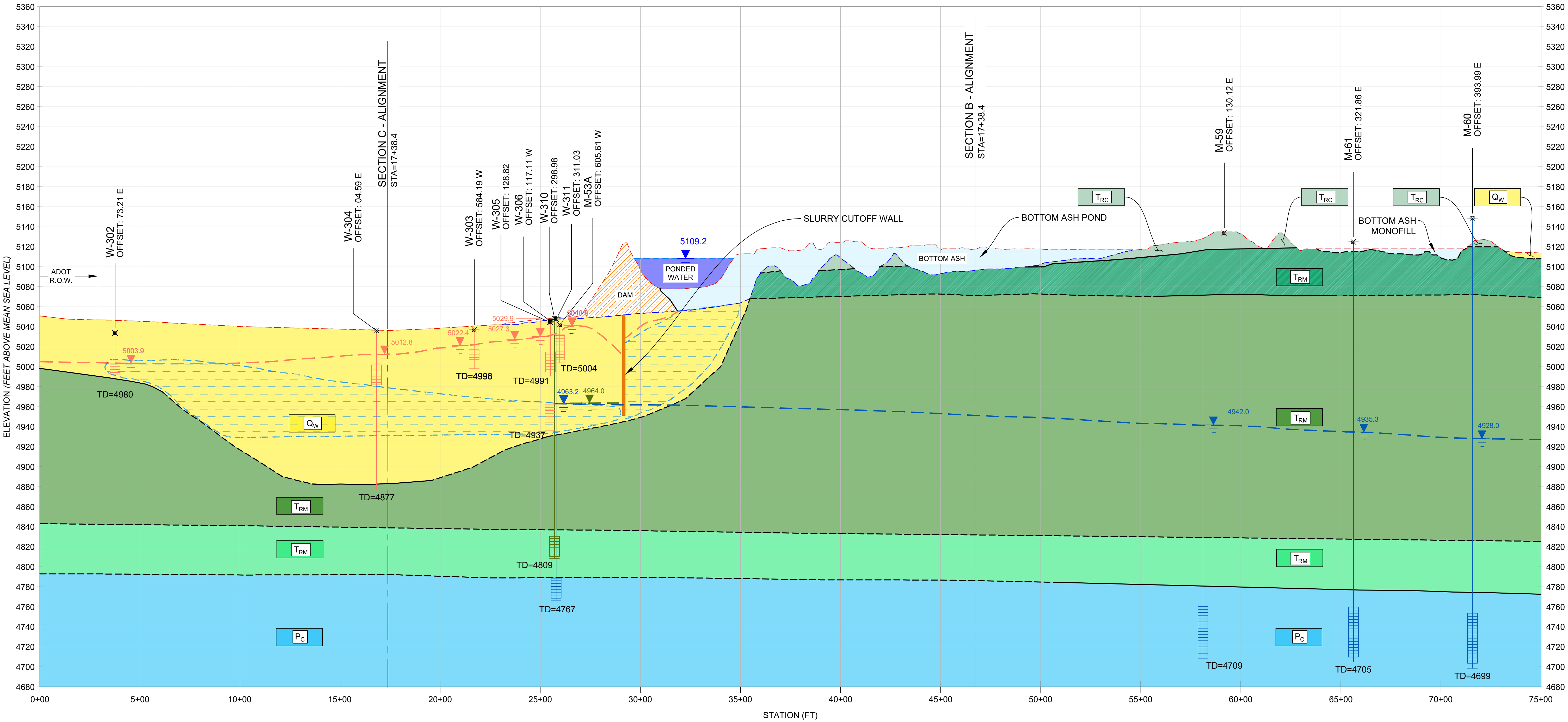


SITE LOCATION MAP

3000 0 3000 6000 FT

CLIENT	aps	
PROJECT	CHOLLA COMPLIANCE SUPPORT	
TITLE	CHOLLA BAP, BAM, SEDI PLAN VIEW	wood.
DESIGNED BY JP	CHECKED BY DA	ISSUED FOR
DRAWN BY PM	APPROVED BY MH	FINAL

0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH / PM	FILENAME: 2040-Cross Sections	FIGURE No.: 2	REV: 0	PROJECT NO.: 14-2018-2040	



SECTION A
FIG 2

LEGEND:

- EXISTING GROUND SURFACE
- ORIGINAL GROUND SURFACE
- CONTACT BETWEEN UNITS
- CONTACT DASH WHERE INFERRED
- MONITORING WELL OR PIEZOMETER
- SCREEN INTERVAL
- TD=4978 ← TOTAL DEPTH
- BORING
- TD=4978 ← TOTAL DEPTH

- Q_W ALLUVIUM
- T_{RC} CHINLE FORMATION
- T_{RM} HOLBROOK (MEMBER OF MOENKOPI)
- T_{RM} MOQUI (MEMBER OF MOENKOPI)
- T_{RM} WUPATKI (MEMBER OF MOENKOPI)
- P_C COCONINO SANDSTONE
- DAM
- BOTTOM ASH

- APPROXIMATE EXTENT OF GROUNDWATER IMPACTS

WATER LEVEL APRIL, 2020
- ALLUVIUM
- MOQUI (MEMBER OF MOENKOPI)
- WUPATKI (MEMBER OF MOENKOPI)
- COCONINO SANDSTONE

POTENTIOMETRIC SURFACE
- ALLUVIUM
- MOQUI (MEMBER OF MOENKOPI)
- WUPATKI (MEMBER OF MOENKOPI)
- COCONINO SANDSTONE

HORIZONTAL: 250 0 250 500 FT
VERTICAL: 50 0 50 100 FT

CLIENT	aps
PROJECT	CHOLLA COMPLIANCE SUPPORT
TITLE	CHOLLA BOTTOM ASH POND AND BOTTOM ASH MONOFILL SECTION A
DESIGNED BY JP	CHECKED BY DA	ISSUED FOR
DRAWN BY PM	APPROVED BY MH	FINAL

0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH / PM	FILENAME 2040-Cross Sections	FIGURE No. 2A	REV 0	PROJECT NO. 14-2018-2040

wood.

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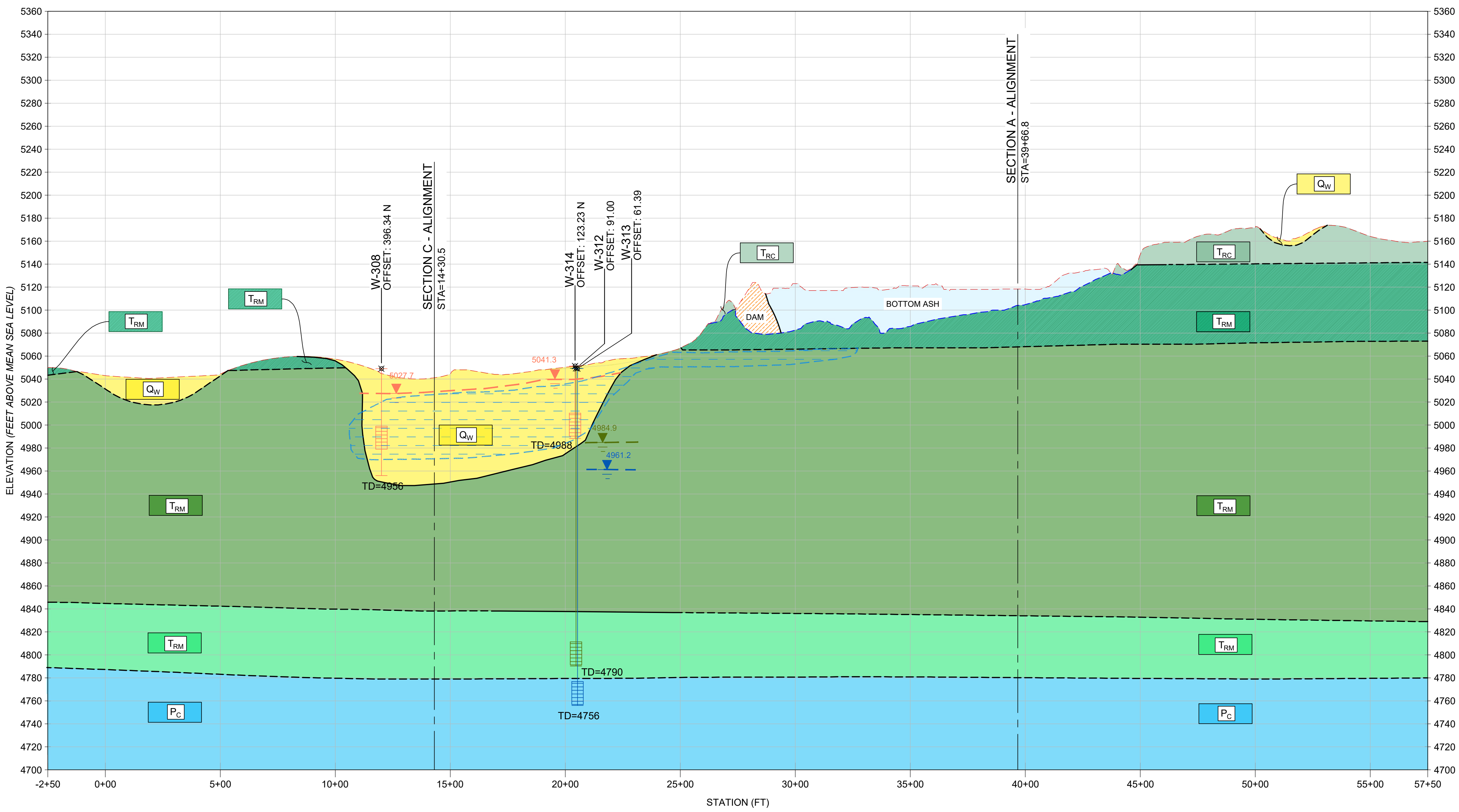

SECTION B
FIG 2

LEGEND:

EXISTING GROUND SURFACE
ORIGINAL GROUND SURFACE
CONTACT BETWEEN UNITS
CONTACT DASH WHERE INFERRED
MONITORING WELL OR PIEZOMETER
SCREEN INTERVAL
TD=4978 — TOTAL DEPTH
BORING
TD=4978 — TOTAL DEPTH

Q_W ALLUVIUM
T_{RC} CHINLE FORMATION
T_{RM} HOLBROOK (MEMBER OF MOENKOPI)
T_{RM} MOQUI (MEMBER OF MOENKOPI)
T_{RM} WUPATKI (MEMBER OF MOENKOPI)
P_C COCONINO SANDSTONE
DAM
BOTTOM ASH

APPROXIMATE EXTENT OF GROUNDWATER IMPACTS

WATER LEVEL APRIL, 2020
ALLUVIUM
WUPATKI (MEMBER OF MOENKOPI)
COCONINO SANDSTONE

POTENTIOMETRIC SURFACE
ALLUVIUM
WUPATKI (MEMBER OF MOENKOPI)
COCONINO SANDSTONE

HORIZONTAL
250 0 250 500 FT

VERTICAL
50 0 50 100 FT

CLIENT
aps

PROJECT
CHOLLA COMPLIANCE SUPPORT

TITLE
CHOLLA BOTTOM ASH POND
SECTION B

DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL

0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH / PM	FILENAME: 2040–Cross Sections	FIGURE No.: 2B	REV: 0	PROJECT NO.: 14–2018–2040

wood.

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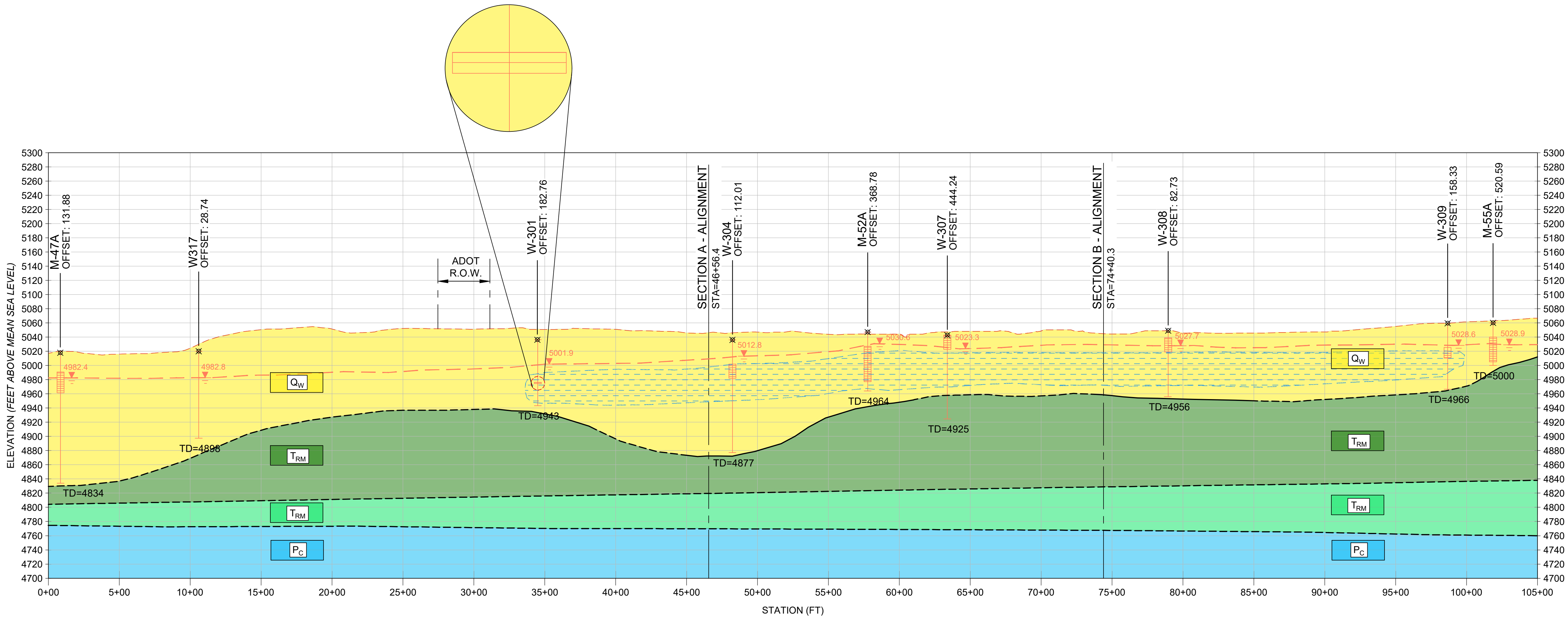

SECTION C
FIG 2

LEGEND:

- EXISTING GROUND SURFACE
- ORIGINAL GROUND SURFACE
- CONTACT BETWEEN UNITS
- CONTACT DASH WHERE INFERRED
- MONITORING WELL OR PIEZOMETER
- SCREEN INTERVAL
- TD=4978 TOTAL DEPTH
- BORING
- TD=4978 TOTAL DEPTH

- Q_W ALLUVIUM
- T_{RM} MOQUI (MEMBER OF MOENKOPI)
- T_{RM} WUPATKI (MEMBER OF MOENKOPI)
- P_C COCONINO SANDSTONE

- APPROXIMATE EXTENT OF GROUNDWATER IMPACTS

WATER LEVEL APRIL, 2020
- ALLUVIUM

POTENTIOMETRIC SURFACE
- ALLUVIUM

HORIZONTAL: 400 0 400 800 FT

VERTICAL: 80 0 80 160 FT

CLIENT	aps			
PROJECT	CHOLLA COMPLIANCE SUPPORT			
TITLE	CHOLLA BOTTOM ASH POND SECTION C			
DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL
FILENAME	2040–Cross Sections	FIGURE No. 2C	REV 0	PROJECT NO. 14–2018–2040

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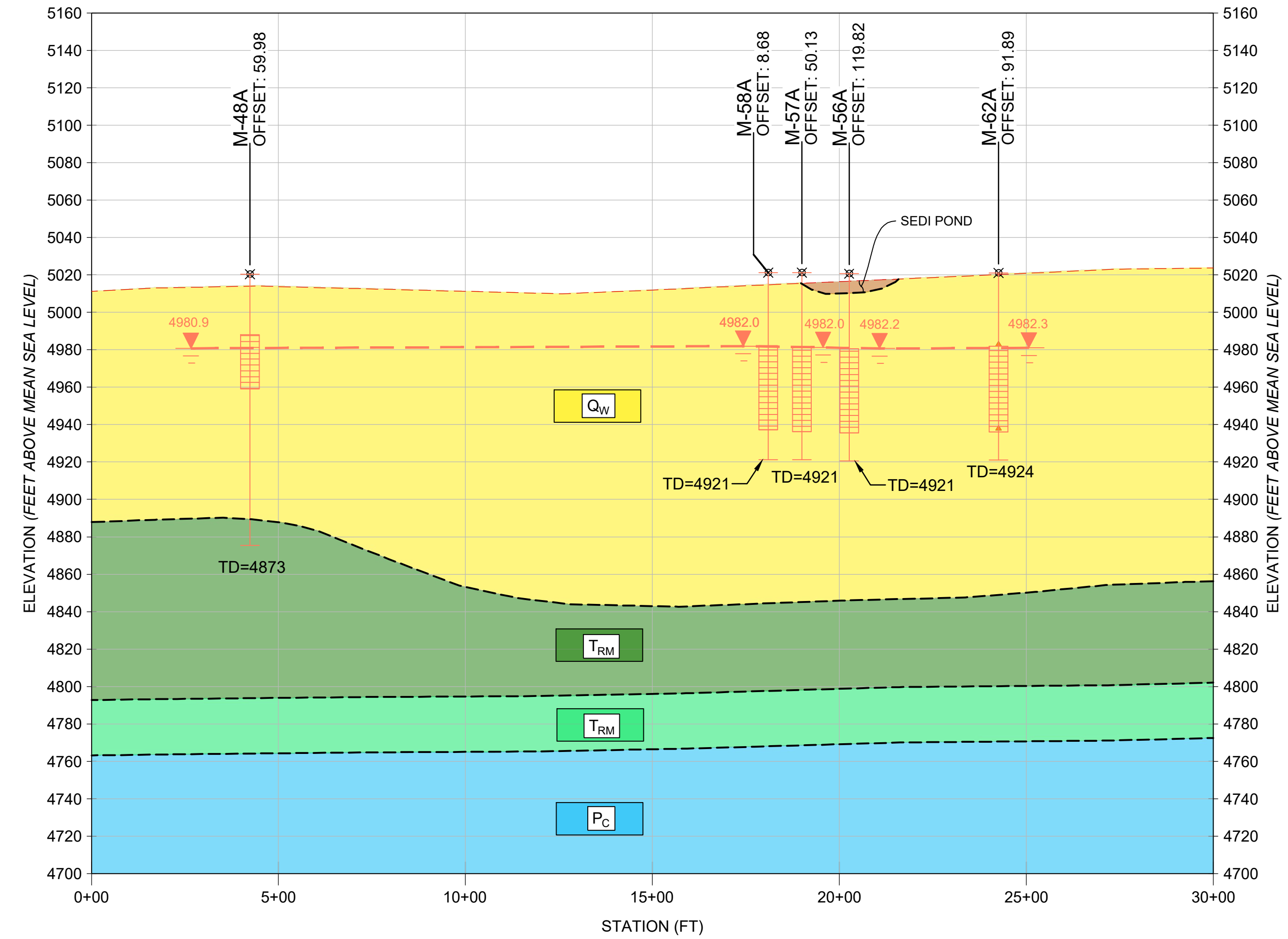

SECTION D
FIG 2D

LEGEND:

- EXISTING GROUND SURFACE
- CONTACT BETWEEN UNITS
- CONTACT DASH WHERE INFERRED
- MONITORING WELL OR PIEZOMETER
- SCREEN INTERVAL
- TD=4978 — TOTAL DEPTH
- BORING
- TD=4978 — TOTAL DEPTH

- Q_W ALLUVIUM
- T_{RM} MOQUI (MEMBER OF MOENKOPI)
- T_{RM} WUPATKI (MEMBER OF MOENKOPI)
- P_C COCONINO SANDSTONE
- SEDIMENT

WATER LEVEL APRIL, 2020

- ALLUVIUM

POTENTIOMETRIC SURFACE

- ALLUVIUM

HORIZONTAL: 250 0 250 500 FT

VERTICAL: 50 0 50 100 FT

CLIENT	aps	
PROJECT	CHOLLA COMPLIANCE SUPPORT	
TITLE	CHOLLA SEDI POND SECTION D	

DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL

REV	DATE	DESCRIPTION	BY		FILENAME	FIGURE No.	REV	PROJECT NO.
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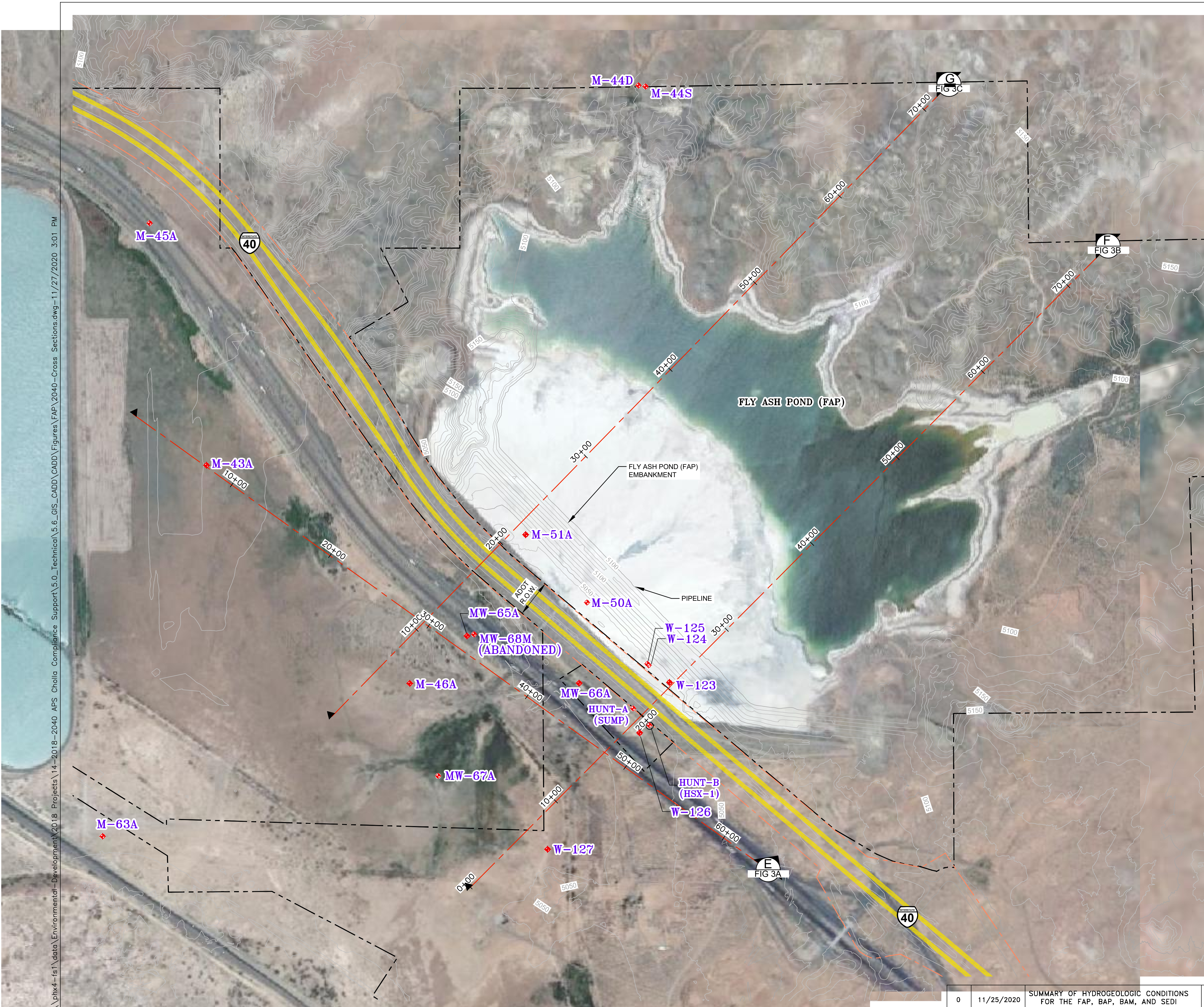
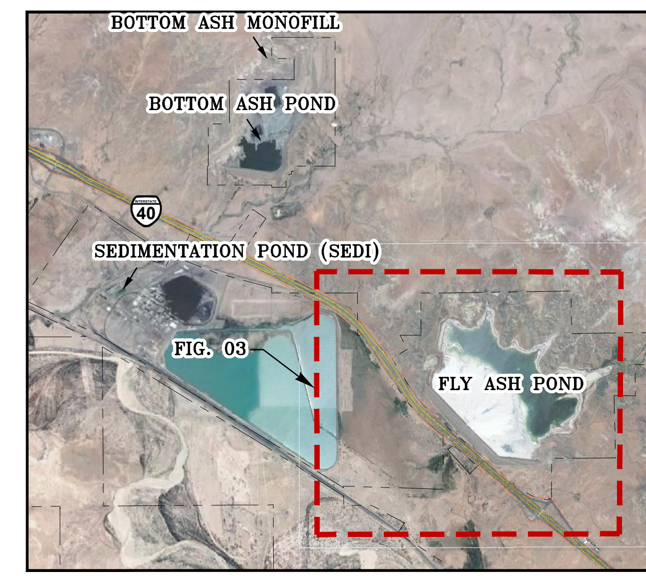
wood.



LEGEND:

- EXISTING GROUND SURFACE CONTOUR EL, FEET
- MONITORING WELLS
- EXISTING FENCE
- PROPERTY BOUNDARY
- ADOT RIGHT-OF-WAY

400 0 400 800 FT



SITE LOCATION MAP

3000 0 3000 6000 FT

CLIENT

aps

PROJECT

CHOLLA COMPLIANCE SUPPORT

TITLE

CHOLLA FLY ASH POND PLAN VIEW

DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL

0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH	PM

FILENAME	FIGURE No.	REV	PROJECT NO.
2040-Cross Sections	3	0	14-2018-2040

wood.

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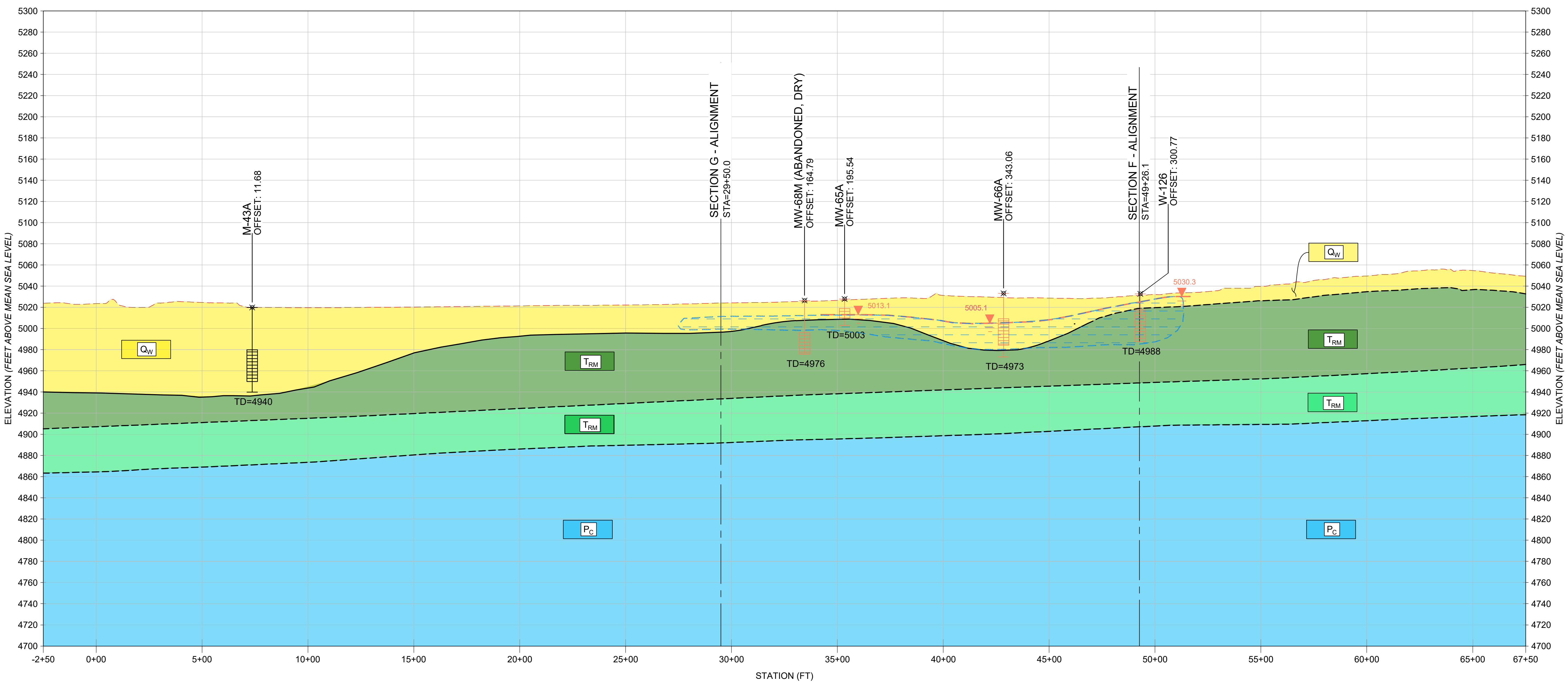


SECTION E
FIG 3

LEGEND:

- EXISTING GROUND SURFACE
- ORIGINAL GROUND SURFACE
- CONTACT BETWEEN UNITS
- CONTACT DASH WHERE INFERRED
- MONITORING WELL OR PIEZOMETER
- SCREEN INTERVAL
- TD=4978 — TOTAL DEPTH
- BORING
- TD=4978 — TOTAL DEPTH

- Qw ALLUVIUM
- TRM MOQUI (MEMBER OF MOENKOPI)
- TRM WUPATKI (MEMBER OF MOENKOPI)
- Pc COCONINO SANDSTONE

- APPROXIMATE EXTENT OF GROUNDWATER IMPACTS

WATER LEVEL APRIL, 2020
- ALLUVIUM
- MOQUI (MEMBER OF MOENKOPI)

POTENTIOMETRIC SURFACE
- ALLUVIUM
- MOQUI (MEMBER OF MOENKOPI)

HORIZONTAL: 250 0 250 500 FT
VERTICAL: 50 0 50 100 FT

CLIENT: aps

PROJECT: CHOLLA COMPLIANCE SUPPORT

TITLE: CHOLLA FLY ASH POND SECTION E

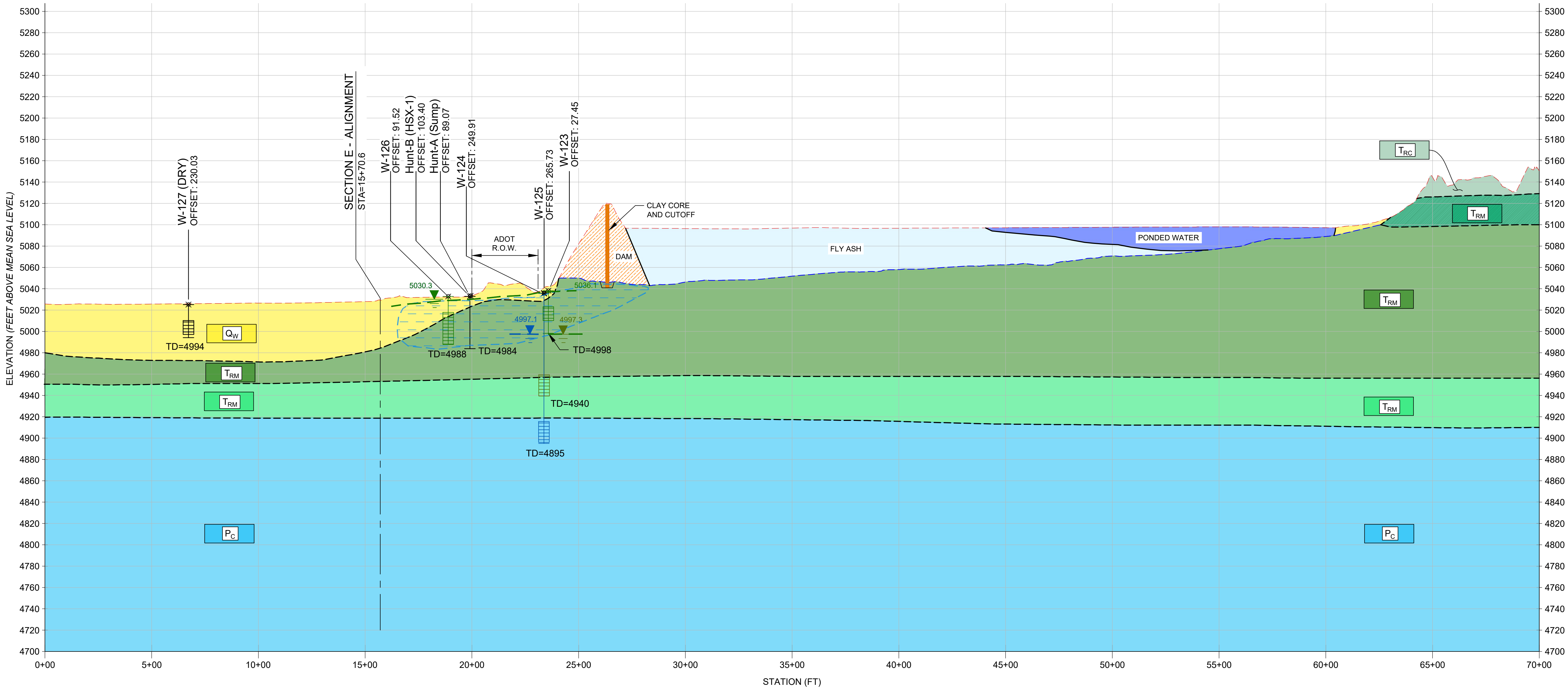
DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL

FILENAME	FIGURE No.	REV	PROJECT NO.
2040-Cross Sections	3A	0	14-2018-2040

0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH	PM

wood.

\\phx4-fs1\data\Environmental-Development\2018 Projects\14-2018-2040 APS Cholla Compliance Support\5.0_Technical\5.6_GIS_CADD\CADD\Figures\FAP\2040-Cross Sections.dwg-11/27/2020 3:51 PM



SECTION F
FIG 3

LEGEND:

- EXISTING GROUND SURFACE
- ORIGINAL GROUND SURFACE
- CONTACT BETWEEN UNITS
- CONTACT DASH WHERE INFERRED
- MONITORING WELL OR PIEZOMETER
- SCREEN INTERVAL
- TD=4978 — TOTAL DEPTH
- BORING
- TD=4978 — TOTAL DEPTH

- Q_W ALLUVIUM
- T_{RC} CHINLE FORMATION
- T_{RM} HOLBROOK (MEMBER OF MOENKOPI)
- T_{RM} MOQUI (MEMBER OF MOENKOPI)
- T_{RM} WUPATKI (MEMBER OF MOENKOPI)
- P_C COCONINO SANDSTONE
- DAM
- FLY ASH

- APPROXIMATE EXTENT OF GROUNDWATER IMPACTS

WATER LEVEL APRIL, 2020

- MOQUI (MEMBER OF MOENKOPI)
- WUPATKI (MEMBER OF MOENKOPI)
- COCONINO SANDSTONE

POTENTIOMETRIC SURFACE

- MOQUI (MEMBER OF MOENKOPI)
- WUPATKI (MEMBER OF MOENKOPI)
- COCONINO SANDSTONE

HORIZONTAL: 250 0 250 500 FT

VERTICAL: 50 0 50 100 FT

CLIENT	aps			
PROJECT	CHOLLA COMPLIANCE SUPPORT			
TITLE	CHOLLA FLY ASH POND SECTION F			
DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL
FILENAME	2040-Cross Sections	FIGURE No. 3B	REV 0	PROJECT No. 14-2018-2040

0	11/25/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH	PM

wood.

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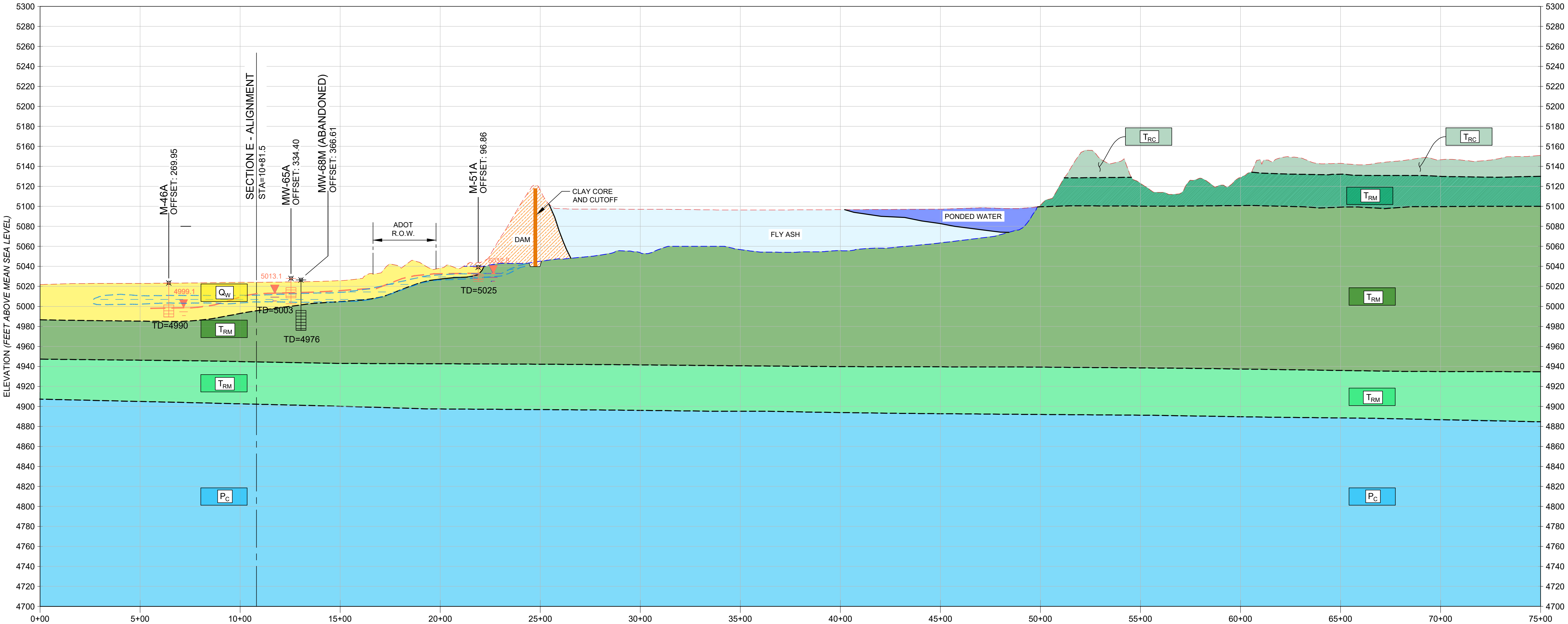

SECTION G
FIG 3

LEGEND:

- EXISTING GROUND SURFACE
- ORIGINAL GROUND SURFACE
- CONTACT BETWEEN UNITS
- CONTACT DASH WHERE INFERRED
- MONITORING WELL OR PIEZOMETER
- SCREEN INTERVAL
- TD=4978 — TOTAL DEPTH
- BORING
- TD=4978 — TOTAL DEPTH

- Qw — ALLUVIUM
- TRC — CHINLE FORMATION
- TRM — HOLBROOK (MEMBER OF MOENKOPI)
- TRM — MOQUI (MEMBER OF MOENKOPI)
- TRM — WUPATKI (MEMBER OF MOENKOPI)
- PC — COCONINO SANDSTONE
- DAM
- FLY ASH

- APPROXIMATE EXTENT OF GROUNDWATER IMPACTS

WATER LEVEL APRIL, 2020

- ALLUVIUM
- MOQUI (MEMBER OF MOENKOPI)

POTENTIOMETRIC SURFACE

- ALLUVIUM
- MOQUI (MEMBER OF MOENKOPI)

HORIZONTAL: 250 0 250 500 FT

VERTICAL: 50 0 50 100 FT

0	11/22/2020	SUMMARY OF HYDROGEOLOGIC CONDITIONS FOR THE FAP, BAP, BAM, AND SEDI	MH	PM

CLIENT: aps

PROJECT: CHOLLA COMPLIANCE SUPPORT

TITLE: CHOLLA FLY ASH POND SECTION G

DESIGNED BY	JP	CHECKED BY	DA	ISSUED FOR
DRAWN BY	PM	APPROVED BY	MH	FINAL

FILENAME	FIGURE No.	REV	PROJECT NO.
2040–Cross Sections	3C	0	14–2018–2040

wood.

wood.

ASSESSMENT OF CORRECTIVE MEASURES
FOR THE FLY ASH POND AND THE BOTTOM ASH POND
Coal Combustion Residuals Rule and Aquifer Protection Permit Compliance
Arizona Public Service Company
Cholla Power Plant
Navajo County, Arizona

Submitted to:
Arizona Public Service
400 North 5th St.
Phoenix, Arizona 85004

Prepared by:
Wood Environment & Infrastructure Solutions, Inc.
Phoenix, Arizona

Registered Professional Engineer (Civil)
CERTIFICATE NO.
31672
N. CHRISMAN LAZARR
Date Signed 14June19
ARIZONA U.S.A.
Expires 09/30/2021

June 14, 2019

Project No. 14-2018-2040

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
31672
N. CHRISMAN
LAZARR
Date Signed 14 JUNE 19
ARIZONA U.S.A.
Expires 09/30/2021

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

§	Section
ASD	Alternative Source Demonstration
AMEC	AMEC Environment & Infrastructure, Inc.
Amec Foster Wheeler	Amec Foster Wheeler, Environment & Infrastructure, Inc.
amsl	above mean sea level
APP	Aquifer Protection Permit
APS	Arizona Public Service Company
AWQS	Aquifer Water Quality Standard
BAP	Bottom Ash Pond
BAM	Bottom Ash Monofill
BTV	background threshold value
CCR	coal combustion residuals
Cholla	Cholla Power Plant
CFR	Code of Federal Regulations
CM(s)	corrective measure(s)
COC(s)	constituent(s) of concern
CSM	conceptual site model
FAP	Fly Ash Pond
ft	foot, feet
GWPS(s)	Groundwater Protection Standard(s)
HDPE	high density polyethylene
I-40	Interstate 40
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
POC	Point of Compliance
SEDI	Sedimentation Pond
SSI	statistically significant increase
SSL	statistically significant level
TDS	total dissolved solids
US EPA	United States Environmental Protection Agency
Wood	Wood Environment & Infrastructure Solutions, Inc.

1.0 INTRODUCTION

On behalf of Arizona Public Service Company (APS), Wood Environment & Infrastructure Solutions, Inc. (Wood) prepared this report documenting an Assessment of Corrective Measures (CMs) for two existing coal combustion residuals (CCR) units located at the Cholla Power Plant (Cholla) near Joseph City, Arizona (the Site).

The CM assessment documented herein was conducted in accordance with 40 Code of Federal Regulations (CFR) Part 257 (herein referred to as the CCR Rule; Federal Register, 2018) to support future selection of remedies for groundwater impacts. The CCR Rule became effective on October 19, 2015 and established standards for the disposal of CCR in landfills and surface impoundments at applicable sites. APS has conducted CCR Rule groundwater compliance activities at the Site and performed statistical assessments of collected groundwater data. Based on the results of these statistical evaluations, there is evidence to suggest that releases from the Site Fly Ash Pond (FAP) and Bottom Ash Pond (BAP) have impacted downgradient groundwater at concentrations that exceed applicable Groundwater Protection Standards (GWPSs) and require corrective action.

At present, discharging facilities at Cholla are also regulated under Arizona Aquifer Protection Permit (APP) regulations. Since June of 2017, fluoride concentrations monitored at an APP compliance well downgradient of the FAP have exceeded the permitted alert level for this constituent. It is the intent of this CM assessment to concurrently address the requirements of Site APP P-100568 by identifying the extent of fluoride impacts in the alluvial aquifer downgradient of the FAP and presenting an assessment of CMs to address fluoride releases from the FAP.

The remainder of this section (Section 1.0) provides a summary description of the power generating facility, Site CCR units, the facility's environmental setting, and groundwater compliance activities conducted at the Site to date which form the basis for this CM assessment. Section 2.0 identifies the nature and extent of the constituents of concern (COCs) by unit with documentation of unit-specific conditions affecting CM assessment. Section 3.0 defines the objective of CMs, screens applicable technologies, develops alternatives for evaluation and documents a CM assessment for each unit. Future requirements for remedy selection are listed in Section 4.0. Section 5.0 presents report references.

1.1 Site Background

1.1.1 <u>Facility and CCR Unit Descriptions</u>

Facility Description. Cholla is an operating power plant owned by APS and PacifiCorp. The plant burns coal in three electrical generating units (Units 1, 3, and 4) and has a net generating capacity of 767 megawatts. Unit 2 was retired in October of 2015.

Coal burned at the plant was previously sourced from the McKinley Mine in New Mexico. When the McKinley Mine closed in 2009, the source of coal switched to the Lee Ranch and El Segundo mines near Grants, New Mexico.

Coal combustion power generating operations at Cholla are scheduled to cease in 2025.

Facility Location. The plant and associated infrastructure are located on land owned/leased by APS adjacent to Interstate 40 (I-40) between the City of Winslow and the City of Holbrook in Navajo County, Arizona (Figure 1-1). The plant sits next to the Cholla Reservoir, a cooling pond and water storage reservoir that was originally constructed in the early 1900s by the Joseph City Irrigation Company (Shilling, 2005). Now used by APS for cooling water, Cholla Reservoir receives deliveries of groundwater pumped from the nearby Cholla Well Field extracting from the Coconino Sandstone Aquifer. The typical water surface elevation of Cholla Reservoir is 5,022 feet (ft) above mean sea level (amsl).

CCR Unit Descriptions. Plant infrastructure includes four single CCR units referred to as the FAP, BAP, Bottom Ash Monofill (BAM), and Sedimentation Pond (SEDI). All the CCR units except the SEDI are located north of I-40 (Figure 1-2). The SEDI was the first of the CCR Units placed into service in 1976. The FAP and BAP dams were completed in 1978, and the BAM came into operation in the late 1990s. Table 1-1 summarizes the location, function, operation, size/construction, and history of each unit. The boundaries of CCR units depicted in Figure 1-2 are based on available historical plans for the units. Figure 1-3 identifies the ownership of property in the vicinity of Site CCR units.

1.1.2 Environmental Setting

Unless otherwise noted, the following information is abstracted from Montgomery & Associates (2011), Montgomery & Associates (2017), and AMEC Environment & Infrastructure, Inc. (AMEC, 2012).

Climate. The plant is located in an arid climate within the Little Colorado River Basin. The area receives an average of 6 to 12 inches of precipitation annually. The evaporation rate exceeds the rate of precipitation by an order of magnitude.

Topography. Cholla is located at an elevation of approximately 5,025 ft amsl in the Colorado Plateau physiographic province of northeastern Arizona. This area is characterized by canyons, high elevations, and narrow, widely-spaced riverbeds. The topography of the plant area is characterized by rolling terrain, open vistas, and incised drainages/arroyos. In the vicinity of the plant, the ground surface gently slopes towards the Little Colorado River to the south at approximately 60 ft per mile; however, surface drainage immediately near Cholla Reservoir flows towards the reservoir. About two miles north and south of the plant, the ground surface rises out of the alluvial floodplain to an elevation of 5,100 to 5,200 ft amsl.

Surface Water Hydrology. The plant is located north of the Little Colorado River within the Middle Little Colorado watershed. The Little Colorado River is a meandering, intermittent stream with a large alluvial floodplain.

Two of the Site CCR units, the FAP and BAP, are located within ephemeral tributaries to the Little Colorado River (Figure 1-2). An unnamed wash system with a drainage basin of approximately 1,200 acres discharges into the FAP. The BAP is located within a tributary to Tanner Wash.

Site Geology. The Colorado Plateau, on which the plant is located, is typified by horizontal layered sequences of sedimentary rock, primarily sandstones, siltstones, and claystones. At the plant and nearby CCR units, the geologic units that are expected to influence groundwater flow and contribute to variations in naturally occurring constituent concentrations across the site are as follows (in descending order):

- **Little Colorado River and Tanner Wash Alluviums**: These quaternary surface alluviums overlie the bedrock formations in localized areas at Cholla and surrounding CCR units. The alluvium is unconsolidated, heterogeneous, and consists of clay, silt, sand, and gravel. In general, the Tanner Wash Alluvium is finer-grained than the Little Colorado River Alluvium. The alluvium ranges in thickness from non-existent to approximately 200 ft, and in general is thickest underneath the plant and Cholla Reservoir. A lower permeability layer of fine grained alluvial materials underlies the

Cholla Reservoir and limits leakage from the reservoir to the underlying alluvial aquifer. Around the CCR units, the alluvium ranges from approximately 50 ft thick in the vicinity of the FAP Dam to 100 ft thick in the vicinity of the BAP Dam.

- **Chinle Formation**: An outcropping of the Chinle Formation of Triassic age is present in the vicinity of the BAP. The Chinle is divided into the Shinarump and Petrified Forest Members. In this area, the Shinarump Member is present and mostly a yellowish-orange to yellowish-gray sandstone that is composed of very fine to very coarse quartz grains and rounded to well-rounded pebbles. The member is, for the most part, weakly cemented and forms slopes. Typically, the surface is soft, and covered with well-rounded pebbles of quartzite, jasper and chert.
- **Moenkopi Formation**: The Moenkopi Formation is the uppermost geologic unit beneath the plant and the CCR units and is present at land surface in areas where the alluvium is non-existent. The thickness of the Moenkopi Formation near the plant ranges from non-existent to over 300 feet thick; where it is sufficiently thick, the Moenkopi Formation acts as an aquitard between the shallow alluvial aquifer and the underlying Coconino Sandstone Aquifer. The Moenkopi Formation consists of three members, described below:
  - Holbrook Member: This member is composed of pale-red, thin to thick bedded sandstone. It is made up of medium to very fine poorly sorted sand and contains considerable silt. It is relatively permeable. In the area northwest of Tanner Wash near the BAP (which is the only region it is known to be present near the plant), the sandstone is overlain by about 30 ft of reddish-brown, thin-bedded mudstone and siltstone. This unit is generally a 40- to 50-ft thick member of the Moenkopi.
  - Moqui Member: This member is composed of pale-brown to reddish-brown gypsiferous mudstone and siltstone beds. It contains an abundance of gypsum nodules, stringers and layers. It contains thin bands composed of greenish-gray and dark yellow siltstone. The beds are lenticular and sharply defined channels are present. This unit is generally a 250- to 300-ft thick member of the Moenkopi although it is observed to be only 22 ft thick on the south side of the FAP at W-125.
  - Wupatki Member: This member consists of a lower sequence of pale-reddish-brown, thin-bedded siltstone with a few feet of yellowish-gray to almost white thin-bedded sandstone and mudstone at the base. An upper sequence consists of a grayish red to reddish-brown, very fine to fine-grained sandstone with minor amounts of silt. The sandstone in this unit can be in hydraulic connection with the underlying Coconino Sandstone. The Wupatki member is generally a 30- to 50-ft thick member of the Moenkopi.
- **Coconino Sandstone**: The Permian-age Coconino Sandstone is the principal lithologic unit of the C-aquifer, a regionally important aquifer for water supply. It is composed of very fine- to medium-grained, well-sorted, rounded to subangular quartz grains cemented commonly with silicious cement. The sandstone has variable permeability depending on the degree of fracturing and cementation. It is very pale orange to almost pure white in color. The unit is approximately 375 to 400 ft thick in the vicinity of the plant.
- **Schnebly Hill Formation**: The Schnebly Hill Formation is a very fine-grained, reddish sandstone that is about 300 to 350 ft thick near the plant. It is part of the C-aquifer, but its hydraulic conductivity is about 10 to 28 percent that of the Coconino Sandstone.
- **Supai Formation**: The Pennsylvanian to Lower Permian Supai Formation underlies the Coconino Sandstone. It has minimal impact on the surface operations of Cholla, other than containing an

approximately 600-ft thick deposit of halite and anhydrite in the Cholla well field area that impacts groundwater quality both regionally and in the vicinity of the plant.

Applicable Hydrostratigraphy. Two important hydrostratigraphic units are conceptualized beneath the plant and associated CCR units. These units form the basis for the hydrogeologic Conceptual Site Model (CSM) developed by Montgomery & Associates (2011 and 2017) for the purpose of evaluating point of compliance wells (POC) for Cholla's APP and the CCR Groundwater Monitoring System.

The first hydrogeologic unit, the Little Colorado River and Tanner Wash Alluvial Aquifers, is present under the plant area, Cholla Reservoir, and the Tanner Wash and Little Colorado River drainage channels. The alluvial aquifer in this area receives recharge from the Little Colorado River and any leakage through anthropogenic features such as the reservoir and the nearby Joseph City Canal. The alluvial aquifer is not used as a drinking water supply but does support a riparian habitat. Depth to water in the alluvial aquifers ranges from several feet to several tens of feet below land surface in the Cholla area, varying spatially based on proximity to recharge sources and topography and seasonally based on rainfall-runoff patterns. Where present, groundwater flows generally in the downstream direction of the drainages under which it is present, that is, from east to west in the Little Colorado River alluvium and from north to south in the Tanner Wash alluvium. Groundwater flow in the Little Colorado River alluvial aquifer is also influenced by deeper paleochannels that may not coincide with the present river channel.

The second hydrogeologic unit is the C-aquifer, which consists of the Coconino Sandstone and Schnebly Hill Formation in the vicinity of the plant. Groundwater in this aquifer is under confined conditions in areas north of the Little Colorado River where sufficiently thick layers of the Moenkopi Formation's Moqui member acts as a confining bed. Groundwater movement in the C-aquifer is generally to the north. However, the Cholla well field (southwest of the plant) has created a cone of depression that has made the groundwater flow in a westerly direction in that area. Near the FAP, the inferred flow of the groundwater in the C-aquifer is to the west or southwest, possibly due to the broad, northwest-trending anticline that extends from the vicinity of the FAP to near Joseph City.

The alluvial aquifer and the C-aquifer are generally separated by the Moenkopi Formation, a regional aquitard that creates a barrier between the two aquifers in the vicinity of Cholla. In areas where the C-aquifer in the Coconino Sandstone is confined (primarily north of the Little Colorado River), the Wupatki member of the Moenkopi has been observed to be water-bearing; however, the Moqui member, which can be 250 to 300 feet thick in the vicinity of the plant, limits hydraulic connection between the alluvial aquifer and the C-aquifer.

Ambient Groundwater Quality. Ambient groundwater quality has been characterized in several previous reports (Sergent, Hauskins, & Beckwith, 1973; Woodward-Clyde, 1991; Montgomery & Associates, 2011, 2017, and 2018; and AMEC, 2012). In general, early data from the Site suggest that background water quality in the Little Colorado River alluvium is variable and possibly fairly poor due to elevated total dissolved solids (TDS) concentrations (Sergent, Hauskins, & Beckwith, 1973; Montgomery & Associates, 2017). Near the BAP and the FAP, background water quality has naturally elevated concentrations of TDS and sulfate due to interaction with the Moqui member of the Moenkopi, which has gypsum stringers and an overall sulfate mineralogy (Montgomery & Associates, 2017; Woodward-Clyde, 1991). High nitrate concentrations observed in monitoring wells around the BAP are suspected to be naturally occurring (Woodward-Clyde, 1991). Background water quality in the alluvial aquifer improves near the Little Colorado River, as concentrations of TDS tend to decline.

Groundwater in the Wupatki member of the Moenkopi contains relatively high concentrations of TDS compared to what is found in the Coconino Sandstone in the same location. Background water quality in the Coconino Sandstone is variable. TDS concentrations can vary from less than 500 milligrams per liter (mg/L) in the area south of the Little Colorado River to over 60,000 mg/L in the area north of the Little Colorado River. The adverse impacts to groundwater quality are thought to be due to upward leakage of saline groundwater from the underlying Supai formation (Montgomery & Associates, 2017). In general, water quality in the Coconino Sandstone is better than that of groundwater found in the alluvium or the Moenkopi, and regionally the C-aquifer is a valuable drinking water resource.

1.2 Basis for Corrective Measures Assessment

As indicated earlier in this report, Cholla is currently regulated under both the Federal CCR Rule and Arizona's APP program. The following sections present the basis for the evaluation of CMs presented in this report which include both the statistical assessment activities conducted to comply with the CCR Rule and the results of groundwater monitoring required by the Site APP.

1.2.1 Statistical Assessment of Collected CCR Monitoring System Data

The groundwater monitoring and corrective action process defined in the CCR Rule includes a phased approach to groundwater monitoring for each CCR unit:

- Detection Monitoring: This groundwater monitoring phase focuses on a set of constituents (listed in Appendix III of the CCR Rule) that are relatively mobile components of CCR and therefore represent indicators of possible impacts from CCR in groundwater. If statistical significant increases (SSIs) of any of the Appendix III constituents relative to background conditions are detected in the downgradient waste boundary wells, and cannot be demonstrated to be associated with a source other than the CCR unit, then groundwater monitoring moves into assessment monitoring.
- Assessment Monitoring: This groundwater monitoring phase focuses on the constituents listed in Appendix IV of the CCR Rule. The Appendix IV constituents are generally less mobile and occur at lower concentrations in groundwater than the Appendix III constituents. Concentrations of Appendix IV constituents in downgradient wells are compared to GWPSs. The GWPSs, established for Appendix IV constituents only, are the higher of either the Federal Safe Drinking Water Act Maximum Contaminant Level (MCL), an alternative risk-based GWPS identified in the CCR Rule, or a statistically-driven background threshold value for each constituent.
- Groundwater Characterization and Corrective Action Assessment: If exceedances of the GWPSs are determined to be occurring in the downgradient boundary wells at statistically significant levels (SSLs) and no alternative sources for the exceedances can be demonstrated, then both additional groundwater characterization and assessment of corrective actions are initiated. Following assessment of corrective measures, a remedy (or set of remedial activities) is selected and implemented as the groundwater corrective action program for the CCR unit. According to the CCR Rule, groundwater corrective action will continue until compliance with the GWPSs has been attained in all impacted wells, and sustained for a period of three consecutive years

APS initiated CCR groundwater detection monitoring at Cholla in November 2015 and completed collection of at least eight initial rounds of monitoring at all wells in October 2017, in accordance with the CCR Rule. Statistical analysis of Appendix III constituent data collected during detection monitoring was completed in January 2018 and updated in May 2018. The analysis concluded that there is enough evidence to declare an SSI over background for one or more Appendix III constituents at the FAP, BAP and SEDI (Montgomery & Associates, 2018).

On the basis of this analysis, assessment monitoring was initiated at these CCR units and a statistical evaluation of Appendix IV constituent monitoring data was conducted. Table 1-2 summarizes GWPSs derived for each constituent by unit and identifies constituents and wells at which SSLs of the constituent over GWPSs have been reported. As indicated, there was sufficient evidence to declare GWPS exceedances for arsenic, cobalt fluoride, lithium, and molybdenum downgradient of the FAP (Wood, 2018a) and cobalt and lithium downgradient of the BAP (Wood, 2018b). No GWPS exceedances were declared for the SEDI (Wood, 2019a).

1.2.2 APP Alert Level Exceedances

The FAP has one alluvial POC well (W-126), a set of paired Moenkopi Wupatki/Coconino Sandstone POC wells (W-124 and W-125), and a Coconino Sandstone POC well (M-44D) that are monitored annually. W-126 is monitored for fluoride, nitrate, nitrite, pH, sulfate, TDS, boron, lead, cadmium, thallium, and total chromium. W-124, W-125, and M-44D are monitored for the same constituents at W-126 plus chloride. The results of monitoring show that average concentrations of monitored constituents in M-44D, W-124, and W-125 are less than respective alert levels. Average concentrations of monitored constituents in W-126 are less than respective alert levels with the exception of fluoride.

Concentrations of fluoride at W-126 have exceeded the permitted alert level of 3.2 mg/L since June of 2017, triggering monthly sampling of W-126 that continues to date. Some of the monthly samples have had fluoride concentrations above the Arizona Aquifer Water Quality Standard (AWQS) of 4.0 mg/L.

2.0 NATURE AND EXTENT OF COCS

This section presents the current understanding of site conditions relevant to an assessment of CMs for the FAP and BAP based on Site information available through April 2019. Unit-specific CSMs are presented to integrate unit construction/operation, hydrogeologic conditions, observed COC concentration distributions, and potential COC migration pathways. These summary CSMs were developed to assist in developing and evaluating CMs in Section 3.0.

2.1 Fly Ash Pond

Figure 2-1 shows relevant FAP infrastructure including the layout of the dam and locations of existing seepage intercept systems and groundwater monitoring wells completed in the alluvium, which is the uppermost aquifer underlying the FAP per the CCR groundwater monitoring system certification report (Montgomery & Associates, 2017).

Figures 2-2 through 2-6 present iso-concentration contour maps for fluoride, arsenic, cobalt, lithium, and molybdenum at the FAP, respectively, based on the results of monitoring well installation activities and groundwater sampling conducted from October 2018 through March 2019 during a *Hydrogeologic Investigation of the FAP and BAP* (Wood, 2019b). The extent of impact is defined by the respective COC GWPSs. Table 2-1 summarizes concentrations of COCs and select water quality parameters in samples collected from the FAP and downgradient groundwater monitoring wells during the Hydrogeologic Investigation and the first CCR assessment monitoring event of 2019.

Table 2-2 presents chemical properties impacting the mobility of Site COCs in aquifer environments.

2.1.1 <u>Characterization</u>

Key points of the summary CSM for the FAP are as follows:

- The FAP dam was constructed approximately 40 years ago on alluvial and Moenkopi Moqui geologic units within an unnamed wash system that previously discharged to the Little Colorado River alluvium.
- The FAP dam has a clay core and an underlying slurry cutoff wall that extends one foot into the Moenkopi Moqui or two feet into stiff clay along the centerline of the dam where the alluvium prior to dam construction was greater than 20 ft thick. Where the alluvium was less than 20 ft thick, no cutoff wall was constructed and the clay core was extended through the alluvium to the top of the Moenkopi Moqui bedrock. As a result, the slurry cutoff wall is only located in the middle portion of the dam and the extended clay core is located on the edges of the dam (Figure 2-1).
- The alluvium within the footprint of the FAP had minimal quantities of groundwater prior to the construction and operation of the FAP; furthermore, pre-construction boreholes advanced (in support of dam design) within the footprint of the FAP in the Moenkopi Moqui did not generally encounter groundwater prior to construction and operation of the FAP.
- Site investigations and evaluations to support design of the dam concluded that the alluvium has a relatively low permeability for alluvial materials due to the presence of silt and clay in the formation; the underlying Moenkopi Moqui is understood to have a low vertical permeability, but could possibly have a higher lateral secondary permeability through bedding planes, fractures, joint structures, and the presence of gypsum nodules, stringers and layers.

- Following dam construction, fourteen piezometers were drilled and screened in the Moenkopi Moqui downgradient of the dam to monitor dam stability. During drilling in 1979, none of the piezometers encountered groundwater. As of late 2018, all but two of the piezometers downgradient of the dam that are screened in the Moenkopi Moqui have measurable water levels. Piezometers screened downgradient of the FAP dam in the Moenkopi Moqui have approximately 30 to 50 feet of head and monitored levels appear to fluctuate with long-term water level trends in the FAP suggesting a hydraulic connection between the FAP and the Moenkopi Moqui in the vicinity of the dam.
- Cross-section A-A', through a portion of the FAP dam where the clay core extends to the Moenkopi Moqui (Figure 2-7), depicts the current inferred piezometric surface through the dam and relevant geologic units. Figure 2-7 also shows the relative thicknesses of geologic units in the vicinity of the dam. Downgradient of the dam and north of I-40, the depth of alluvium is thin, ranging from not present at the dam abutments to approximately 50 ft thick near the center of the dam. The thickness of the Moenkopi Moqui is less defined but is inferred to be approximately 20 to 45 ft thick in the vicinity of the dam based on the boring log for Coconino monitoring well W-125 (located near alluvial monitoring well W-123) and piezometer well logs, respectively.
- As depicted in Figure 2-1, the potentiometric surface for wells and piezometers screened in the alluvium and the Moenkopi Moqui indicate a significant drop in pressure head across the zone with the slurry cutoff wall, but higher heads at the edges of the dam where there is no cutoff wall. This observation suggests that seepage through or under the dam is more significant where the slurry cutoff wall is not present.
- Iso-concentration maps for FAP COCs fluoride, lithium, and molybdenum depict higher concentrations of these constituents in the alluvium downgradient of the dam where the cutoff wall is not present (Figures 2-2, 2-5, and 2-6). This observation suggests that the presence of the cutoff well mitigates seepage of COC mass from the FAP to the alluvial aquifer.
- Groundwater monitoring data indicate that significant attenuation in COC concentrations occurs between the FAP and downgradient unit boundary monitoring wells M-50A, M-51A, and W-123. Attenuation factors (the ratio of the concentration in the well to the concentration in the FAP) for fluoride and lithium (i.e., constituents that are less likely to participate in adsorption, precipitation or reaction attenuation mechanisms per Table 2-2) range from 0.03 to 0.17 based on recent data (Table 2-1). Groundwater quality observations in downgradient wells after an increase in FAP fluoride concentrations (resulting from the shutdown of the Cholla Plant Unit 2 in October 2015) suggest that corresponding increases in downgradient well fluoride concentrations were relatively immediate (within a year) and that concentrations quickly stabilized to current levels thereafter. These observations suggest that in the vicinity of the dam, migration of contaminants to unit boundary monitoring wells may be influenced by preferential flow paths through or under the dam.
- The distribution of fluoride, lithium and molybdenum exceeding respective GWPSs is similar but not the same. Fluoride concentrations that exceed the GWPS extend southwest from the dam to the west of the slurry cutoff wall (Figure 2-2) and appear to predominantly remain on APS property or I-40 right of way. Lithium concentrations that exceed the GWPS (Figure 2-5) are present across the entire extent of the alluvium downgradient of the dam and extend under I-40 right of way onto property owned by both APS and the Hunt Family. Molybdenum concentrations that exceed the GWPS (Figure 2-6) are predominantly confined to the region near and downgradient of the Geronimo seep which extends under I-40 right of way, APS property and property owned by the Hunt Family.

- Groundwater monitoring conducted after declaring SSLs of arsenic and cobalt over respective GWPSs indicates that the presence of these constituents in groundwater downgradient of the FAP is likely not associated with leakage of COC mass from the FAP. The distributions of arsenic and cobalt in the aquifer downgradient of the FAP (Figures 2-3 and 2-4) are not consistent with the distribution of other FAP COCs (i.e., fluoride, lithium, molybdenum) or boron, which has been used to indicate the presence of CCR at the Site. Arsenic is a naturally occurring constituent in soil and groundwater and observed variations could be associated with the heterogeneity of arsenic-containing minerals in a depositional environment (i.e., alluvial drainage system). Cobalt is not routinely present at concentrations exceeding the GWPS in downgradient monitoring wells and was likely identified as a COC based on a false positive SSL during the initial statistical analysis of Appendix IV data (Wood, 2018a). Section 4.1 presents planned activities supporting remedy selection; preparation of Alternative Source Demonstrations (ASDs) for these constituents is included.

2.1.2 Remedial Efforts Conducted to Date

Three seepage collection systems have been installed in the vicinity of the FAP to address observed seepage at ground surface (Figure 2-1). The seepage collection systems include the:

1. Geronimo Seepage Intercept System;
2. Hunt Seepage Intercept System; and
3. I-40 Seepage Intercept System.

Geronimo Seepage Intercept System. The Geronimo Seepage Intercept System was installed in 1993 in the vicinity of alluvial monitoring well W-123, which is screened from 14 to 29 ft bgs. The seepage intercept system consists of two shallow sumps approximately 10 ft deep and two pumping wells that are approximately 40 ft deep. The wells and the sumps are screened in the alluvium. In the past, flow from the Geronimo Seepage Intercept System was collected and pumped back to the FAP; however, collected seepage water is currently returned to the plant. The average pumping rate of the Geronimo Seepage Intercept System over the past five years ranges from near zero to 50 gallons per minute (gpm). The average pumping rate from the Geronimo Seepage Intercept System has declined concurrent with recent efforts to promote decreases in the water level elevation at the FAP (see Section 2.1.3).

Hunt Seepage Intercept System. The Hunt Seepage Intercept System has been in operation since at least 1995 and is located south of I-40 in the vicinity of alluvial monitoring well W-126, which is screened from 12 to 50 ft bgs. The seepage intercept system consists of a 461-ft long seepage collection trench that is less than 10 ft deep which is sloped to a dewatering sump at the western end of the trench. A 49-ft deep dewatering well (HSX-1) is also present south of the trench and northeast of W-126. The HSX-1 pump is set to pump when groundwater is between 23 and 43 ft bgs. The average pump rate of the Hunt Seepage Intercept System over the past five years ranges from zero to 15 gpm.

I-40 Seepage Intercept System. The I-40 Seepage Intercept System was installed in 1993 downgradient of the right abutment of the FAP. The seepage intercept system consists of approximately 200 ft of perforated high density polyethylene (HDPE) pipe buried close to 1 ft bgs, which connects to approximately 415 ft of unperforated HDPE pipe sloped to drain to a shallow, unlined evaporation pond (approximately 100-ft by 200-ft in area). According to Site operating records, no notable seepage flow has reported to the evaporation pond since monitoring of the I-40 Seepage Intercept System began.

2.1.3 Unit Closure Planning

As indicated in Section 1.1.1, coal combustion power generating operations at Cholla are scheduled to cease in 2025. APS has recently been limiting discharges to the FAP with water conservation measures to promote dewatering of the FAP in advance of unit closure. The water elevation has decreased from approximately 5098 to 5089 ft amsl since 2016.

The closure plan for the FAP includes closure of the unit by leaving the CCR in place, dewatering the liquid CCR present in the unit via evaporation/draining, regrading the area to prevent ponding of stormwater in the unit, placement of a final cover system after the unit is dewatered, and construction of perimeter drainage channels (AECOM, 2016a).

2.2 Bottom Ash Pond

Figure 2-8 shows relevant BAP infrastructure including the layout of the dam and locations of existing seepage intercept systems and groundwater monitoring wells completed in the Tanner Wash alluvium, which is the uppermost aquifer underlying the BAP per the CCR groundwater monitoring system certification report (Montgomery & Associates, 2017).

Figures 2-9 and 2-10 show current iso-concentration contour maps for cobalt and lithium, respectively, at the BAP, based on the results of groundwater sampling conducted from October 2018 through March 2019 during a *Hydrogeologic Investigation of the FAP and BAP* (Wood, 2019b). The extent of impact is defined by the respective COC GWPSs. Table 2-3 summarizes concentrations of COCs and select water quality parameters in samples collected from the BAP and downgradient groundwater monitoring wells during the Hydrogeologic Investigation and the first monitoring event of 2019.

2.2.1 Characterization

Key points of the summary CSM for the BAP are as follows:

- The BAP dam is comprised of southern and eastern dams operating as one dam system. The southern BAP dam was constructed on alluvial and Moenkopi Moqui geologic units within a tributary to Tanner Wash. The eastern BAP dam was constructed on alluvial, Moenkopi Holbrook, Moenkopi Moqui, and Chinle geologic units and generally is aligned parallel to flow in Tanner Wash. The dams have been used to impound bottom ash at the Site for approximately 40 years.
- Similar to the FAP, the southern BAP dam has a slurry cutoff wall in the region of the dam where the alluvium was greater than 20 feet thick prior to construction, and elsewhere in the southern and eastern dams, where the alluvium was less than 20 feet thick, the clay core extended through the alluvium to bedrock. As a result, the slurry cutoff wall was only constructed in the middle portion of the southern dam.
- Since the slurry cutoff wall was designed to provide dam stability and not prevent seepage under the dam, the slurry cutoff wall in the southern portion of the dam does not extend all the way through the alluvium to the Moenkopi Moqui bedrock. There is an approximately 10 to 20-ft thick layer of alluvium at the base of the cutoff wall above the Moqui. The base of the slurry cutoff wall is at an elevation of 4980 ft amsl.
- The presence of alluvium at the base of the cutoff slurry wall may explain the relationship between the water quality concentrations in the paired alluvial monitoring wells W-305 and W-306 (downgradient of the southern portion of the BAP dam). The screened intervals for W-305 (the

deeper well) and W-306 (the shallower well) range from approximately 4,944 to 4,964 ft amsl and 4,994 to 5,014 ft amsl, respectively. This relationship is shown on Cross-Section A-A′ presented in Figure 2-11. The water elevations in the paired wells are similar, which suggests a hydraulic connection between the wells; however, the concentrations of water quality constituents vary. As indicated in Table 2-3, cobalt concentrations are higher in the deeper well (0.018 mg/L) than in the shallower well (less than 0.0020 mg/L) while lithium concentrations are higher in the shallower well (0.73 to 0.80 mg/L) than in the deeper well (0.21 to 0.22 mg/L).

- The alluvium in Tanner Wash and the wash beneath the southern dam appears to have a zone of coarser material at depth that includes clasts of petrified wood, likely eroded from the Chinle formation. It is likely that the various geologic units surrounding Tanner Wash contribute to natural variations in groundwater quality in the alluvium.
- Along the toe of the eastern dam, piezometers are screened in the Moenkopi Holbrook and Moenkopi Moqui formations and all have water elevations ranging between approximately 5,050 to 5,090 ft amsl. The Moenkopi Moqui is understood to have a low vertical permeability, but could possibly have a higher lateral secondary permeability through bedding planes, fractures, joint structures, and the presence of gypsum nodules, stringers, and layers. To the east of the eastern dam, the ground surface elevation declines and intersects the potentiometric surface produced by to the head in the BAP. Surface seeps have occurred where flow may be migrating through distinct beds in the Moqui that intersect ground surface. This relationship is depicted on Cross Section B-B′ (Figure 2-12).
- In general, there are multiple pathways for seepage flow beyond the southern and eastern dams. The potentiometric surface and Cross Sections A-A′ and B-B′ (Figures 2-11 and 2-12, respectively) indicate hydraulic connection between the water in the BAP and the groundwater elevations in monitoring wells and piezometers screened in the alluvium, Moenkopi Holbrook, and Moenkopi Moqui. Water elevations in a majority of the piezometers have increased over the period of operation since their installation.
- Iso-concentration maps for BAP COC cobalt (Figure 2-9) suggest that this constituent is present in groundwater around the entire downgradient extent of the south and eastern dams at concentrations that exceed the GWPS (0.006 mg/L). Cobalt concentrations that exceed the GWPS extend onto adjacent properties owned by the US Forest Service and the Hansen Family. The highest concentrations are located in the vicinity of M-52A (screened from 20 to 70 ft bgs) and Tanner Wash well W-307 (screened from 40 to 60 ft bgs) at 0.036 mg/L and 0.076 mg/L, respectively. Cobalt concentrations were notably lower in samples collected from the water surface within the BAP (0.00099 mg/L). It is possible that water quality samples collected from the surface of the BAP are not representative of water throughout the BAP, and/or seepage from the BAP promotes mobilization of naturally occurring cobalt from aquifer material. Based on data collected from one well (W-301 at 0.017 mg/L), concentrations of cobalt in alluvial groundwater appear to exceed the GWPS a significant distance downgradient of the BAP, potentially to the vicinity of I-40. Groundwater monitoring downgradient of I-40 indicates that the plant area is not impacted by elevated concentrations of cobalt.
- Groundwater monitoring conducted after declaring SSLs of lithium over the GWPS indicates that the presence of this constituent in groundwater downgradient of the BAP is not associated with leakage of COC mass from the BAP. An ASD conducted for this constituent (see Appendix A) indicates that the distribution of lithium in the aquifer downgradient of the BAP (Figure 2-10) is not consistent with the distribution of boron, a CCR indicator constituent. Further, the absence of lithium in water samples collected from the BAP and the nature of variability in lithium

concentrations in Tanner Wash alluvium suggest that observed concentrations are associated with natural variation due to aquifer heterogeneity. On the basis of the ASD documented herein, lithium is declared not to be a COC at the BAP.

2.2.2 Remedial Efforts Conducted to Date

In the past, four seepage intercept systems and one seep monitoring location were installed in the vicinity of the BAP where seepage has been observed at ground surface (Figure 2-8). These intercept systems include the:

1. P-226 Seepage Intercept System,
2. Tanner Wash Seepage Intercept System,
3. Petroglyph Seepage Intercept System,
4. Toe Drain Seepage Intercept System, and
5. West Abutment Seep Monitoring Location.

The seepage intercept systems at P-226, Tanner Wash, and the Petroglyph Seep Areas are connected by piping, trenches, and electrical conduit to function as one system.

P-226 Seepage Intercept System. The P-226 Seepage Intercept System was installed in 1993 downgradient of the eastern dam of the BAP northwest of Tanner Wash, near piezometer P-226 and well W-314, which are screened from 18 to 48 ft bgs (in the alluvium and the Moenkopi Moqui) and 46 to 61 ft bgs (in the alluvium), respectively. The seepage intercept system consists of ten 5-inch diameter pumping wells spaced approximately 50 to 70 ft apart and installed to around 40 ft bgs in the alluvium. Pumps are only installed in eight of the wells and the pumps are set to operate when groundwater is between 21 and 35 ft bgs (set points vary by well). The average pumping rate of the P-226 Seepage Intercept System typically ranges from 10 to 25 gpm.

Tanner Wash Seepage Intercept System. The Tanner Wash Seepage Intercept System was installed in 1993 downgradient of the bend in the dam of the BAP northwest of Tanner Wash. The seepage intercept system consists of three 4- to 6-ft deep seepage intercept trenches with a total length of approximately 850 ft sloped to one 4-ft diameter sump installed to approximately 10.5 ft bgs. The pump in the sump is set to operate when the water level in the sump is between 6.5 to 7.5 ft bgs. The average pumping rate of the Tanner Wash Seepage Intercept System typically ranges from 2 to 13 gpm.

Petroglyph Seepage Intercept System. The Petroglyph Seepage Intercept System was installed in 1993 at the toe of the bend in the dam of the BAP. The seepage intercept system consists of two 4- to 6-ft deep seepage intercept trenches with a total length of approximately 250 ft sloped to one 4-ft diameter sump installed to approximately 10 ft bgs. The pump in the sump is set to operate when the water level in the sump is between 6 and 7 ft bgs. The average pumping rate of the Petroglyph Seepage Intercept System typically ranges from 4 to 12 gpm.

Toe Drain Seepage Intercept System. The Toe Drain Seepage Intercept System is downgradient of the center of the southern dam and in the vicinity of M-53A, which is screened from 10 to 35 ft bgs. The average pumping rate of the Toe Drain Seepage Intercept System typically ranges from 3 to 10 gpm.

West Abutment Seep Monitoring. Seepage at the western abutment of the southern dam is monitored using a weir. The average flow rate of the West Abutment Seep typically ranges from 1 to 4 gpm. After monitoring, seepage infiltrates back into the aquifer and is collected in the Toe Drain Seepage Intercept System.

2.2.3 Unit Closure Planning

The closure plan for the BAP includes closure of the unit by leaving the CCR in place, dewatering the liquid CCR present in the unit via evaporation/draining, regrading the area to prevent ponding of stormwater in the unit, placement of a final cover system after the unit is dewatered, and construction of perimeter drainage channels (AECOM, 2016b).

3.0 CORRECTIVE MEASURES ASSESSMENT

In accordance with 40 CFR Section (§)257.96 of the CCR Rule, assessment of CMs must be conducted after an Appendix IV constituent has been detected at an SSL exceeding a GWPS to prevent further releases, remediate any releases that have occurred, and restore affected areas to original conditions. The assessment must include an analysis of CM effectiveness in meeting all of the requirements and objectives of the remedy as described in §257.97 of the CCR Rule (Selection of Remedy). Remedies must:

1) Be protective of human health and the environment;
2) Attain the GWPS;
3) Control the sources(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment;
4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5) Comply with standards for management of wastes as specified in §257.98(d) of the CCR Rule.

In consideration of these remedial objectives, this section screens applicable technologies for each unit, assembles retained technologies into developed alternatives, and then assesses the alternative CMs using the criteria defined in §257.96 of the CCR Rule (Assessment of Corrective Measures). The criteria include:

1) Performance, reliability, ease of implementation, and potential impacts of appropriate remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
2) Time required to begin and complete the remedy; and
3) Institutional requirements, such as state or local permits or other requirements or public health requirements that may substantially affect the implementation of the remedy(s).

The technology screening process and CM assessment documented herein were informed by the development of a numerical contaminant flow and transport groundwater model for the Site which reflects the current understanding of the unit-specific CSMs summarized in Section 2.0. Appendix B documents the specifications for and use of the Cholla Power Plant Groundwater Model (the Groundwater Model) as part of this assessment, including the modeling platform, structure, parameters, conceptual water budget, calibration data, model run development, and model run results. The observed distribution of representative COCs in groundwater (fluoride at the FAP and cobalt at the BAP) and results from the *Hydrogeologic Investigation of the FAP and BAP* (Wood, 2019b) were used to calibrate the Groundwater Model to Site conditions prior to use as a tool in this CM assessment.

As identified in Section 2.0, APS has implemented existing CMs at both the FAP and BAP and developed closure plans for the units in accordance with §257.102(b) of the CCR Rule (Criteria for Conducting the Closure or Retrofit of CCR Units). These CMs are incorporated into the CM alternatives developed for the Site.

3.1 Fly Ash Pond

3.1.1 Technology Screening

Table 3-1 presents a description of the individual technologies considered applicable to the FAP as CMs based on the unit-specific CSM presented in Section 2.1. The benefits, constraints, risks, and an assessment of the relative time to benefit from implementation of the technology are also summarized for the individual technologies in Table 3-1.

Evaluation of benefits, constraints, risks, and the relative time to benefit was conducted using technical judgement and the following considerations:

- Benefits include a lowered risk to human health or environmental receptors; reduced concentrations, volumes, or overall quantities of COC mass in the aquifer; decreased liability and increased acceptance of the public; efficient or enhanced implementation leading to increases in technology effectiveness; and preservation of existing or future uses.
- Constraints include site factors that adversely impact the performance, reliability, or ease of implementation; or an extensive amount of predesign work that is required to implement the technology.
- Risks include adverse safety impacts or an increase in the potential of exposure to receptors of residual contamination.
- Relative time to benefit was assessed on a scale that identified technologies that have already been implemented as ‘fast’ and technologies that leave COCs in place to attenuate over time as ‘slow’.

The existing technologies implemented or currently identified for future implementation at the FAP were retained and include:

- Technology A – Operation of existing seepage collection systems near the I-40, Geronimo, and Hunt seeps to intercept seepage in areas where impacts at ground surface were previously observed;
- Technology B – Draining the FAP with closure of the CCR in place using engineering control measures to limit the introduction of stormwater into the unit, thereby controlling the ongoing source of seepage from the unit in the future; and
- Technology D – Ongoing natural attenuation of COCs.

These technologies are supplemented in Table 3-1 with various strategies to remove more of the potential source of groundwater impacts, capture impacted groundwater and remove COC mass thereby reducing risk and limiting the duration that remedies must be in place (i.e., the duration that COCs are present at concentrations exceeding GWPSs) At the FAP, these technologies include:

- Technology C - Excavation of the CCR contained in the FAP as a change to the current closure strategy;
- Technologies E and G - Capture of impacted groundwater directly downgradient of the FAP with new containment wells or a gravel filled seepage collection trench at potentially high contaminant flux locations;
- Technology F – Capture of impacted groundwater, south of I-40 in the downgradient alluvium; and

- Technology H – Installation of partial cutoff walls directly downgradient of the FAP to divert water to a centralized groundwater extraction system.

Removal of CCR as part of closure implementation would reduce the mass of COCs present at the Site and limit the potential for ongoing mobilization of COCs into groundwater. However, the duration required for impacts to be mitigated would not be appreciably shortened compared to CCR closure in place because the CCR would still require dewatering prior to excavation and the duration required to implement an excavation and disposal program would be extensive. The earliest date that discharges to the FAP could cease and draining/evaporation of free liquid in the ponds could begin is in three to four years when a new fly ash disposal facility could be designed, constructed, permitted, and placed in service. Excavation of CCR as part of closure would also have the following constraints and risks:

- Potential cross-media impacts during excavation, transport, and final placement at a suitable location;
- Logistical difficulties in locating and/or constructing a suitable facility for the excavated waste; and
- Likely concerns by the public regarding the high volume of traffic associated with transporting large quantities of waste in transportation corridors where the public could be exposed to the waste.

Given the potential benefit of this technology, removal of CCR as part of closure implementation is retained.

All identified groundwater containment technologies were retained except the cutoff wall with an associated groundwater extraction well system. Although this approach would likely be effective, the risk of potentially compromising the integrity of the thin Moenkopi Moqui when other retained technologies are likely to be equally effective is not warranted.

3.1.2 Development and Evaluation of Alternatives

Evaluation of CM alternatives included incorporating existing and planned technologies into CM Alternative 1 (i.e., operation of existing seepage collection systems, closure of the FAP including draining/evaporation of standing water either in place or by CCR removal, and natural attenuation of COCs in the impacted alluvial aquifer) and developing retained variations of the screened containment strategies presented in Table 3-1 into CM Alternatives 2 through 4 for comparison. Table 3-2 summarizes these CMs and presents the results of an assessment of these alternatives using the CCR Rule CM assessment criteria noted in the introduction to this section. Figures 3-1 through 3-4 visually depict the alternatives for further evaluation.

As indicated in Table 3-2, the estimated time to complete the remedy for CM Alternative 1 is longer than typical facility planning periods (i.e., 30 years). To estimate the required duration of CM Alternative 1, groundwater modeling was performed using fluoride at the FAP as it is the only constituent present at concentrations that exceed an Arizona AWQS, which is also the USEPA MCL and the GWPS for this constituent. The GWPSs for lithium and molybdenum are based on background threshold values (BTVs) and alternative risk-based GWPSs identified in the CCR Rule, respectively (Table 1-2). Although the exceedances of fluoride concentrations above the GWPS in groundwater downgradient of the FAP are relatively minor, the Groundwater Model predicts that fluoride concentrations will exceed the GWPS for 61 years. This extended duration is likely attributable to:

- Projected ongoing seepage from the FAP and associated alluvium through 2036 (based on Site dewatering projections and the elevation of the ground surface before FAP construction [i.e., 5,035 ft amsl]);
- Low permeability soils in the alluvium;
- Potential interactions between the alluvium and the Moenkopi Moqui that can to retard the migration of fluoride mass from regions where impacted groundwater has saturated the Moqui (i.e., around the FAP dam); and
- Limited inflow of non-impacted groundwater into the impacted aquifer in the region downgradient of the FAP.

The primary factors that distinguish alternatives with containment strategies (CM Alternatives 2, 3, and 4) include the footprint and location of the containment strategies, the quantity of water that will likely need to be extracted to contain impacted groundwater, and the estimated duration that these containment strategies will have to operate. The results from the groundwater modeling effort provide some insight into the potential advantages and constraints of the evaluated strategies:

- Locating a seepage interception system (either a containment well system or seepage collection trench) on APS property, downgradient of the dam and north of I-40, contributes to shorter remedial durations (CM Alternatives 2 and 4 have Groundwater Model predicted durations of 26 years and 22 years, respectively). In general, these durations are significantly impacted by how long ongoing seepage of impacted water from the FAP and associated alluvium will continue (17 years from present is predicted by the Groundwater Model).
- To contain COC impacted plumes, extraction from wells screened in the Moenkopi Moqui may be required. Figures 3-2 through 3-4 depict the number and locations of wells used in the Groundwater Model to contain the fluoride plume. These wells were sited iteratively and required screening of select wells in the Moenkopi Moqui (Layer 3 in the Groundwater Model; see Appendix B). Construction of the Groundwater Model relied on data collected from FAP dam piezometers that indicates the Moqui is locally saturated in the vicinity of the dam.
- Solely locating a containment well system south of I-40 (CM Alternative 3) will require a larger quantity of groundwater extraction to contain the plumes than a comparable system located north of I-40 due to the thicker alluvium and longer plume travel time to the containment system. Siting a containment well system south of I-40 also has more potential to adversely impact off-site property owners, as wells would likely be required off APS property.

The estimated durations of remedial implementation, volumes of extracted groundwater, and locations of containment infrastructure derived from the Groundwater Model are approximations of these parameters in a complex aquifer environment based on currently available information. The parameter values presented in this CM assessment should be considered for alternative evaluation purposes only.

Section 4.1 identifies planned CM predesign activities that will be conducted to refine the summary CSM for the FAP and inform remedy development and selection.

3.2 Bottom Ash Pond

3.2.1 Technology Screening

Table 3-3 presents a description of the individual technologies considered applicable to the BAP as CMs based on the unit-specific CSM presented in Section 2.2. Evaluation of benefits, constraints, risks, and the relative time to benefit from implementation of the technology was conducted in a manner similar to that described for the FAP in Section 3.1.1.

The existing technologies implemented or currently identified for future implementation at the BAP were retained and include:

- Technology A – Operation of existing seepage collection systems to the south and east of the dam to intercept seepage in areas where impacts at ground surface were previously observed;
- Technology B – Draining the BAP with closure of the CCR in place using engineering control measures to limit the introduction of stormwater into the unit, thereby controlling the ongoing source of seepage from the unit in the future; and
- Technology D – Ongoing natural attenuation of COCs.

These technologies are supplemented in Table 3-3 with various strategies to remove more of the potential source of groundwater impacts, capture impacted groundwater and remove COC mass thereby reducing risk and limiting the duration that remedies must be in place, and decrease the extent of hydraulic connection between water in the dam and the alluvium. At the BAP, these technologies include:

- Technology C - Excavation of the CCR contained in the BAP as a change to the current closure strategy;
- Technologies E, G and H - Capture of impacted groundwater directly downgradient of the BAP with new containment wells or collection trenches at potentially high contaminant flux locations; cut off walls could be used to enhance the effectiveness of these systems;
- Technology F – Capture of impacted groundwater in the downgradient alluvium of Tanner Wash; and
- Technology I – Permeation grouting on the south side of the dam in the alluvium at the base of the slurry cut off wall to target the gap of alluvium beneath the cut off wall.

The advantages and disadvantages of Removal of CCR as part of closure implementation would be the same as discussed in Section 3.1.1. Given the potential benefit of this technology, removal of CCR as part of closure implementation (Technology C) is retained.

Containment wells and/or collection trenches sited in close proximity to the dam with potential cutoff walls to increase the effectiveness of containment wells near the dam (Technologies E, G, and H) were retained. However, implementing these technologies along the entire length of the dam would likely be challenging given the difficult terrain and potential presence of uncharacterized discharges to the alluvium where seepage is not visible at the surface. These factors can limit the effectiveness of containment systems at the BAP.

Based on the extensive distribution of cobalt in groundwater downgradient of the BAP (Figure 2-9) and unreasonable volume of groundwater that would need to be extracted from a finite groundwater resource to contain very small quantities of cobalt mass (a constituent without an AWQS or MCL), containment wells located farther downgradient from the dam in the alluvium (Technology F) were not retained.

Given that cobalt concentrations appear to be elevated around the entire extent of the BAP and that the highest concentrations are associated with M-52A and W-307, and not W-305 which is sited directly downgradient of the alluvial gap at the base of the BAP dam cutoff slurry wall, permeation grouting of the alluvial gap (Technology I) is expected to have limited effectiveness in addressing the cobalt plume and was therefore not retained.

3.2.2 Development and Evaluation of Alternatives

Like the evaluation of CM alternatives for the FAP, evaluation of CM alternatives included incorporating existing and planned technologies into CM Alternative 1 (i.e., operation of existing seepage collection systems, closure of the BAP including draining/evaporation of standing water either in place or by CCR removal, and natural attenuation of cobalt in the impacted alluvial aquifer). CM Alternative 1 was assessed against a comparable alternative (CM Alternative 2) that is comprised of retained containment technologies in the vicinity of the BAP dam (i.e., new containment wells, collection trenches, and/or cutoff walls to enhance interception of seepage discharging into the alluvium). Table 3-4 summarizes these CMs and presents the results of an assessment of these alternatives using the CCR Rule CM assessment criteria. Figures 3-5 and 3-6 visually depict these alternatives for further comparison.

As indicated in Table 3-2, both CM Alternatives 1 and 2 are currently assessed as having limited effectiveness in intercepting seepage from the BAP prior to impacting the alluvial aquifer. This is due in part to a poor understanding of the mechanisms responsible for introducing cobalt into the alluvial aquifer to as well as incomplete characterization of where impacts are occurring. As indicated in the unit-specific CSM for the BAP, cobalt concentrations are not known to be elevated in the BAP and seepage investigation has only been conducted where surface seepage has been evident. Additional investigation is needed to better understand the nature of cobalt mass releases at the BAP and whether existing seepage collection systems can be enhanced and/or expanded to intercept seepage prior to discharge into the alluvium.

In addition to potential issues with efficacy, the duration that both CM Alternative 1 and 2 would need to remain in place is difficult to estimate at this time. The Groundwater Model predicts that cobalt will remain at concentrations that exceed the GWPS for more than 100 years which significantly exceeds the 30-year typical facility planning period. This extended duration is potentially attributable to:

- The thickness of the alluvium in Tanner Wash which has the capacity to store large volume of impacted groundwater, if contaminated.
- The significant head in the BAP relative to the ambient alluvial piezometric surface, which in the model, results in a reversal of flow direction in Tanner Wash towards the model boundary where boundary effects may be occurring.
- The unknown length of time required to dewater the BAP (bottom ash is anticipated to dewater quicker than fly ash but the duration has not been quantified). For the purpose of the model, the BAP was assumed to dewater at the same rate as the FAP.

The estimated durations of remedial implementation, volumes of extracted groundwater, and locations of containment infrastructure derived from the Groundwater Model are approximations of these parameters in a complex aquifer environment based on currently available information. The values presented in this CM assessment should be considered for alternative evaluation purposes only.

Section 4.1 identifies planned CM predesign activities that will be conducted to refine the summary CSM for the BAP and inform remedy development and selection.

4.0 FUTURE WORK

4.1 Pre-Design Studies

Additional site characterization is necessary prior to selection and design of FAP and BAP remedies. Currently planned activities include:

- *Moenkopi Moqui Investigation at the FAP*. At least one new well will be advanced on the south side of I-40 to investigate water quality in the Moqui downgradient of the FAP.
- *Aquifer Testing Downgradient of the FAP*. Aquifer testing will be conducted at various locations downgradient of the FAP to better understand aquifer properties in this region of the site.
- *Preparation of Alternative Source Demonstrations for Arsenic and Cobalt at the FAP*. ASDs for these constituents will be prepared to demonstrate that the source of GWPS exceedances in groundwater downgradient of the FAP is not the leakage of arsenic or cobalt mass from the FAP.
- *Stratified Sampling of Water in the BAP*. To assess spatial and depth-specific variations in cobalt concentrations in BAP water, a water sampling characterization program will be implemented.
- *Leaching Evaluation at the BAP*. Bottom ash as well as distinct geological units found at the BAP (i.e., the alluvium, the Chinle, the Moenkopi Holbrook, and the Moenkopi Moqui) will be sampled and evaluated for CCR Rule constituents and then subject to leach testing to evaluate the potential source of cobalt at the BAP.
- *Bottom Ash Pond Dewatering Projection*. A water balance will be developed to project pond dewatering at the BAP.
- *Seepage Intercept System Evaluation, Optimization, and Testing*. Existing systems at both the FAP and BAP will be evaluated and optimization strategies will be investigated. If feasible, testing will be conducted to better understand the influence of these systems in intercepting seepage discharges to the alluvium.

4.2 Public Notice and Remedy Selection

After placing this report documenting the CM assessment for the FAP and BAP in the facility's operating record in accordance with §257.96(d) of the CCR Rule, APS will select a remedy as soon as feasible. Assessment monitoring of groundwater at the FAP and BAP will continue throughout remedy selection and implementation.

As required by §257.96(e) of the CCR Rule, the results of this CM assessment will be made available to interested and affected parties through a public meeting at least 30 days prior to selecting remedy or remedies for the FAP and the BAP.

5.0 REFERENCES

AECOM, 2016a. Cholla Power Plant Closure Plan §257.102(b) – Fly Ash Pond. CH_ClosPlan_002_20161017. Certified August 30, 2016.

AECOM, 2016b. Cholla Power Plant Closure Plan §257.102(b) – Bottom Ash Pond. CH_ClosPlan_003_20161017. Certified August 30, 2016.

AMEC Earth & Infrastructure, Inc. (AMEC), 2012. Well Completion Report, Installation of Aquifer Protection Permit Monitor Wells, Arizona Public Service Company, Cholla Power Plant, Navajo County, Arizona. AMEC Job No. 17-2011-4054. May 7, 2012.

Federal Register, 2018. *40 Code of Federal Regulations Part 257 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule promulgated April 17, 2015 with Amendments to the National Minimum Criteria (Phase One, Part One) effective August 29, 2018*.

Montgomery & Associates, 2011. Arizona Public Service Cholla Power Plant Point of Compliance Evaluation. Prepared for APS. January 26, 2011.

Montgomery & Associates, 2017. *Cholla Power Plant Coal Combustion Residuals Program – Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks*. Navajo County, Arizona. Document #CH_GW_SystemCert_020_20170919. September 19, 2017.

Montgomery & Associates, 2018. *Cholla Power Plant Coal Combustion Residuals Program – Statistical Analysis of Baseline Groundwater Monitoring Data, November 2015 through September 2017*. Navajo County, Arizona. January 12, 2018. Updated May 22, 2018.

Sergent, Hauskins & Beckwith, 1973. *Proposed Ash Disposal Areas Soil and Geologic Study Report*. *APS Cholla Power Plant, Near Joseph City, Arizona*. December 14, 1973.

Wood Environment & Infrastructure Solutions, Inc. (Wood), 2018a. *CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Fly Ash Pond*. Arizona Public Service Cholla Power Plant – Navajo County, Arizona. October 15, 2018.

Wood, 2018b. *CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Bottom Ash Pond*. Arizona Public Service Cholla Power Plant – Navajo County, Arizona. October 15, 2018.

Wood, 2019a. *CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Sedimentation Pond*. Arizona Public Service Cholla Power Plant – Navajo County, Arizona. January 14, 2019.

Wood, 2019b. *Hydrogeologic Investigation of the FAP and BAP*. Arizona Public Service Cholla Power Plant – Navajo County, Arizona. June 2019.

Woodward-Clyde Consultants, 1991. *Cholla Ash Ponds Groundwater Interpretative Report, Navajo County, Arizona*. Prepared for APS. June 30, 1991.

TABLES

Table 1-1
Description of Coal Combustion Residual Units

CCR Unit	Function	Operation	Size/Construction	History
Fly Ash Pond (FAP)	*Single CCR unit* - surface impoundment to store slurried fly ash from the plant.	Receives a slurry from the plant that contains primarily fly ash and flue gas emission control residuals but may also contain some bottom ash, boiler slag, boiler cleaning waste, oil/water separator solids, and storm water. Periodically receives solids from the SEDI.	- 430 acres in aerial extent. - Total storage capacity of about 18,000 acre-feet. - Normal operating pool elevation of 5,114 feet amsl.	- Constructed beginning in 1976 and placed into service in 1978. - Unlined; constructed on Moenkopi bedrock and a thin veneer of alluvial sediments. - The dam is constructed of earth fill with a central clay core that extends to bedrock where bedrock is shallow. In the central portion of the dam, where bedrock is deeper, a slurry cutoff wall extends one foot into bedrock or two feet into stiff clay.
Sedimentation Pond (SEDI)	*Single CCR unit* - collects water from drains around plant site, including storm water, process water, plant water, and slurry from plant leaks.	Collects discharge from on-site secondary wastewater treatment plant, effluent from the oil/water separator, vehicle wash water, plant wash water, and FGD wastes from scrubber or scrubber feed tank upsets. Water collected in the SEDI is pumped to Cholla's general water sump for recycling as process water.	- 1.3 acres in aerial extent. - Total storage capacity of 10.5 acre-feet. - Maximum pond depth of 10 feet. - the top of the pond side slope is at 5,019 feet amsl	- Placed into service in 1976. - Lined with a 2-foot-thick layer of compacted clay. - Constructed below grade.
Bottom Ash Pond (BAP)	*Single CCR unit* - surface impoundment to store slurried bottom ash from the plant.	Bottom ash is pumped to the BAP as a slurry. The bottom ash settles in the east and west upstream storage cells and the water is decanted to the reservoir and ultimately siphoned back to the plant for reuse. Slurry may also contain fly ash, boiler slag, flue gas emission control residuals, sedimentation pond effluent, cooling tower blowdown, oil/water separator effluent and solids, boiler cleaning waste, and storm water.	- 105 acres in aerial extent. - Total storage capacity of 2,300 acre-feet. - Normal operating pool elevation of 5,117.8 feet amsl.	- Constructed beginning in 1976 and placed into service in 1978. - Unlined; constructed on Moenkopi bedrock and Tanner Wash alluvium. - Consists of a reservoir directly behind the dam and two storage cells upstream of the reservoir. - The dam is constructed of earth fill with a central clay core that extends to bedrock where bedrock is shallow. Where bedrock is deeper, a slurry cutoff wall extends below the central clay core to provide stability to the dam.
Bottom Ash Monofill (BAM)	*Single CCR unit* - landfill for bottom ash solids excavated from the BAP.	Bottom ash that has been drained of water is excavated from the BAP and permanently stored in the BAM. Periodically receives solids from the SEDI.	- 41 acres in aerial extent.	- Placed into service in 1999.

Notes:

amsl - above mean sea level
BAP - Bottom Ash Pond
BAM - Bottom Ash Monofill
CCR - Coal combustion residuals
FAP - Fly Ash Pond
FGD - flue gas deulfurization
SEDI - Sedimentation Pond

Source:

GEI Consultants, Inc. 2009. *Final Coal Ash Impoundment Specific Site Assessment Report, Arizona Public Service, Cholla Power Plant.* Submitted to Lockheed-Martin Corporation. December 2009.

Table 1-2
Summary of GWPSs and Appendix IV Constituent Statistical Analyses

Constituent	BAP					FAP				
	BTV [mg/L]	GWPS [mg/L]	Basis for GWPS	Location of SSLs Over GWPS	Range of Exceeding LCLs [mg/L]	BTV [mg/L]	GWPS [mg/L]	Basis for GWPS	Location of SSLs Over GWPS	Range of Exceeding LCLs [mg/L]
Antimony	0.004	0.006	US EPA MCL	None	---	0.004	0.006	US EPA MCL	None	---
Arsenic	0.004	0.01	US EPA MCL	None	---	0.004	0.01	US EPA MCL	M-51A	0.012
Barium	0.05	2	US EPA MCL	None	---	0.05	2	US EPA MCL	None	---
Beryllium	0.001	0.004	US EPA MCL	None	---	0.001	0.004	US EPA MCL	None	---
Cadmium	0.0004	0.005	US EPA MCL	None	---	0.0004	0.005	US EPA MCL	None	---
Chromium	0.004	0.1	US EPA MCL	None	---	0.004	0.1	US EPA MCL	None	---
Cobalt	0.002	0.006	Alternative Risk-Based GWPS	M-52A, M-53A, W-305, and W-314	0.010-0.038	0.002	0.006	Alternative Risk-Based GWPS	M-51A	0.01*
Fluoride	0.8	4	US EPA MCL	None	---	0.8	4	US EPA MCL	M-51A	4.3
Lead	0.002	0.015	Alternative Risk-Based GWPS	None	---	0.002	0.015	Alternative Risk-Based GWPS	None	---
Lithium	0.31	0.31	BTV	W-306	0.52	0.31	0.31	BTV	M-50A, M-51A, and W-123	0.43 to 0.63
Mercury	0.0002	0.002	US EPA MCL	None	---	0.0002	0.002	US EPA MCL	None	---
Molybdenum	0.0061	0.1	Alternative Risk-Based GWPS	None	---	0.0061	0.1	Alternative Risk-Based GWPS	W-123	0.32
Selenium	0.002	0.05	US EPA MCL	None	---	0.002	0.05	US EPA MCL	None	---
Thallium	0.0014	0.002	US EPA MCL	None	---	0.0014	0.002	US EPA MCL	None	---
Combined Radium	1.6	5	US EPA MCL	None	---	1.6	5	US EPA MCL	None	---

Notes:

BAP - Bottom Ash Pond
BTV - Background Threshold Value
FAP - Fly Ash Pond
GWPS - Groundwater Protection Standard
LCL - Lower Confidence Limit
MCL - Maximum Contaminant Level
mg/L - milligrams per liter
SEDI - Sedimentation Pond
SSLs - statistically significant levels
US EPA - US Environmental Protection Agency

*The reporting limit for cobalt is in exceedance of the GWPS; it is possible this is a false positive SSL over the GWPS on account of the laboratory's inability to detect a concentration below the GWPS.

Table 2-1
Water Quality Data Collected During Recent Groundwater Monitoring at the FAP

				Analyte Concentration by Location and Date							
				FAP	FAP	M-50A	M-50A	M-51A	M-51A	MW-65A	MW-65A
Analyte	**Units**	**GWPS**	**AWQS**	**3/30/19**	**4/29/19**	**10/24/18**	**2/13/19**	**10/24/18**	**2/13/19**	**12/5/18**	**2/14/19**
Boron	mg/L	---	---	350	310	3.1	---	30	---	12	---
Calcium	mg/L	---	---	730	---	630	---	870	---	780	---
Chloride	mg/L	---	---	24000	24000	2200	---	5400	---	3900	---
pH	SU	---	---	6.7	7.1	7.4	---	7.3	---	7.3	---
Sulfate	mg/L	---	---	24000	25000	3100	---	2900	---	2700	---
Total Dissolved Solids	mg/L	---	---	74000	77000	8100	---	12000	---	9900	---
Antimony	mg/L	0.006	0.006	0.036	---	---	<0.0010	---	<0.0010	<0.0010	<0.0010
Arsenic	mg/L	0.01	0.05	**0.17**	---	0.0028	0.0028	**0.032**	**0.025**	0.0025	0.0017
Barium	mg/L	2	2	0.092	---	0.0092	0.0086	0.0074	0.0070	0.040	0.015
Beryllium	mg/L	0.004	0.004	0.0057	---	---	<0.0010	---	<0.0010	---	<0.0010
Cadmium	mg/L	0.005	0.005	<0.00040	<0.0010	<0.00010	<0.00010	0.00010	<0.00010	0.00013	<0.00010
Chromium	mg/L	0.1	0.1	0.0024	<0.020	0.0046	0.0014	0.021	0.013	0.0035	0.0028
Cobalt	mg/L	0.006	NS	0.0053	---	0.00063	0.00069	<0.0050	<0.0020	0.0047	0.0033
Fluoride	mg/L	4	4.0	**68**	**69**	2.3	2.2	**5.0/5.5**	**4.5**	1.9	1.7
Lead	mg/L	0.015	0.05	<0.0020	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	0.0010	<0.00050
Lithium	mg/L	0.31	NS	**4.1**	---	**0.43**	**0.46**	**0.46**	**0.49**	**0.54**	**0.58**
Mercury	mg/L	0.002	0.002	<0.00020	---	---	<0.00020	---	<0.00020	<0.00020	<0.00020
Molybdenum	mg/L	0.1	NS	**0.52**	---	0.0071	0.0070	0.092	0.082	0.059	0.059
Selenium	mg/L	0.05	0.05	0.034	---	0.0026	0.0027	<0.0050	<0.0020	0.0021	0.0022
Thallium	mg/L	0.002	0.002	<0.00040	<0.0010	---	<0.00010	---	0.00013	0.00011	<0.00010
Alkalinity as CaCO3	mg/L	---	---	36	---	---	---	---	---	160	---
Alkalinity, Phenolphthalein	mg/L	---	---	<6.0	---	---	---	---	---	<6.0	---
Bicarbonate Alkalinity as CaCO3	mg/L	---	---	36	---	---	---	---	---	160	---
Carbonate Alkalinity as CaCO3	mg/L	---	---	<6.0	---	---	---	---	---	<6.0	---
Hydroxide Alkalinity as CaCO3	mg/L	---	---	<6.0	---	---	---	---	---	<6.0	---
Magnesium	mg/L	---	---	4900	---	---	---	---	---	290	---
Potassium	mg/L	---	---	340	---	---	---	---	---	28	---
SiO2, Silica	mg/L	---	---	---	---	---	---	---	---	32	---
Sodium	mg/L	---	---	17000	---	---	---	---	---	2000	---

Notes:

Constituents of concern are highlighted in dark green; concentrations greater than the GWPS are bolded.

Acronymns:

AWQS = Aquifer Water Quality Standard
FAP = Fly Ash Pond
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = no standard
SU = standard units

Table 2-1
Water Quality Data Collected During Recent Groundwater Monitoring at the FAP

				Analyte Concentration by Location and Date						
				MW-66A	MW-66A	MW-67A	MW-67A	W-123	W-123	W-126
Analyte	**Units**	**GWPS**	**AWQS**	**12/5/18**	**2/14/19**	**12/5/18**	**2/14/19**	**10/24/18**	**2/13/19**	**12/5/18**
Boron	mg/L	---	---	1.2	---	0.38	---	37	---	43
Calcium	mg/L	---	---	830	---	1500	---	850	---	760
Chloride	mg/L	---	---	4600	---	5000	---	6600	---	7400
pH	SU	---	---	8.1	---	6.9	---	7.7	---	7.4
Sulfate	mg/L	---	---	2900	---	1500	---	3600	---	4200
Total Dissolved Solids	mg/L	---	---	11000	---	9300	---	14000	---	17000
Antimony	mg/L	0.006	0.006	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Arsenic	mg/L	0.01	0.05	0.0034	0.0021	**0.018**	**0.016**	0.0026	0.0024	0.0027
Barium	mg/L	2	2	0.095	0.016	0.058	0.022	0.0092	0.010	0.021
Beryllium	mg/L	0.004	0.004	---	<0.0010	---	<0.0010	---	<0.0010	---
Cadmium	mg/L	0.005	0.005	0.00029	0.00027	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	mg/L	0.1	0.1	0.0098	<0.0010	0.0082	0.0012	0.043	0.12	0.0026
Cobalt	mg/L	0.006	NS	0.0026	0.0013	0.0058	0.0037	0.0016	0.0018	0.0049
Fluoride	mg/L	4	4.0	0.93	1.1	1.0	<0.80	3.7/4.0	3.7	3.5
Lead	mg/L	0.015	0.05	0.0040	<0.00050	0.0019	<0.00050	<0.00050	<0.00050	0.00072
Lithium	mg/L	0.31	NS	**0.51**	**0.55**	<0.20	<0.20	**0.65**	**0.75**	**0.78**
Mercury	mg/L	0.002	0.002	<0.00020	<0.00020	<0.00020	<0.00020	---	<0.00020	<0.00020
Molybdenum	mg/L	0.1	NS	0.016	0.014	0.0061	0.0050	**0.37**	**0.37**	**0.20**
Selenium	mg/L	0.05	0.05	0.031	0.027	0.0011	0.00066	0.0059	0.0063	0.0015
Thallium	mg/L	0.002	0.002	0.00015	0.00012	<0.00010	<0.00010	---	<0.00010	0.00015
Alkalinity as CaCO3	mg/L	---	---	80	---	180	---	---	---	100
Alkalinity, Phenolphthalein	mg/L	---	---	<6.0	---	<6.0	---	---	---	<6.0
Bicarbonate Alkalinity as CaCO3	mg/L	---	---	80	---	180	---	---	---	100
Carbonate Alkalinity as CaCO3	mg/L	---	---	<6.0	---	<6.0	---	---	---	<6.0
Hydroxide Alkalinity as CaCO3	mg/L	---	---	<6.0	---	<6.0	---	---	---	<6.0
Magnesium	mg/L	---	---	280	---	270	---	---	---	470
Potassium	mg/L	---	---	11	---	12	---	---	---	91
SiO2, Silica	mg/L	---	---	55	---	41	---	---	---	24
Sodium	mg/L	---	---	2500	---	1400	---	---	---	4000

Notes:

Constituents of concern are highlighted in dark green; concentrations greater than the GWPS are bolded.

Acronymns:

AWQS = Aquifer Water Quality Standard
FAP = Fly Ash Pond
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = no standard
SU = standard units

Table 2-2
Constituent of Concern Properties Impacting Mobility in Aquifer Environments

Constituent	General Behavior	pH and Redox Sensitivities	Adsorption Characteristics	Solubility Characteristics
Arsenic	Behaves as oxi-anions (arsenate and arsenite), not as a metallic cation	Redox sensitive – toxicity and mobility (retardation) depends on valence state	Adsorbs to iron (and manganese) oxide coatings on soils; adsorption is pH dependent since these oxides are soluble at low pH (less than 2 standard units) and reducing conditions Can be forced to desorb by competition for adsorption sites by other anions like phosphate or sulfate if concentrations are high enough	Elementary arsenic is fairly insoluble; arsenic compounds may readily dissolve
Cobalt	Cationic metal ion	More mobile at low pH and reducing conditions	Likely pH and adsorbent dependent	Forms numerous complexes that somewhat increase solubility (organic matter, chloride, etc.) Cobalt carbonate precipitation can limit solubility to low values
Fluoride	Anion	Not redox or pH sensitive	Not readily adsorbed to soils; little retardation	Soluble in water
Lithium	Cationic metal ion (+1 charge)	Not redox or pH sensitive	Not strongly adsorbed to soils	Generally quite soluble and mobile No major insoluble compounds
Molybdenum	Behaves as an oxi-anion (molybdate, etc.), not as a metallic cation	Dependent on redox conditions (mostly +4 and +6, but also +3)	Adsorbs to iron oxide coatings on soils	Can form low solubility metal molybdate compounds (e.g., iron and calcium)

Table 2-3
Water Quality Data Collected During Recent Groundwater Monitoring at the BAP

				Analyte Concentration by Location and Date							
				BAP	**BAP**	**M-52A**	**M-52A**	**M-53A**	**M-53A**	**M-55A**	**M-55A**
Analyte	**Units**	**GWPS**	**AWQS**	**3/30/19**	**4/29/19**	**12/8/18**	**2/15/19**	**12/7/18**	**2/15/19**	**12/8/18**	**2/15/19**
Boron	mg/L	---	---	4.8	---	4.3	---	3.4	---	0.43	---
Calcium	mg/L	---	---	550	---	920	---	620	---	700	---
Chloride	mg/L	---	---	2100	2100	4900	---	2300	---	4300	---
pH	SU	---	---	8.3	8.2	6.8	---	7.4	---	7.3	---
Sulfate	mg/L	---	---	3100	3100	2700	---	3000	---	3400	---
Total Dissolved Solids	mg/L	---	---	7700	8200	11000	---	7600	---	11000	---
Antimony	mg/L	0.006	0.006	0.0027	---	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010
Arsenic	mg/L	0.01	0.05	0.017	---	0.0022	0.00077	<0.0020	0.00064	<0.0020	0.0033
Barium	mg/L	2	2	0.20	---	0.019	0.015	0.0085	0.013	0.014	0.014
Beryllium	mg/L	0.004	0.004	<0.0010	---	---	<0.0010	---	<0.0010	---	<0.0010
Cadmium	mg/L	0.005	0.005	0.00011	---	<0.0010	0.00027	0.0014	0.0011	<0.0010	<0.00010
Chromium	mg/L	0.1	0.1	0.0035	<0.010	0.043	0.037	<0.0050	0.0025	0.17	0.14
Cobalt	mg/L	0.006	NS	0.00099	---	**0.036**	**0.029**	**0.014**	**0.011**	<0.0020	0.00095
Fluoride	mg/L	4	4.0	3.7	3.7	1.0	0.93	2.3	1.2	<0.80	<0.80
Lead	mg/L	0.015	0.05	<0.00050	---	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010	<0.00050
Lithium	mg/L	0.31	NS	<0.20	---	0.29	**0.32**	0.20	0.21	**0.39**	**0.43**
Mercury	mg/L	0.002	0.002	<0.00020	---	---	<0.00020	---	<0.00020	---	<0.00020
Molybdenum	mg/L	0.1	NS	0.027	---	0.031	0.020	0.042	0.0067	0.020	0.019
Selenium	mg/L	0.05	0.05	0.014	---	<0.0060	0.0015	<0.0060	0.00078	0.083	0.13
Thallium	mg/L	0.002	0.002	<0.00010	---	<0.0010	<0.00010	<0.0010	<0.00010	<0.0010	<0.00010
Alkalinity as CaCO3	mg/L	---	---	120	---	230	---	92	---	190	---
Alkalinity, Phenolphthalein	mg/L	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0	---
Bicarbonate Alkalinity as CaCO3	mg/L	---	---	120	---	230	---	92	---	190	---
Carbonate Alkalinity as CaCO3	mg/L	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0	---
Hydroxide Alkalinity as CaCO3	mg/L	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0	---
Magnesium	mg/L	---	---	300	---	300	---	220	---	160	---
Potassium	mg/L	---	---	28	---	7.1	---	13	---	3.0	---
SiO2, Silica	mg/L	---	---	---	---	14	---	9.4	---	12	---
Sodium	mg/L	---	---	1500	---	2600	---	1600	---	2900	---

Notes:

Constituents of concern are highlighted in dark green; concentrations greater than the GWPS are bolded.

Acronymns:

AWQS = Aquifer Water Quality Standard
BAP = Bottom Ash Pond
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = no standard
SU = standard units

Table 2-3
Water Quality Data Collected During Recent Groundwater Monitoring at the BAP

				Analyte Concentration by Location and Date							
				M-64A	W-301	W-301	W-302	W-302	W-304	W-304	W-305
Analyte	**Units**	**GWPS**	**AWQS**	**2/13/19**	**12/7/18**	**2/15/19**	**12/7/18**	**2/15/19**	**12/7/18**	**2/15/19**	**12/7/18**
Boron	mg/L	---	---	---	2.4	---	0.64	---	0.50	---	0.35
Calcium	mg/L	---	---	---	760	---	560	---	590	---	710
Chloride	mg/L	---	---	---	4000	---	2600	---	2900	---	2400
pH	SU	---	---	---	7.2	---	7.3	---	7.3	---	7.3
Sulfate	mg/L	---	---	---	3300	---	2400	---	2900	---	2300
Total Dissolved Solids	mg/L	---	---	---	10000	---	7200	---	8100	---	7000
Antimony	mg/L	0.006	0.006	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050
Arsenic	mg/L	0.01	0.05	0.00089	<0.0020	0.0017	<0.0020	0.0043	<0.0020	0.0020	<0.0020
Barium	mg/L	2	2	0.012	0.013	0.0080	0.014	0.36	0.0083	0.011	0.012
Beryllium	mg/L	0.004	0.004	<0.0010	---	<0.0010	---	<0.0010	---	<0.0010	---
Cadmium	mg/L	0.005	0.005	<0.00010	<0.0010	0.00018	<0.0010	0.00089	<0.0010	<0.00010	<0.0010
Chromium	mg/L	0.1	0.1	<0.0010	<0.0050	<0.0010	<0.0050	0.020	<0.0050	<0.0010	<0.0050
Cobalt	mg/L	0.006	NS	<0.00050	**0.017**	**0.018**	0.0049	**0.022**	0.0034	0.0029	**0.018**
Fluoride	mg/L	4	4.0	<0.80	<0.80	<0.40	0.98	0.88	<0.80	<0.80	<0.80
Lead	mg/L	0.015	0.05	<0.00050	0.0012	<0.00050	<0.0010	0.028	<0.0010	<0.00050	0.0030
Lithium	mg/L	0.31	NS	0.29	**0.43**	**0.59**	**0.32**	**0.37**	**0.40**	**0.48**	0.21
Mercury	mg/L	0.002	0.002	<0.00020	---	<0.00020	---	0.00022	---	<0.00020	---
Molybdenum	mg/L	0.1	NS	0.0049	0.080	0.0046	0.068	0.0039	0.026	0.0017	0.021
Selenium	mg/L	0.05	0.05	0.00052	<0.0060	0.0084	<0.0060	0.0035	<0.0060	0.00059	<0.0060
Thallium	mg/L	0.002	0.002	<0.00010	<0.0010	<0.00010	<0.0010	0.00016	<0.0010	<0.00010	<0.0010
Alkalinity as CaCO3	mg/L	---	---	---	180	---	140	---	140	---	99
Alkalinity, Phenolphthalein	mg/L	---	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0
Bicarbonate Alkalinity as CaCO3	mg/L	---	---	---	180	---	140	---	140	---	99
Carbonate Alkalinity as CaCO3	mg/L	---	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0
Hydroxide Alkalinity as CaCO3	mg/L	---	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0
Magnesium	mg/L	---	---	---	170	---	120	---	100	---	110
Potassium	mg/L	---	---	---	4.6	---	5.5	---	5.8	---	3.0
SiO2, Silica	mg/L	---	---	---	14	---	12	---	9.6	---	11
Sodium	mg/L	---	---	---	2600	---	1800	---	2100	---	1500

Notes:

Constituents of concern are highlighted in dark green; concentrations greater than the GWPS are bolded.

Acronymns:

AWQS = Aquifer Water Quality Standard
BAP = Bottom Ash Pond
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = no standard
SU = standard units

Table 2-3
Water Quality Data Collected During Recent Groundwater Monitoring at the BAP

				Analyte Concentration by Location and Date							
				W-305	W-306	W-306	W-307	W-307	W-308	W-308	W-309
Analyte	**Units**	**GWPS**	**AWQS**	**2/15/19**	**12/7/18**	**2/15/19**	**12/8/18**	**2/15/19**	**12/8/18**	**2/15/19**	**12/8/18**
Boron	mg/L	---	---	---	1.1	---	2.4	---	0.45	---	0.42
Calcium	mg/L	---	---	---	410	---	790	---	730	---	280
Chloride	mg/L	---	---	---	1900	---	2700	---	2900	---	1300
pH	SU	---	---	---	7.9	---	7.2	---	7.1	---	8.1
Sulfate	mg/L	---	---	---	12000	---	2600	---	3000	---	2900
Total Dissolved Solids	mg/L	---	---	---	19000	---	7800	---	8300	---	6500
Antimony	mg/L	0.006	0.006	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050
Arsenic	mg/L	0.01	0.05	0.00087	0.0041	0.0053	<0.0020	0.00088	0.0023	0.0019	0.0044
Barium	mg/L	2	2	0.011	0.010	0.011	0.012	0.012	0.0082	0.0066	0.011
Beryllium	mg/L	0.004	0.004	<0.0010	---	<0.0010	---	<0.0010	---	<0.0010	---
Cadmium	mg/L	0.005	0.005	<0.00010	<0.0010	<0.00010	<0.0010	0.00028	<0.0010	<0.00010	<0.0010
Chromium	mg/L	0.1	0.1	0.0017	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050
Cobalt	mg/L	0.006	NS	**0.018**	<0.0020	0.00097	**0.076**	**0.073**	0.0033	0.00079	<0.0020
Fluoride	mg/L	4	4.0	<0.40	1.4	1.2	<0.80	<0.80	<0.80	<0.80	1.0
Lead	mg/L	0.015	0.05	0.0018	<0.0010	<0.00050	0.0020	0.00085	<0.0010	<0.00050	<0.0010
Lithium	mg/L	0.31	NS	0.22	**0.73**	**0.80**	0.24	0.26	**0.37**	**0.39**	<0.20
Mercury	mg/L	0.002	0.002	<0.00020	---	<0.00020	---	<0.00020	---	<0.00020	---
Molybdenum	mg/L	0.1	NS	0.020	0.028	0.031	0.0044	0.0045	0.032	0.0020	0.024
Selenium	mg/L	0.05	0.05	<0.00050	<0.0060	0.0021	<0.0060	0.00063	<0.0060	0.074	<0.0060
Thallium	mg/L	0.002	0.002	<0.00010	<0.0010	<0.00010	<0.0010	<0.00010	<0.0010	<0.00010	<0.0010
Alkalinity as CaCO3	mg/L	---	---	---	130	---	100	---	160	---	55
Alkalinity, Phenolphthalein	mg/L	---	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0
Bicarbonate Alkalinity as CaCO3	mg/L	---	---	---	130	---	100	---	160	---	55
Carbonate Alkalinity as CaCO3	mg/L	---	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0
Hydroxide Alkalinity as CaCO3	mg/L	---	---	---	<6.0	---	<6.0	---	<6.0	---	<6.0
Magnesium	mg/L	---	---	---	230	---	150	---	120	---	34
Potassium	mg/L	---	---	---	2.6	---	5.4	---	7.7	---	12
SiO2, Silica	mg/L	---	---	---	12	---	13	---	12	---	22
Sodium	mg/L	---	---	---	5700	---	1700	---	1900	---	1700

Notes:
Constituents of concern are highlighted in dark green; concentrations greater than the GWPS are bolded.

Acronymns:
AWQS = Aquifer Water Quality Standard
BAP = Bottom Ash Pond
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = no standard
SU = standard units

Table 2-3
Water Quality Data Collected During Recent Groundwater Monitoring at the BAP

				Analyte Concentration by Location and Date			
				W-309	W-314	W-314	W-317
Analyte	**Units**	**GWPS**	**AWQS**	**2/15/19**	**12/8/18**	**2/15/19**	**3/30/19**
Boron	mg/L	---	---	---	1.1	---	0.20
Calcium	mg/L	---	---	---	800	---	320
Chloride	mg/L	---	---	---	2700	---	1400
pH	SU	---	---	---	7.3	---	7.5
Sulfate	mg/L	---	---	---	2100	---	670
Total Dissolved Solids	mg/L	---	---	---	7700	---	3300
Antimony	mg/L	0.006	0.006	<0.0010	<0.0050	<0.0010	<0.0010
Arsenic	mg/L	0.01	0.05	0.0047	<0.0020	0.0011	0.0036
Barium	mg/L	2	2	0.0083	0.013	0.011	0.039
Beryllium	mg/L	0.004	0.004	<0.0010	---	<0.0010	<0.0010
Cadmium	mg/L	0.005	0.005	<0.00010	<0.0010	0.00017	<0.00010
Chromium	mg/L	0.1	0.1	<0.0010	0.014	0.046	0.0035
Cobalt	mg/L	0.006	NS	<0.00050	**0.014**	**0.016**	0.00085
Fluoride	mg/L	4	4.0	1.1	0.89	0.82	<0.40
Lead	mg/L	0.015	0.05	<0.00050	<0.0010	<0.00050	<0.00050
Lithium	mg/L	0.31	NS	**0.35**	**0.32**	**0.34**	<0.20
Mercury	mg/L	0.002	0.002	<0.00020	---	<0.00020	<0.00020
Molybdenum	mg/L	0.1	NS	0.028	0.0087	0.012	0.064
Selenium	mg/L	0.05	0.05	0.19	<0.0060	<0.00050	<0.00050
Thallium	mg/L	0.002	0.002	<0.00010	<0.0010	<0.00010	<0.00010
Alkalinity as CaCO3	mg/L	---	---	---	94	---	190
Alkalinity, Phenolphthalein	mg/L	---	---	---	<6.0	---	<6.0
Bicarbonate Alkalinity as CaCO3	mg/L	---	---	---	94	---	190
Carbonate Alkalinity as CaCO3	mg/L	---	---	---	<6.0	---	<6.0
Hydroxide Alkalinity as CaCO3	mg/L	---	---	---	<6.0	---	<6.0
Magnesium	mg/L	---	---	---	160	---	110
Potassium	mg/L	---	---	---	1.8	---	7.1
SiO2, Silica	mg/L	---	---	---	8.9	---	
Sodium	mg/L	---	---	---	1500	---	650

Notes:

Constituents of concern are highlighted in dark green; concentrations greater than the GWPS are bolded.

Acronymns:

AWQS = Aquifer Water Quality Standard
BAP = Bottom Ash Pond
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
NS = no standard
SU = standard units

Table 3-1
Corrective Measures Technology Screening for Releases from the FAP

Technology	Description	Benefits	Constraints and Risks	Relative Time to Benefit	Retained?
(A) Operation of existing seepage collection systems	Existing well and collection systems attempt to intercept seepage in areas where impacts at ground surface were previously observed. After coal combustion power generation activites are shut down in 2025, collected seepage will be routed to a future evaporation pond.	(1) Targets known areas of surface seepage, theoretically controlling in part, the source of impacts to the alluvium.	(1) Existing systems are not deep and/or extensive enough to intercept the seepage responsible for currently observed impacts in the alluvium.	Fast	Yes
(B) Draining/evaporation of free liquid from the FAP and closure with CCR in place	Discharges to the FAP will be controlled through water conservation measures prior to the cessation of coal combustion power generation activities*; after these activites are shut down, free liquid will be allowed to evaporate and/or be actively drained from the FAP until a date when the FAP can be closed with CCR in place. Stormwater control measures would be implemented to prevent ponding behind the dam.	(1) Reduces head in the pond which will reduce the rate of seepage from the FAP. (2) Promotes FAP closure.	(1) Reducing/eliminating the head in the FAP will reduce seepage but will take time. (2) Although a low permeability cap will be installed on the FAP after it is dewatered and engineering control measures to divert stormwater away from the FAP will be put in place, if stormwater percolates through the drained FAP, impacted seepage from the FAP could be mobilized because the CCR remains in place. (3) Will not address existing impacts in groundwater.	Slow	Yes
(C) Draining/evaporation of free liquid from the FAP and closure of the pond through CCR removal	Discharges to the FAP will be controlled through water conservation measures prior to the cessation of coal combustion power generation activities*; after these activities are shut down, free liquid will be allowed to evaporate and/or be actively drained from the FAP until the CCR can be removed and placed in an appropriately lined facility.	(1) Reduces head in the pond which will reduce the rate of seepage from the FAP. (2) Promotes FAP closure. (3) Removes a potential ongoing source of contaminant mass from the Site.	(1) Removing the CCR in the FAP will take time to dewater and excavate. (2) Potential for cross media impacts during excavation, transport and final placement at new location. (3) Logistical difficulties in locating and/or constructing a suitable facility for the excavated waste. (4) Likely concerns from the public regarding the transport of and potential exposure to the waste in transportation corridors. (5) Will not address existing impacts in groundwater.	Slow	Yes

Table 3-1
Corrective Measures Technology Screening for Releases from the FAP

Technology	Description	Benefits	Constraints and Risks	Relative Time to Benefit	Retained?
(D) Monitored natural attenuation of COCs in the impacted alluvial aquifer	The COCs would be allowed to naturally attenuate via dilution, dispersion, and adsorption. Groundwater monitoring would continue as long as COC concentrations exceed GWPSs.	(1) No active mitigation would be required.	(1) The extent of COC plumes would continue to increase until the rate of attenuation exceeds the rate of migration; expansion of the plume could occur for some time before attenuating. (2) Additional monitoring wells would likely be required to monitor migration.	Slow	Yes
(E) Containment wells sited between the dam and I-40 in the vicinity of existing seepage collection systems.	A series of containment wells would target high contaminant flux locations at the right abutments and Geronimo Knob location. Wells would need to be completed deeper than existing collection systems, targeting the alluvium and distinct transmissive layers of the Moqui, up to 50 feet deep. Extracted water would be managed in the same manner as existing seepage collection systems.	(1) Wells could be installed incrementally so that spacing and depths could be evaluated and adjusted to promote effectiveness.	(1) Containment flows from individual wells could potentially be very low with only localized impacts. (2) The technology does not address the COC plume in the alluvium downgradient of the dam.	Fast	Yes
(F) Containment wells sited south of I-40 in downgradient alluvium	Containment wells would be located hydraulically downgradient in the alluvium across from the highway and sited to optimize the objectives of plume containment and treatment. Extracted water would be managed in the same manner as existing seepage collection systems.	(1) Could be more effective in containing a larger extent of the plume than containment wells located near the dam.	(1) Aquifer properties may require a series of wells to adequately contain and treat the plume. (2) Extraction systems would likely need to operate for long durations to clean up the COC plume. (3) Placement of the wells may be constrained by property ownership.	Moderate	Yes
(G) Gravel filled seepage collection trench (up to 50 ft deep)	A deep seepage collection system would be installed through the alluvium and into the Moqui. The trench would be backfilled with gravel and be a higher permeability than the adjacent units. Pumps would be installed in sumps located in the trench to pump seepage from the trench. Extracted water would be managed in the same manner as existing seepage collection systems.	(1) Could be very effective in intercepting seepage if adequate design information can be collected in advance of installation.	(1) A predesign investigation would need to be conducted. (2) The trench would likely need to extend into the Moqui and the length could be extensive; there is a risk that trenching into the Moqui could compromise vertical migration through the Moenkopi where the unit is thin. (3) The technology does not address the COC plume in the alluvium downgradient of the dam.	Moderate	Yes

Table 3-1
Corrective Measures Technology Screening for Releases from the FAP

Technology	Description	Benefits	Constraints and Risks	Relative Time to Benefit	Retained?
(H) Partial cutoff walls along the right and left portions of dam, with a groundwater extraction system near the center of the dam in the alluvium.	A cutoff slurry wall would be installed along the right and left side, along portions where the slurry cutoff wall beneath the dam was not installed. This would funnel flow to the center in alluvium where multiple wells would be installed to extract the groundwater from the subsurface. Extracted water would be managed in the same manner as existing seepage collection systems.	(1) The cutoff wall would increase the effectiveness of containment wells located in the alluvium.	(1) A predesign investigation would need to be conducted. (2) The trench would likely need to extend into the Moqui and the length could be extensive; there is a risk that trenching into the Moqui could compromise vertical migration through the Moenkopi where the unit is thin. (3) The technology may not address the COC plume in the alluvium downgradient of the dam, depending on where the cutoff wall is placed.	Moderate	No

Notes:

* Dewatering of the FAP for pond closure is not feasible prior to the cessation of coal combustion power generation activities in 2025 unless a new fly ash disposal facility is constructed. Siting, design and construction of a new facility would require three to four years to be operational. Since starting this work sooner than 2025 would have an immaterial impact on the time to achieve completion of the remedy, construction of a new fly ash pond is not considered a viable option.

FAP = Fly Ash Pond
COCs = Constituent of concerns (i.e., fluoride, lithium, and molybdenum)
GWPS = Groundwater Protection Standard

Table 3-2
Evaluation of Corrective Measures for the FAP

Corrective Measures	Performance and Reliability	Ease of Implementation	Potential Impacts[a]	Time to Begin Remedy	Time to Complete the Remedy	Institutional Requirements[b]
Alternative 1: (A) Operation of existing seepage collection systems (B/C) Draining/evaporation of free liquid from the FAP with closure either in place or by CCR removal (D) Natural attenuation of COCs in the impacted alluvial aquifer *As modeled: The October/December 2018 fluoride plume and hydraulic heads were evaluated in a transient, three-layer groundwater flow and transport model.*	Existing seepage collection systems do not prevent the discharge of all seepage from the FAP to the alluvium and thus may not effectively reduce the source and magnitude of risk until there is no free liquid in the FAP or the CCR has been removed from the FAP. If the CCR is removed after dewatering, the risk of future impacted seepage is lessened. However, the COCs will likely continue to be present at concentrations exceeding GWPSs in alluvial groundwater downgradient of the FAP for some time.	CMs for existing collection systems and wells are in place - long term-operation and management are required. Additional wells will likely be necessary to monitor impacts over time as the plume continues to migrate - these wells may not be located on APS property which would require coordination with neighboring property owners. A small amount of at least one of the COC plumes has already migrated offsite which could elicit concerns from the downgradient property owner. Removal of CCR as part of closure would be logistically intensive, requiring locating and/or constructing a suitable facility and arranging for transport of large quantities of waste between the Site and the facility, likely on public thoroughfares.	No human or ecological receptors are currently known to be impacted. If excavation of CCR is conducted, there would be a potential for cross media impacts during excavation (to air via dust and to surface water via runoff), transport (through spills, accidents, and/or transport vessel contamination), and final placement (if the receiving facility is not properly constructed or the integrity of the facility degrades over time).	Seepage collection systems are currently in place. Dewatering and pond closure will begin in 2025 (dewatering could take 10 or more years). Expansion of the monitoring system would be conducted as required.	*The groundwater model predicts fluoride will attenuate to concentrations less than the GWPS by 2080 (in 61 years or 44 years after removal of the source of seepage by draining and/or removing the CCR present in the FAP)*	Future wells would require ADWR permitting. If the CCR is removed, waste characterization/ management activities and permitting of the new facility where the excavated CCR is placed by ADEQ under the Aquifer Protection Permit program would be required.

Table 3-2
Evaluation of Corrective Measures for the FAP

Corrective Measures	Performance and Reliability	Ease of Implementation	Potential Impacts[a]	Time to Begin Remedy	Time to Complete the Remedy	Institutional Requirements[b]
Alternative 2: (A) Operation of existing seepage collection systems (B/C) Draining/evaporation of free liquid from the FAP with closure either in place or by CCR removal (D) Natural attenuation of COCs in the impacted alluvial aquifer (E/G) Containment wells/seepage collection trench sited north of I-40 *As modeled: 14 hypothetical pumping wells (in an evenly spaced line adjacent to the dam) extracting groundwater at a total rate of 335 gpm were evaluated using a transient, three-layer groundwater flow and transport model.*	New containment wells located north of I-40 that intercept seepage to the alluvium could reduce the source and magnitude of risk resulting from future FAP seepage. Alternatively, a seepage collection trench could be installed in the same location. COCs would continue to be present at concentrations exceeding GWPSs in alluvial groundwater downgradient of the FAP for some time.	The location, quantity and construction of new containment wells would likely be developed iteratively to promote effective seepage interception. Long term operation and management would be required. Downgradient impacts would be the same as Alternative 1.	Same as Alternative 1.	A new containment well installation program can begin within 3 months of remedy selection. Completion of constructible portions of the remedy could require 12 to 48 months.	Once new containment wells are in place - they would need to be operated for as long as adverse impacts from seepage occur (likely at least as long as there is standing water in the FAP). *The groundwater model predicts fluoride will exceed the GWPS until 2045 (for 26 years) with containment well operation.*	Same as Alternative 1.
Alternative 3: (A) Operation of existing seepage collection systems (B/C) Draining/evaporation of free liquid from the FAP with closure either in place or by CCR removal (D) Natural attenuation of COCs in the impacted alluvial aquifer (F) Containment wells sited on the south side of I-40 in the alluvium *As modeled: 15 hypothetical pumping wells (in an evenly spaced line along the southern edge of I-40) extracting groundwater at a total rate of 375 gpm were evaluated using a transient, three-layer groundwater flow and transport model.*	Downgradient containment wells could assist in containing the migration and extent of the COC plumes.	The location, quantity and design of new containment wells would likely be developed iteratively to promote effective seepage/COC plume interception. Long term operation and management would be required. Operation of containment wells on the southern side of I-40 could mitigate concerns that the plume may be migrating offsite.	Same as Alternative 1.	A new containment well installation program can begin within 3 months of remedy selection for wells that are located on APS property; initiation of an offsite well program could take 12 to 24 months and require another 12 to 36 months for construction completion.	Once new containment wells are in place - they would need to be operated for as long as adverse impacts from seepage occur (likely at least as long as there is standing water in the FAP). Downgradient containment wells would need to be operated until GWPSs are achieved or reasonably expected to be achieved based on a natural attenuation analysis. *The groundwater model predicts fluoride will exceed the GWPS until 2055 (for 36 years) with containment well operation.*	Same as Alternative 1.

Table 3-2
Evaluation of Corrective Measures for the FAP

Corrective Measures	Performance and Reliability	Ease of Implementation	Potential Impacts[a]	Time to Begin Remedy	Time to Complete the Remedy	Institutional Requirements[b]
Alternative 4: (A) Operation of existing seepage collection systems (B/C) Draining/evaporation of free liquid from the FAP with closure either in place or by CCR removal (D) Natural attenuation of COCs in in the impacted alluvial aquifer (E/G) Containment wells/seepage collection trench sited north of I-40 (F) Containment wells sited on the south side of I-40 in the alluvium *As modeled: 29 hypothetical pumping wells extracting groundwater at a total rate of 710 gpm were evaluated using a transient, three-layer groundwater flow and transport model.*	New containment wells or a seepage trench located north of I-40 that intercept seepage to the alluvium could reduce the source and magnitude of risk resulting from future FAP seepage. Downgradient containment wells could assist in containing the migration and extent of the COC plumes.	The location, quantity and design of new containment wells would likely be developed iteratively to promote effective seepage/COC plume interception. Long term operation and management would be required. Operation of containment wells on the southern side of I-40 could mitigate concerns that the plume may be migrating offsite.	Same as Alternative 1.	A new containment well installation program can begin within 3 months of remedy selection if wells are located on APS property; initiation of offsite well program could take 12 to 24 months and require another 12 to 48 months for construction completion.	Once new containment wells are in place - they would need to be operated for as long as adverse impacts from seepage occur (likely at least as long as there is free liquid in the FAP). Downgradient containment wells would need to be operated until GWPSs are achieved or reasonably expected to be achieved based on a natural attenuation analysis. *The groundwater model predicts fluoride will exceed the GWPS until 2041 (for 22 years with containment well operation).*	Same as Alternative 1.

Notes:
FAP = Fly Ash Pond
COCs = Constituents of concern (i.e., fluoride, lithium, and molybdenum)
GWPS(s) = Groundwater Protection Standard(s)

(a) Including safety impacts, cross-media impacts, and control of exposure to any residual contamination.
(b) Such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

Table 3-3
Corrective Measure Technology Screening for Releases from the BAP

Technology	Description	Benefits	Constraints and Risks	Relative Time to Benefit	Retained?
(A) Operation of existing seepage collection systems	Existing well and trench-based collection systems intercept seepage to the south and east of the dam and discharge to the BAP. After coal combustion power generation activites are shut down in 2025, collected seepage will be routed to a future evaporation pond.	(1) Targets known areas of surface seepage, theoretically controlling in part, the source of impacts to the alluvium.	(1) Existing systems are not deep and/or extensive enough to intercept the seepage responsible for currently observed impacts in the alluvium.	Fast	Yes
(B) Draining/evaporation of free liquid from the BAP	Solids would continue to be dewatered and a portion of the clarified water in the BAP would continue to be piped to the plant for reuse until 2025; after the cessation of coal combustion power generation activities*, free liquid would either be drained from the BAP or allowed to evaporate.	(1) Reduces head in the pond which will reduce the rate of seepage from the BAP. (2) Promotes BAP closure.	(1) The volume of water to be drained is significant and could require an extensively sized evaporation pond if active dewatering is conducted. If evaporation is the only mechanism for removing water from the pond, the time to implement this measure would be longer.	Slow	Yes
(C) Draining/evaporation of free liquid from the BAP and closure of the pond through CCR removal	Solids would continue to be dewatered and a portion of the clarified water in the BAP would continue to be piped to the plant for reuse until 2025; after the cessation of coal combustion power generation activities*, free liquid will be allowed to evaporate and/or be actively drained from the BAP until the CCR can be removed and placed in an appropriately lined facility.	(1) Reduces head in the pond which will reduce the rate of seepage from the BAP. (2) Promotes BAP closure. (3) Removes a potential ongoing source of contaminant mass from the Site.	(1) Removing the CCR in the BAP will take time to dewater and excavate. (2) Potential for cross media impacts during excavation, transport and final placement at new location. (3) Logistical difficulties in locating and/or constructing a suitable facility for the excavated waste. (4) Likely concerns from the public regarding the transport of and potential exposure to the waste in transportation corridors. (5) Will not address existing impacts in groundwater.	Slow	Yes
(D) Natural attenuation of the COC in the impacted alluvial aquifer	The COC would be allowed to naturally attenuate via dilution, dispersion, and adsorption. Groundwater monitoring would continue as long as COC concentrations exceed the GWPS.	(1) No active mitigation would be required.	(1) The extent of the COC plume would continue to increase until the rate of attenuation exceeds the rate of migration; expansion of the plume could occur for some time before attenuating. (2) Additional monitoring wells would likely be required to monitor migration.	Slow	Yes

Table 3-3
Corrective Measure Technology Screening for Releases from the BAP

Technology	Description	Benefits	Constraints and Risks	Relative Time to Benefit	Retained?
(E) Containment wells sited adjacent to the south and east of the dam	A series of containment wells would target high contaminant flux locations close to the south and east of the dam. Wells would need to be completed deeper than existing collection systems, potentially targeting possibly distinct beds in the Moenkopi.	(1) Wells could be installed incrementally so that spacing and depths could be evaluated and adjusted to promote effectiveness. (2) A deep well sited near W-305 and W-306 may have significant impact in intercepting COC flux from the dam at depth.	(1) Containment flows from individual wells could potentially be very low with only localized impacts. (2) Targeting appropriate locations on the east side of the BAP could be difficult and may require a series of wells greater than 50 feet deep. (3) The technology does not address the COC plume in the alluvium downgradient of the dam.	Fast	Yes
(F) Containment wells sited further downgradient from the dam in alluvium	Containment wells would be located hydraulically downgradient in the Tanner Wash Alluvium and sited to optimize the objectives of plume containment and treatment.	(1) Could be more effective in containing a larger extent of the plume than containment wells located in shallow alluvium, near the dam.	(1) Wells would likely need to be located on non-APS property limiting ability to implement and access. (2) Extraction systems would likely need to extract significant quantities of water and operate for long durations to clean up the COC plume.	Moderate	No
(G) Collection trenches on east side of the dam	A deeper seepage collection system would be installed than currently exists. The current systems on the east side of the BAP are approximately 40 feet in depth or shallower and address visible seeps; there may be impacted seepage discharging deeper in the alluvium than the current systems can address.	(1) Could be very effective in intercepting seepage on the east side of the dam if adequate design information can be collected in advance of installation.	(1) A predesign investigation of the eastern dam area would need to be conducted. (2) The trench would likely need to extend into the Moqui and the length could be extensive. (3) The technology does not address the COC plume in the alluvium downgradient of the dam.	Moderate	Yes
(H) Cutoff wall along the east side of the dam with containment wells	A cutoff slurry wall would be installed along the east side of the dam to enhance the effectiveness of containment wells located between the dam and the cutoff wall.	(1) Would increase the effectiveness of containment wells located along the eastern side of the dam.	(1) The cutoff would likely need to extend into the Moqui and the length could be extensive. (2) The technology does not address the COC plume in the alluvium downgradient of the dam.	Moderate	Yes

Table 3-3
Corrective Measure Technology Screening for Releases from the BAP

Technology	Description	Benefits	Constraints and Risks	Relative Time to Benefit	Retained?
(I) Permeation grouting on the south side of the dam in the alluvium at the base of the slurry cutoff wall	Permeation grouting would target the gap of alluvium beneath the southern slurry cutoff wall with injected grout (the slurry cutoff wall placed during construction was not keyed into bedrock at the deepest portion of the alluvial channel).	(1) Could be very effective in reducing seepage from the southern side of the dam if successfully implemented.	(1) May be difficult to assess effectiveness and additional control along the southern side of the dam may still be required to address localized flux through the dam. (2) The technology does not address the COC plume in the alluvium downgradient of the dam.	Moderate	No

Notes:

* Dewatering of the BAP for pond closure is not feasible prior to the cessation of coal combustion power generation activities in 2025 unless a new bottom ash disposal facility is constructed. Siting, design and construction of a new facility would require three to four years to be operational. Since starting this work sooner than 2025 would have an immaterial impact on the time to achieve completion of the remedy, construction of a new bottom ash pond is not considered a viable option.

BAP = Bottom Ash Pond
COC = Constituent of concern (i.e., cobalt)
GWPS = Groundwater Protection Standard

Table 3-4
Evaluation of Corrective Measures for the BAP

Corrective Measures	Performance and Reliability	Ease of Implementation	Potential Impacts[a]	Time to Begin Remedy	Time to Complete the Remedy	Institutional Requirements[b]
Alternative 1: (A) Operation of existing seepage collection systems (B/C) Draining/evaporation of free liquid from the BAP and closure of the unit with CCR in place or by removal (D) Natural attenuation of COC in the impacted alluvial aquifer *As modeled: The December 2018 cobalt plume and hydraulic heads were evaluated in a transient, three-layer groundwater flow and transport model.*	Existing seepage collection systems do not prevent the discharge of all seepage from the BAP to the alluvium and thus may not effectively reduce the source and magnitude of risk until there is no free liquid in the BAP or the CCR has been removed from the BAP. If the CCR is removed after dewatering, the risk of future impacted seepage is lessened. However, the COC would continue to be present at concentrations exceeding GWPSs in alluvial groundwater downgradient of the BAP for some time.	CMs for existing collection systems and wells are in place - long term-operation and management would be required. Additional wells will likely be necessary to monitor impacts over time - these wells may not be located on APS property which would require coordination with neighboring property owners. The plume has already migrated offsite which could elicit concerns from downgradient property owners. Removal of CCR as part of unit closure would be logistically intensive, requiring locating and/or constructing a suitable facility and arranging for transport of large quantities of waste between the Site and the facility on transporation corridors.	No human or ecological receptors are currently known to be impacted. If excavation of CCR is conducted, there would be a potential for cross media impacts during excavation (to air via dust and surface water via runoff), transport (through spills and/or transport vessel contamination), and final placement (if the receiving facility is not properly constructed or the integrity of the facility degrades over time).	Seepage collection systems are currently in place. Dewatering and pond closure will begin in 2025 (dewatering could take years). Expansion of the monitoring system would be conducted as required.	Difficult to estimate. *The groundwater model predicts cobalt will exceed the GWPS for over 100 years with only natural attenuation to address residual COC mass in the system.*	Future wells would require ADWR permitting. If the CCR is removed, waste characterization and management activities would be required.
Alternative 2: (A) Operation of existing seepage collection systems (B/C) Draining/evaporation of free liquid from the BAP and closure of the unit with CCR in place or by removal (D) Natural attenuation of COC in the impacted alluvial aquifer (E/G/H) Containment wells or seepage trenches sited adjacent to the south and east of the dam with potential cut off walls *As modeled: 15 hypothetical pumping wells (in an evenly spaced line adjacent to the dam) extracting groundwater at a total rate of 375 gpm were evaluated using a transient, three-layer groundwater flow and transport model.*	New on-site containment wells or seepage collection trenches that intercept seepage to the alluvium could reduce the source and magnitude of risk resulting from future BAP seepage. However, the COC would continue to be present at concentrations exceeding GWPSs in alluvial groundwater downgradient of the BAP for some time.	The location, quantity and construction of new containment wells would likely be developed iteratively to promote effective seepage interception. Long term operation and management would be required. Offsite impacts would be the same as Alternative 1.	Same as Alternative 1.	A new containment well installation program can begin within 3 months of remedy selection if wells are located on APS property. Completion of constructible portions of the remedy could require 12 to 48 months.	Difficult to estimate. Once new containment wells are in place - they would need to be operated for as long as adverse impacts from seepage occur (likely at least as long as there is standing water in the BAP). *The groundwater model predicts cobalt will exceed the GWPS until 2126 (for 107 years) with containment pumping as described.*	Same as Alternative 1.

Notes:
BAP = Bottom Ash Pond
COC = Constituent of concern (i.e., cobalt)
GWPS = Groundwater Protection Standard

[a] Including safety impacts, cross-media impacts, and control of exposure to any residual contamination.
[b] Such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

FIGURES

Job No.	14-2018-2040
PM:	NC
Date:	5/31/2019
Scale:	1" = 1.5 miles

The map shown here has been created with all due and reasonable care and is strictly for use with Wood Environment & Infastructure Solutions, Inc. Project Number 14-2018-2040. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. Wood Environment & Infrastructure Solutions, Inc. assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.

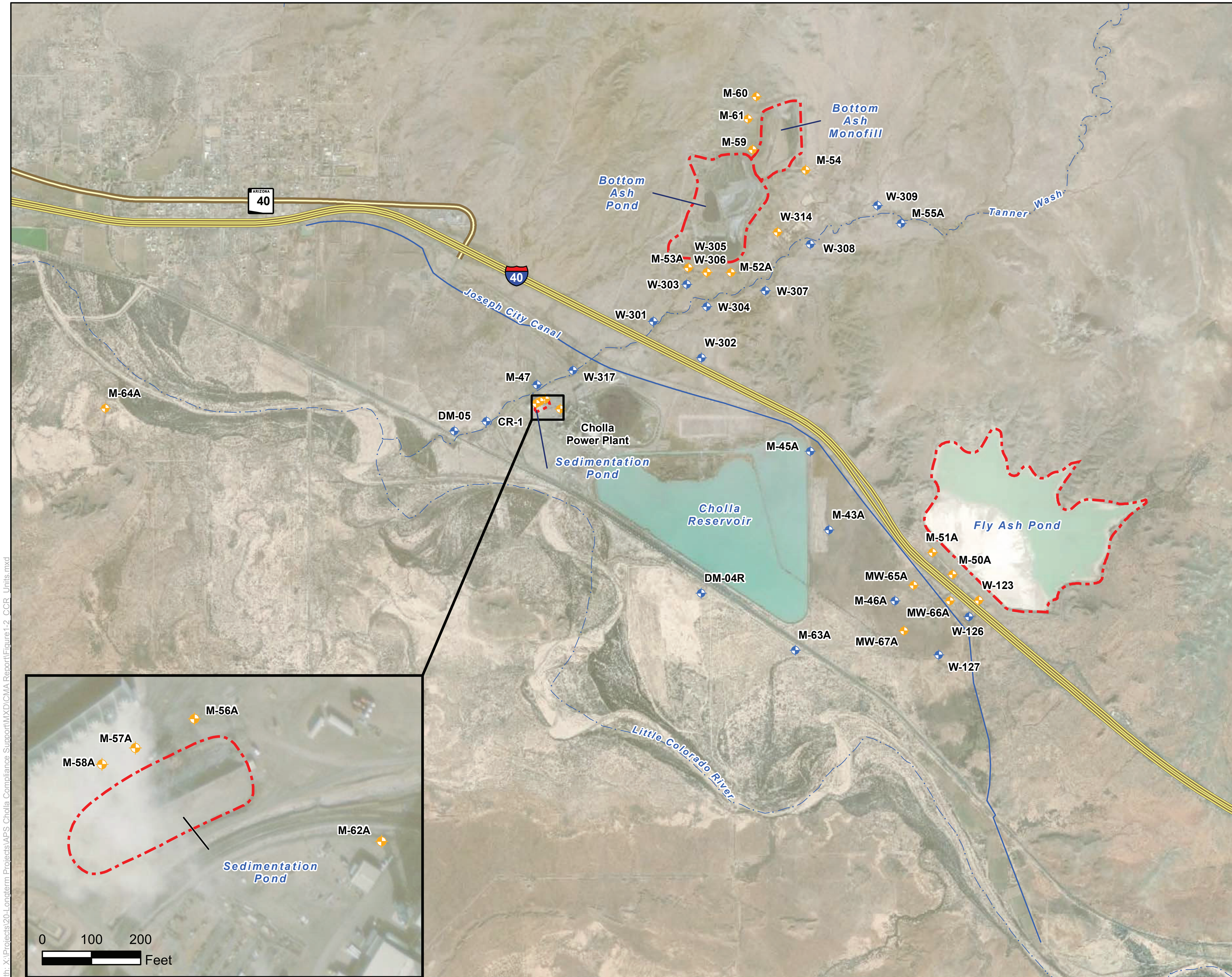
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

Site Location Map

FIGURE
1-1

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure1-1_SiteLocationMap.mxd



Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Ephemeral Surface Water Feature
- Canal
- Approximate Extent of CCR Unit

Notes:

CCR Coal Combustion Residuals

0 1,250 2,500
Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

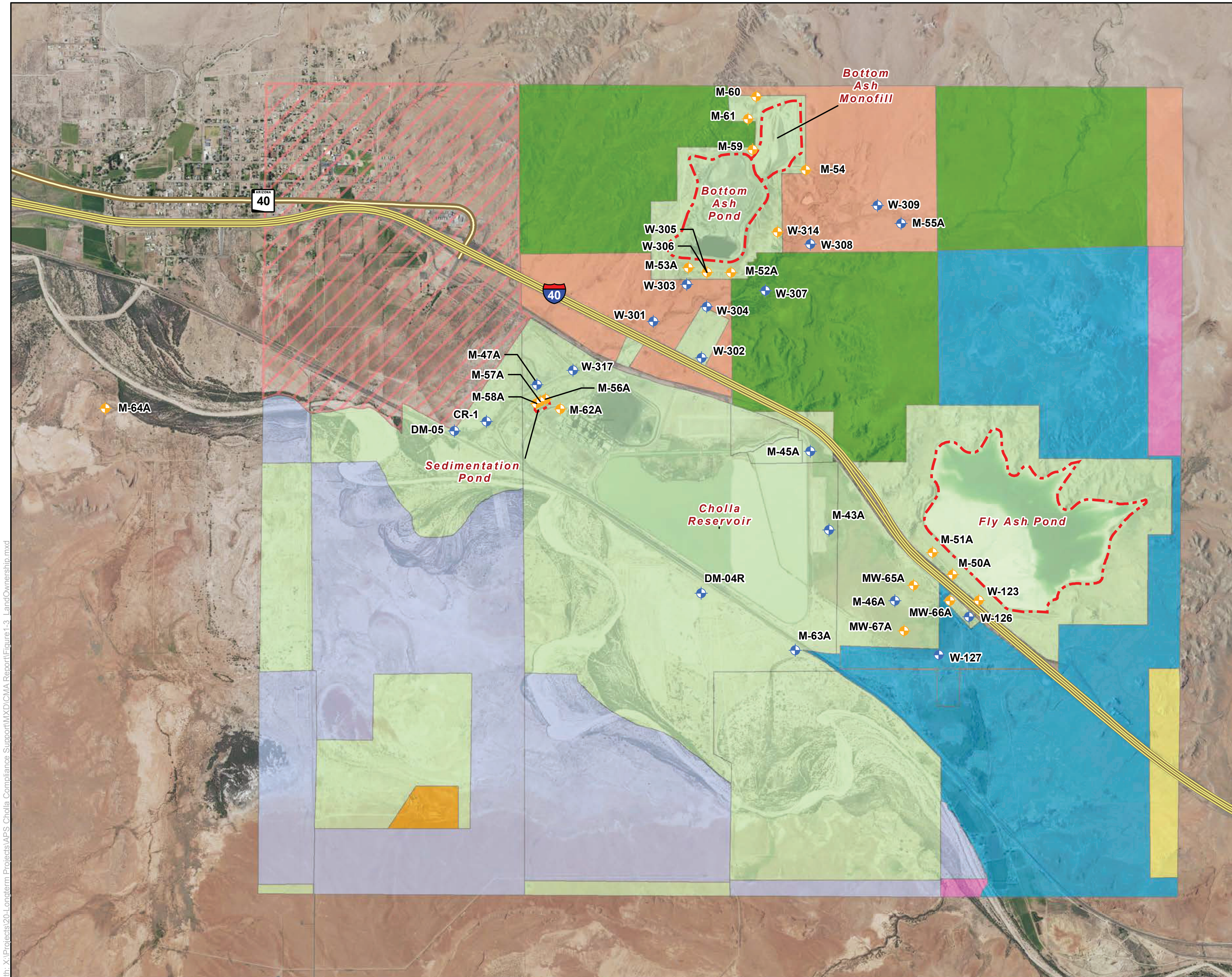
FIGURE **1-2**

CCR Units and Monitoring System Summary

Job No. 1420182040
PM: NCL
Date: 6/12/2019
Scale: 1"= 2500'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure1-2_CCR_Units.mxd



Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Approximate Extent of CCR Unit
- Hansen Family
- Hunt Family
- Arizona Public Service
- Arizona State Land Department
- Aztec
- DeSpain Ranch Trust Land
- Federal (BLM)
- US Forest Service
- Other Ownership

NOTES:
Parcel sizes and shapes are approximate.

Property Ownership Information Sources:
1. Navajo County Assessor Property Tax Map
2. Arizona State Land Department Land Ownership shapefile

0 1,250 2,500 Feet

N

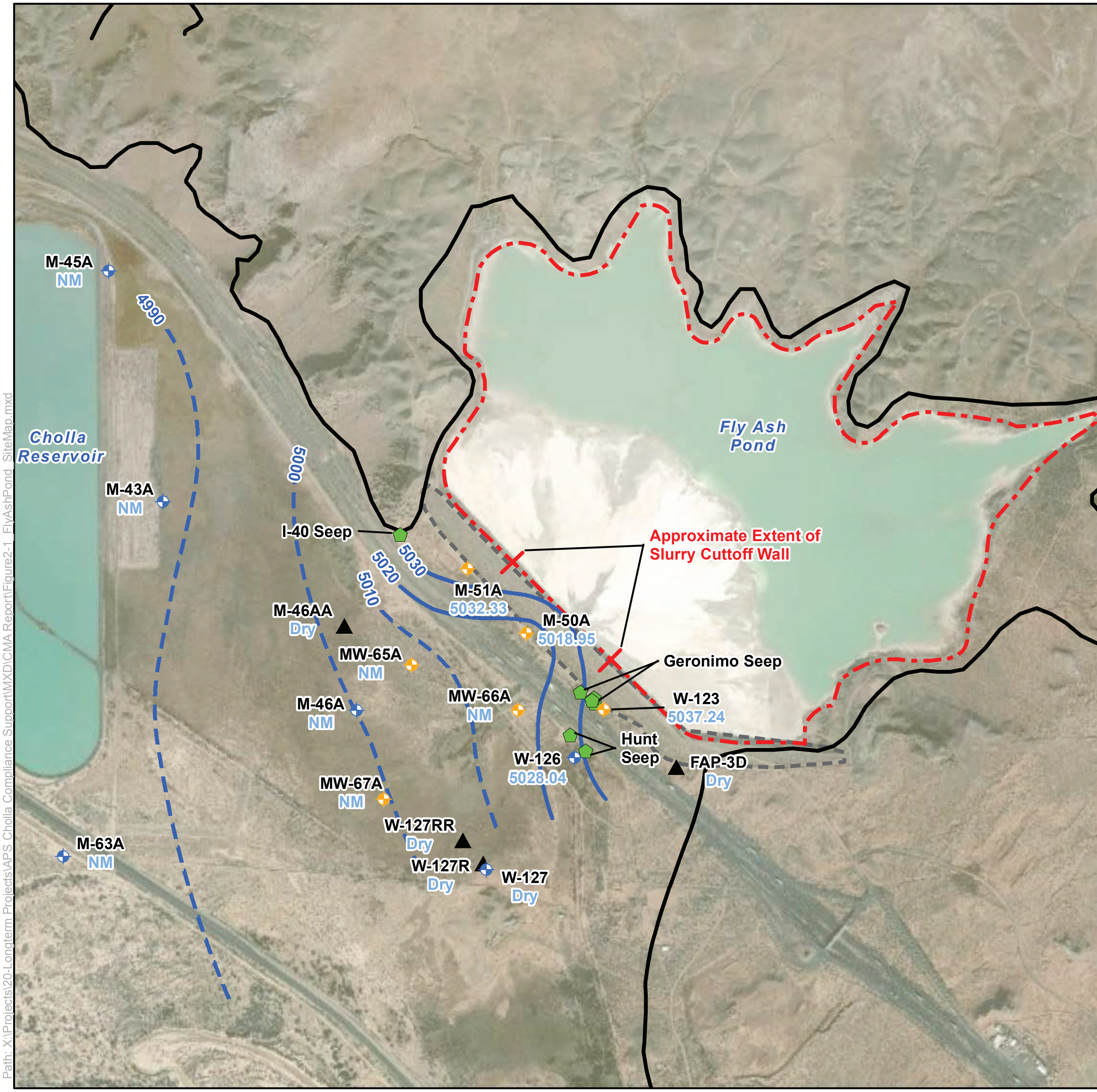
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE **1-3** **Land Ownership**

Job No. 1420182040
PM: NCL
Date: 6/12/2019
Scale: 1"= 2500'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure1-3_LandOwnership.mxd



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Seep and Collection System Location
- Abandoned Boring
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- Approximate Extent of Dam

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.24	Groundwater elevation (ft amsl) measured in October 2018
NM	Not Measured
ft amsl	Feet above mean sea level

0 625 1,250 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

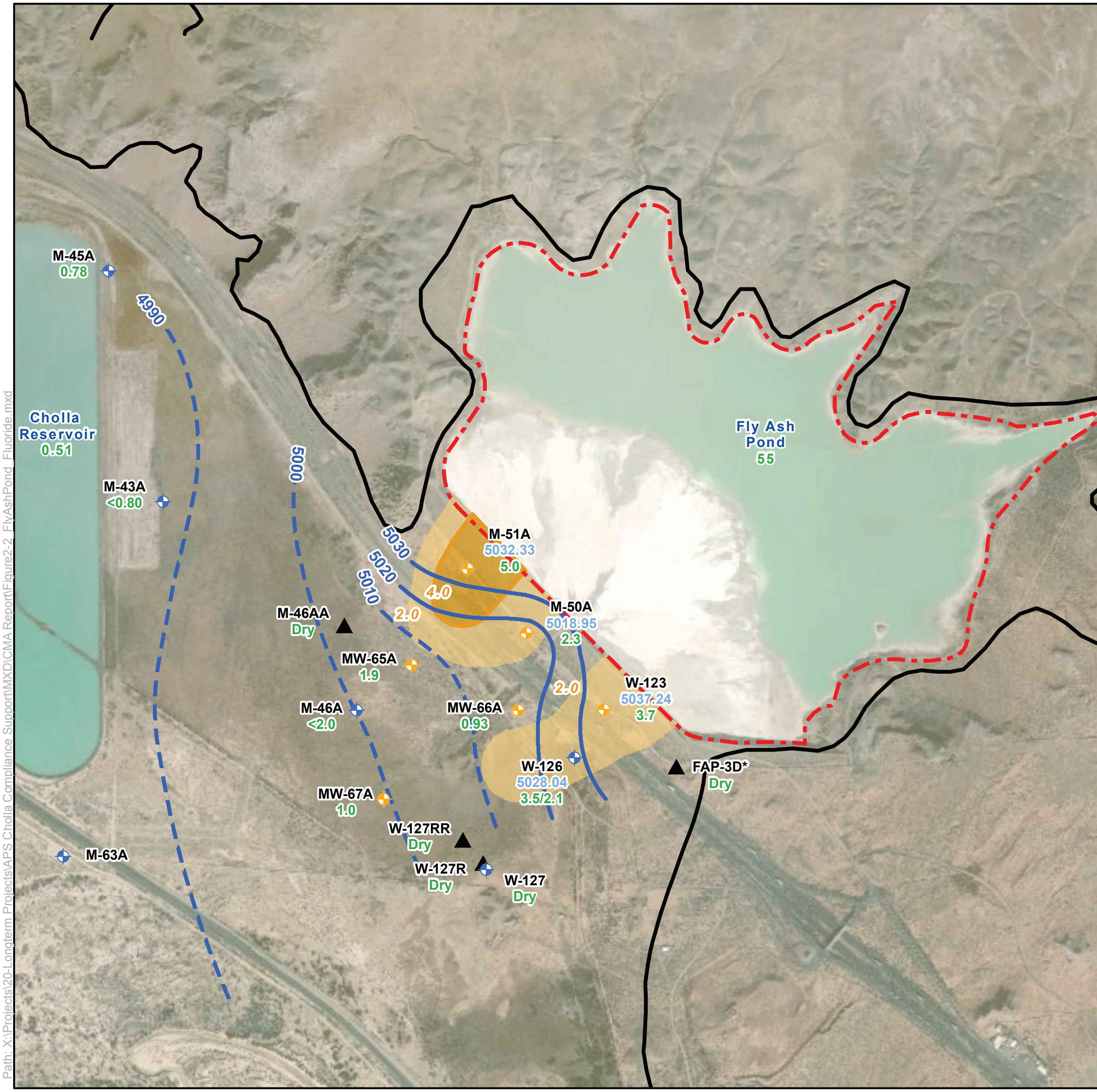
FIGURE **2-1**

Existing Infrastructure at the Fly Ash Pond

Job No. 1420182040
PM: NCL
Date: 6/12/2019
Scale: 1"= 1250'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure2-1_FlyAshPond_SiteMap.mxd



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Abandoned Boring
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Fluoride Concentration in Alluvial Aquifer (October-December 2018)

- 2 mg/L
- 4 mg/L
- GWPS (4 mg/L; Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.24	Groundwater elevation (ft amsl) measured in October 2018
4.0	Fluoride concentration (mg/L)
*	Estimated location per Montgomery & Associates, (September 19, 2017)
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

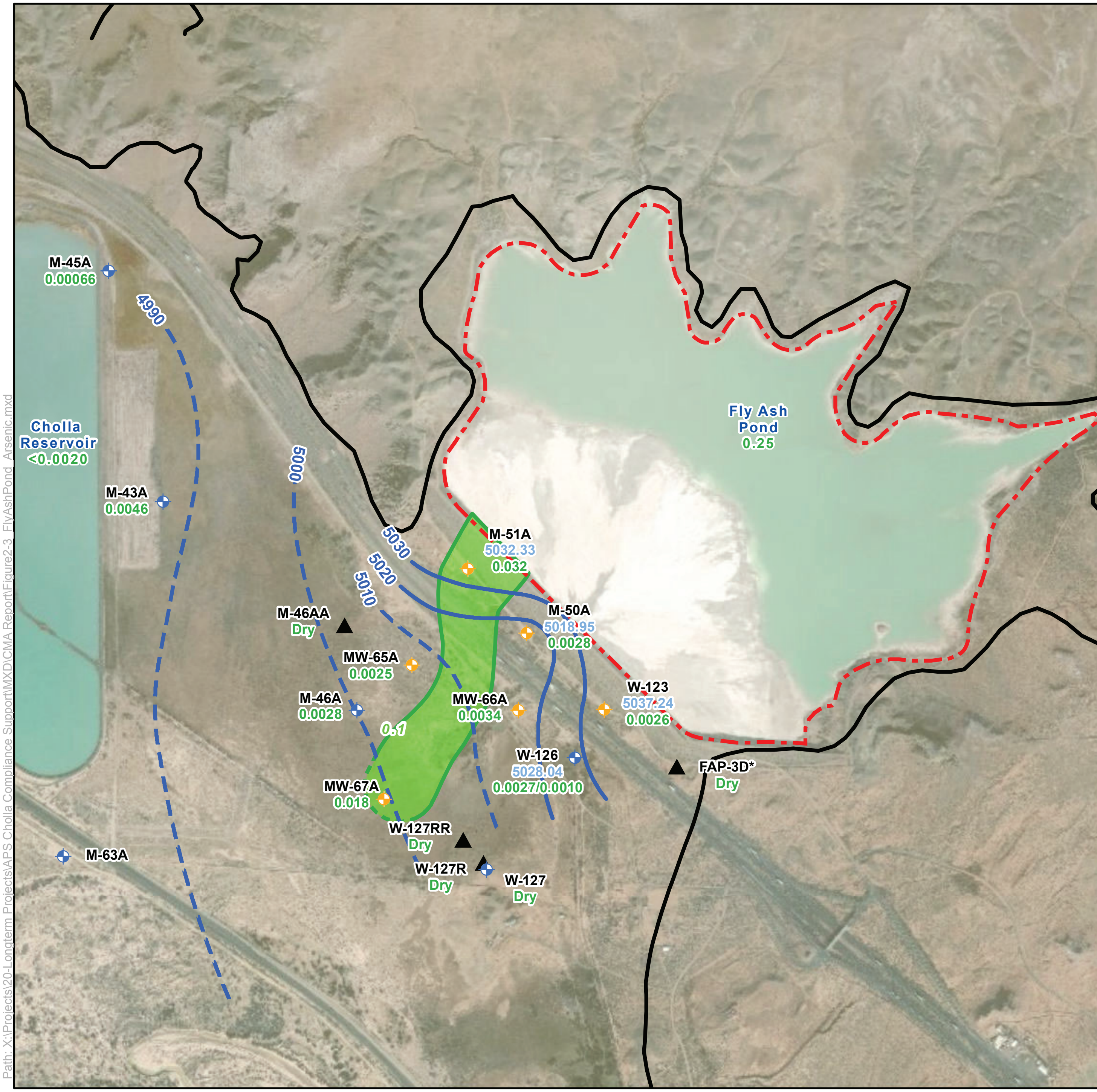
FIGURE 2-2

Fluoride Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 1250'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure2-2_FlyAshPond_Fluoride.mxd



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Abandoned Boring
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Arsenic Concentration in Alluvial Aquifer (October-December 2018)

- >0.01 mg/L
- GWPS (0.01 mg/L; Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.24	Groundwater elevation (ft amsl) measured in October 2018
0.0026	Arsenic concentration (mg/L)
*	Estimated location per Montgomery & Associates, (September 19, 2017)
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

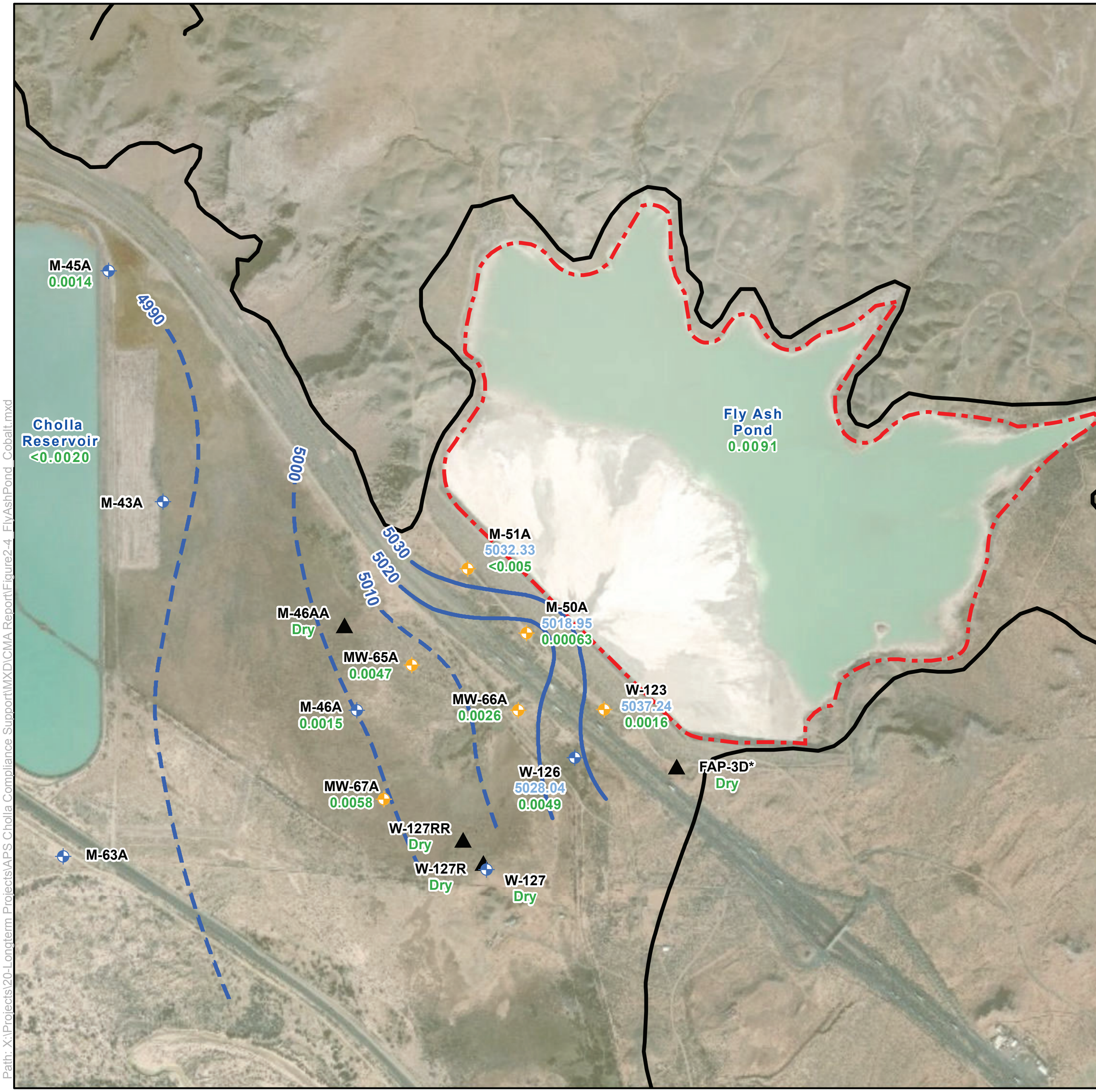
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 2-3

Arsenic Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 1250'

wood.



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well
- Abandoned Boring
- Estimated Alluvial
- Approximate Extent of CCR Unit

Potentiometric Surface - October

- (Dashed Where Inferred)

GWPS for Cobalt is 0.006 mg/L (no exceedences)

Notes:

W-123	Well Identification
5037.24	Groundwater elevation (ft amsl) measured in October 2018
0.0016	Cobalt concentration (mg/L)
*	Estimated location per Montgomery & Associates, (September 19, 2017)
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

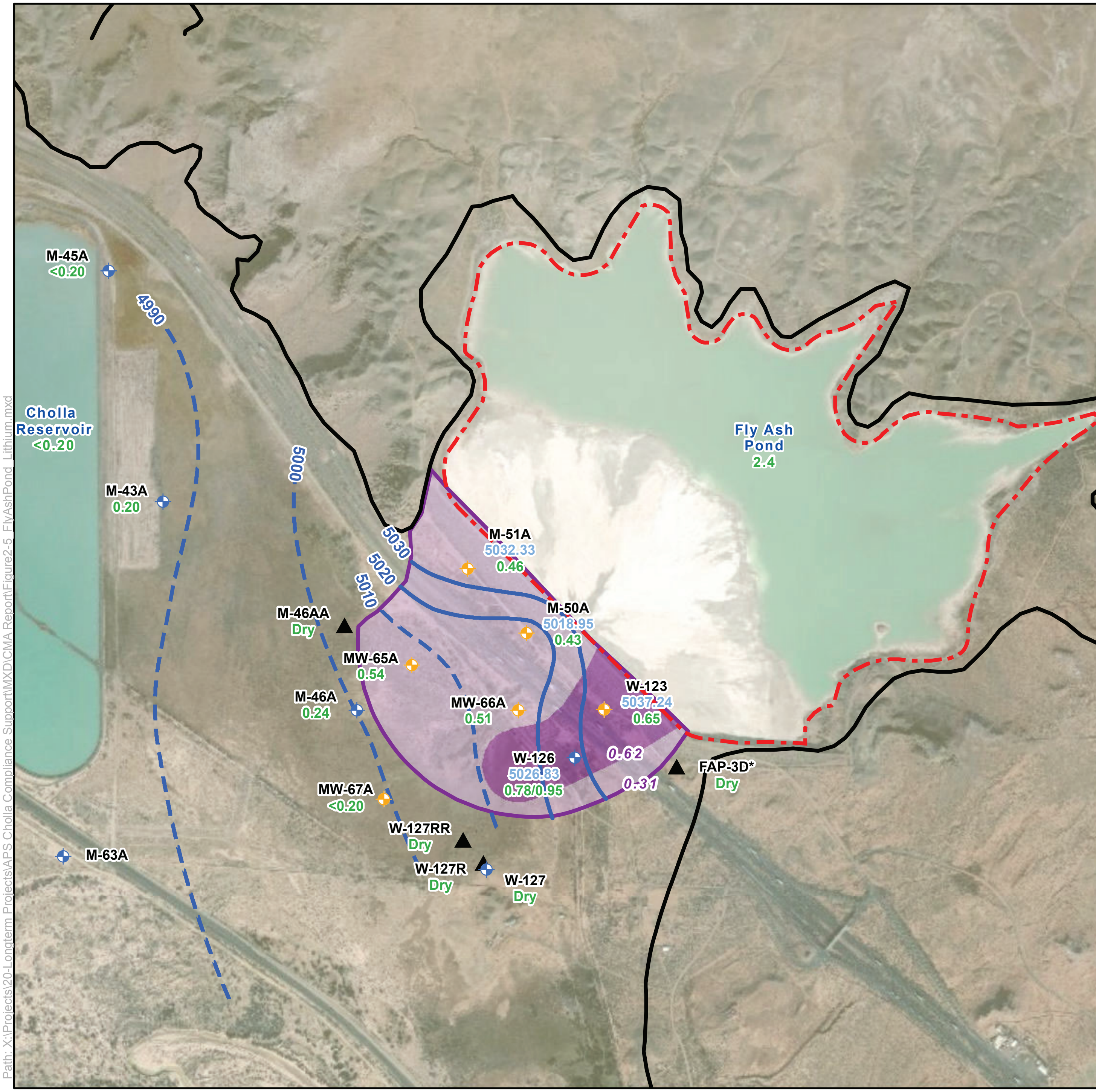
FIGURE 2-4

Cobalt Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 1250'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure2-4_FlyAshPond_Cobalt.mxd



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Abandoned Boring
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Lithium Concentration in Alluvial Aquifer (October-December 2018)

- >0.31 mg/L
- >0.62 mg/L
- GWPS (0.31 mg/L; Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.24	Groundwater elevation (ft amsl) measured in October 2018
0.65	Lithium concentration (mg/L)
*	Estimated location per Montgomery & Associates, (September 19, 2017)
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

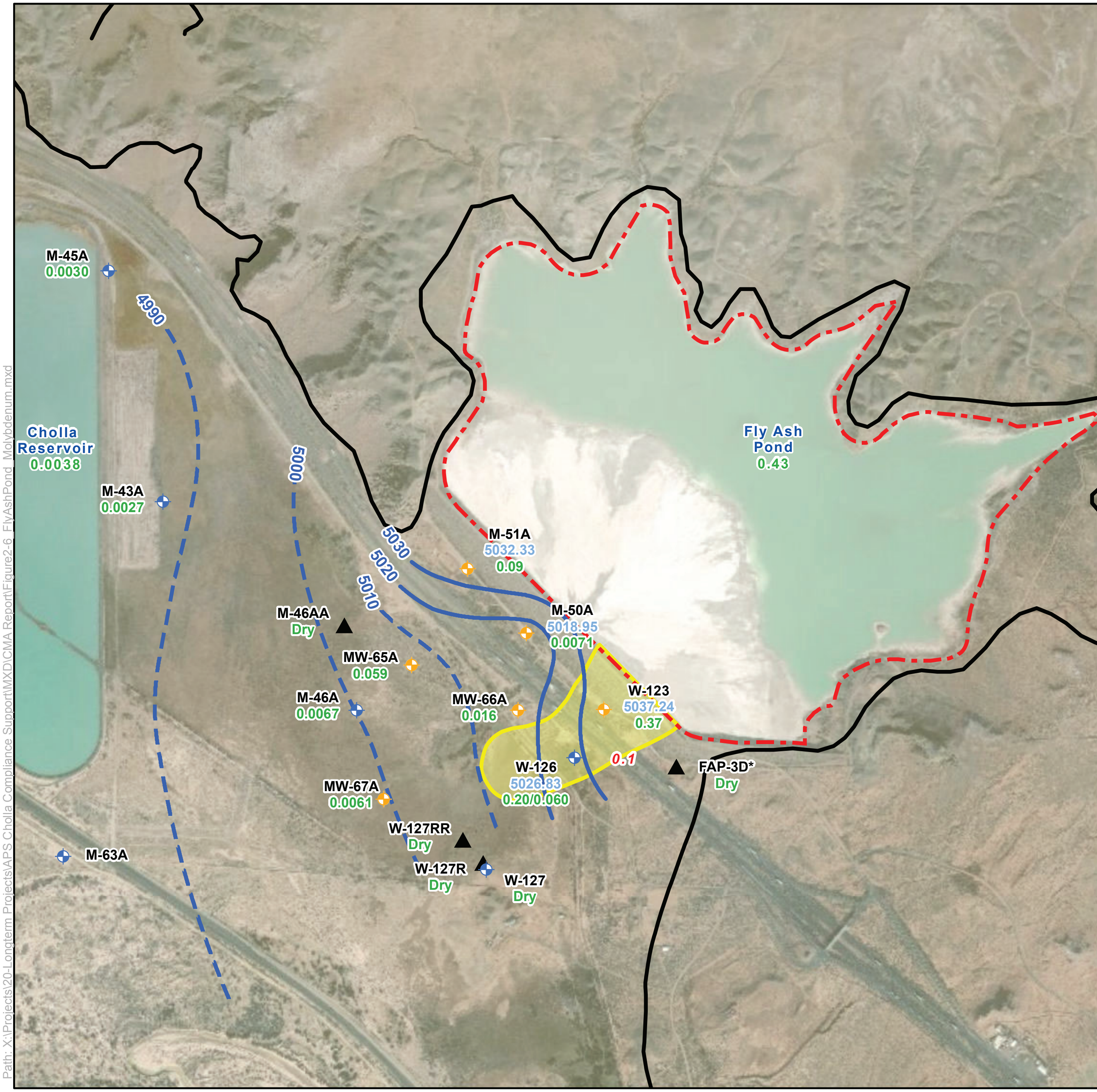
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE **2-5**

Lithium Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 1250'

wood.



Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure2-6_FlyAshPond_Molybdenum.mxd

State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Abandoned Boring
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Molybdenum Concentration in Alluvial Aquifer (October-December 2018)

- >0.1 mg/L
- GWPS (0.1 mg/L; Dashed Where Inferred)

Notes:

W-123	Well Identification
5037.24	Groundwater elevation (ft amsl) measured in October 2018
0.37	Molybdenum concentration (mg/L)
*	Estimated location per Montgomery & Associates, (September 19, 2017)
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
GWPS	Groundwater Protection Standard

0 625 1,250 Feet

N

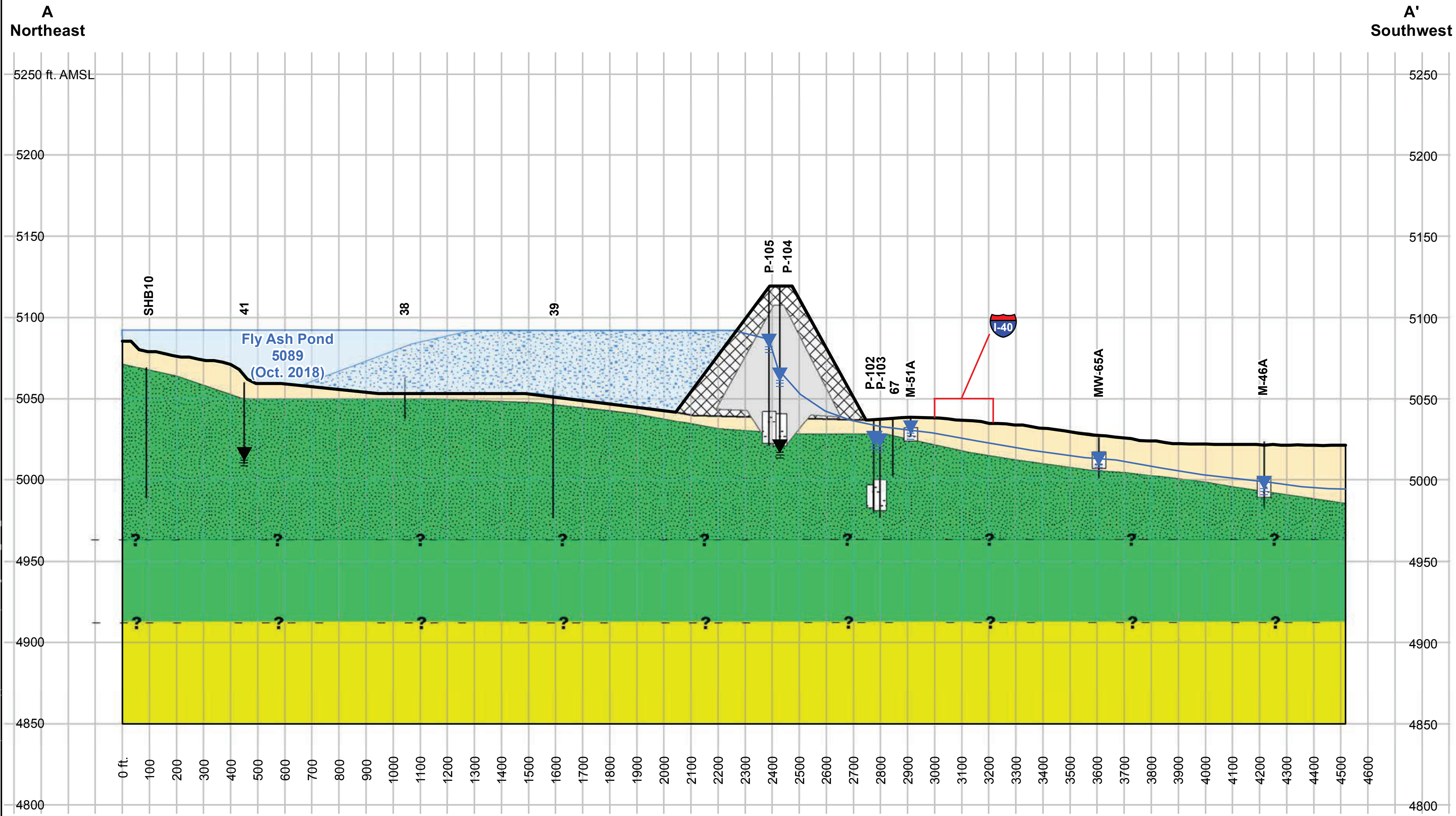
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

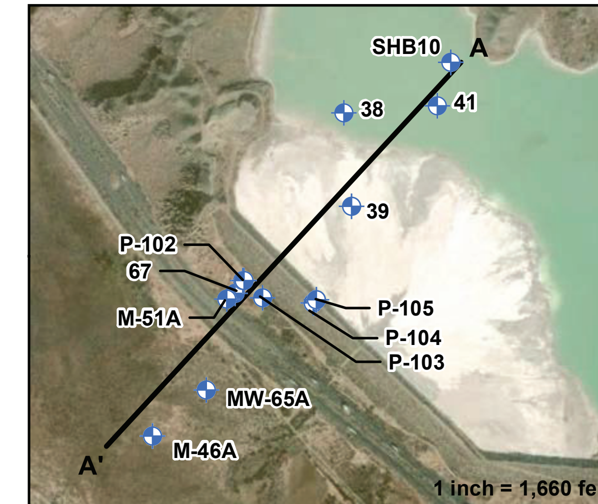
FIGURE 2-6

Molybdenum Iso-Concentration Map for the Fly Ash Pond

Job No.	1420182040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 1250'

wood.





Area of Detail

Legend

- Depth to Water (Feb. 2019)
- Depth to Water During Drilling
- Surface Elevation
- Projected Boring Location and Length
- Piezometric Surface
- Approximate Contact
- Approximate Fly Ash Beach Limits
- Water Elevation at the Fly Ash Pond
- Screened Interval
- Dam Clay Core
- Dam Shell

Lithology

- Alluvium
- Moqui
- Wupatki
- Coconino

Notes:

- Vertical Exaggeration is 4 times the horizontal scale.
- Cross section search area is 900 feet to the northwest and the southeast.
- P-series wells were drilled and installed in 1979.
- SHB well was drilled in 1973.
- 38, 39, and 41 wells were drilled in 1975.
- ft. AMSL = feet above mean sea level

0 215 430 Feet

N

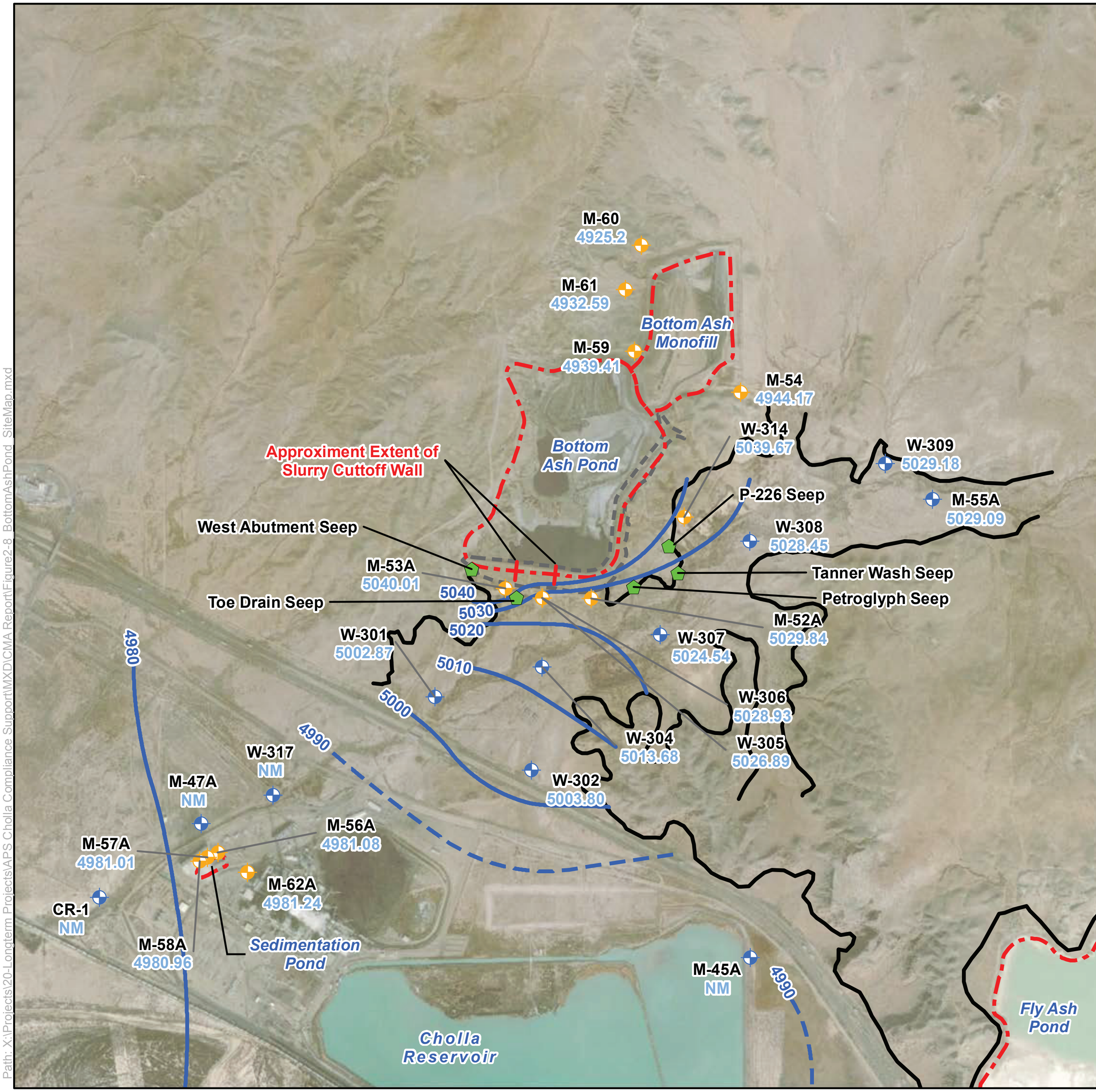
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 2-7

Fly Ash Pond Cross-Section A - A'

Job No. 1420182040
PM: NCL
Date: 6/4/2019
Scale: 1"= 430'

wood.



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Seep and Inception System Location
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit
- Approximate Extent of Dam

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Notes:

W-309	Well Identification
5029.18	Groundwater elevation (ft amsl) measured in October 2018
NM	Not Measured
ft amsl	Feet above mean sea level

0 915 1,830 Feet

N

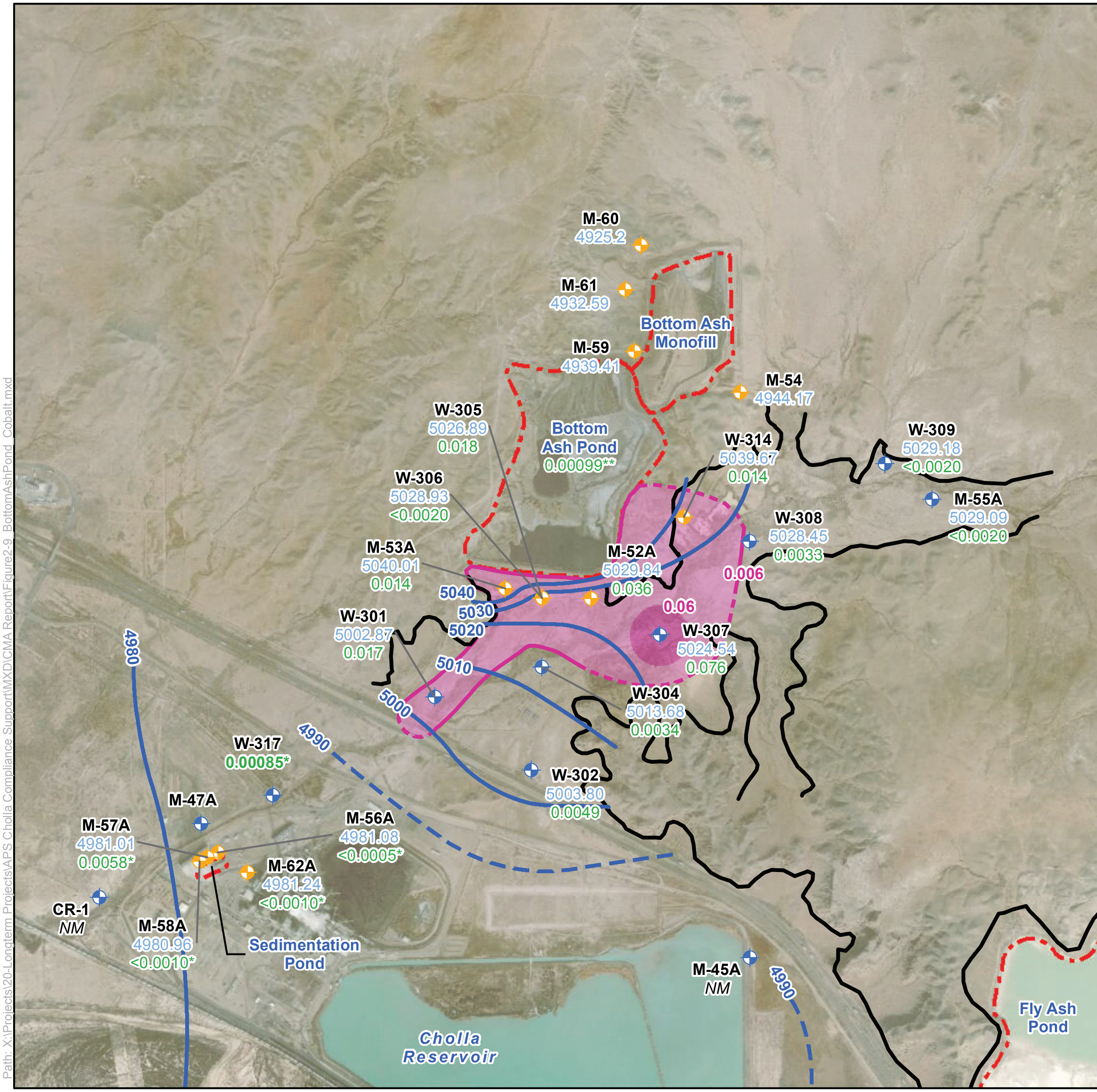
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 2-8

Existing Infrastructure at the Bottom Ash Pond

Job No.	1420182040
PM:	NCL
Date:	6/4/2019
Scale:	1"= 1,830'

wood.



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Estimated Alluvial
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Cobalt Concentration in Alluvial Aquifer (December 2018)

- >0.06 mg/L
- >0.006 mg/L
- GWPS (0.006 mg/L; Dashed Where Inferred)

Notes:

W-309	Well Identification
5029.18	Groundwater elevation (ft amsl) measured in October 2018
<0.0020	Cobalt concentration (mg/L)
*	Sampled in May 2018
**	Sampled in March 2019
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
NM	Not Measured
GWPS	Groundwater Protection Standard

0 915 1,830 Feet

N

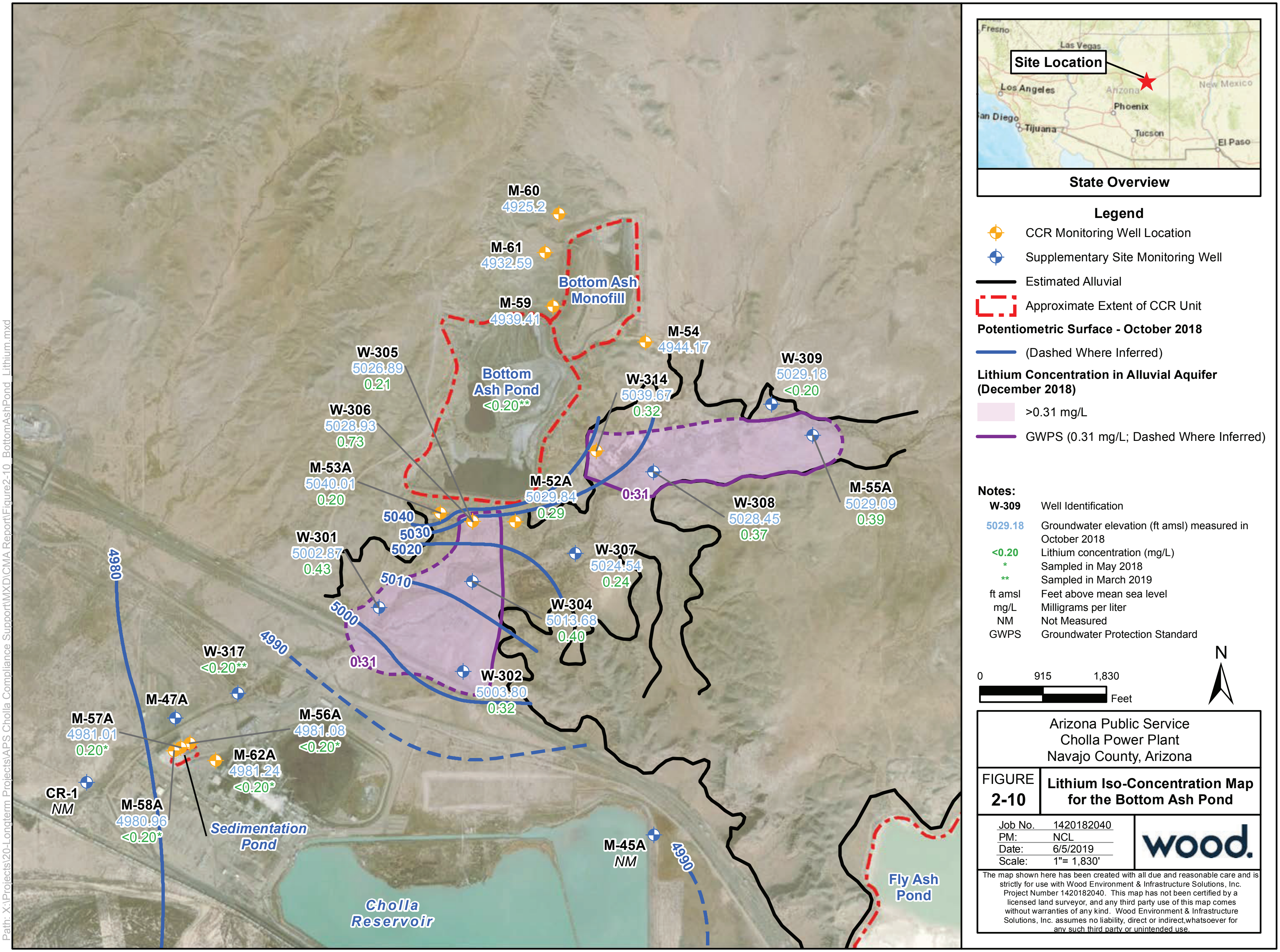
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE **2-9**

Cobalt Iso-Concentration Map for the Bottom Ash Pond

Job No. 1420182040
PM: NCL
Date: 5/31/2019
Scale: 1"= 1,830'

wood.



Site Location
Fresno
Las Vegas
Los Angeles
San Diego
Tijuana
Arizona
Phoenix
Tucson
New Mexico
El Paso
State Overview
Legend
CCR Monitoring Well Location
Supplementary Site Monitoring Well
Estimated Alluvial
Approximate Extent of CCR Unit
Potentiometric Surface - October 2018
(Dashed Where Inferred)
Lithium Concentration in Alluvial Aquifer (December 2018)
>0.31 mg/L
GWPS (0.31 mg/L; Dashed Where Inferred)
Notes:
W-309 Well Identification
5029.18 Groundwater elevation (ft amsl) measured in October 2018
<0.20 Lithium concentration (mg/L)
* Sampled in May 2018
** Sampled in March 2019
ft amsl Feet above mean sea level
mg/L Milligrams per liter
NM Not Measured
GWPS Groundwater Protection Standard
0 915 1,830 Feet
N
M-60 4925.2
M-61 4932.59
M-59 4939.41
M-54 4944.17
Bottom Ash Monofill
Bottom Ash Pond <0.20**
W-305 5026.89 0.21
W-306 5028.93 0.73
M-53A 5040.01 0.20
M-52A 5029.84 0.29
W-314 5039.67 0.32
W-309 5029.18 <0.20
W-308 5028.45 0.37
M-55A 5029.09 0.39
W-301 5002.87 0.43
W-307 5024.54 0.24
W-304 5013.68 0.40
W-302 5003.80 0.32
W-317 <0.20**
M-47A
M-57A 4981.01 0.20*
M-56A 4981.08 <0.20*
M-62A 4981.24 <0.20*
M-58A 4980.96 <0.20*
CR-1 NM
M-45A NM
5040
5030
5020
5010
5000
4990
4980
0.31
Sedimentation Pond
Cholla Reservoir
Fly Ash Pond
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona
FIGURE 2-10
Lithium Iso-Concentration Map for the Bottom Ash Pond
Job No. 1420182040
PM: NCL
Date: 6/5/2019
Scale: 1"= 1,830'
wood.
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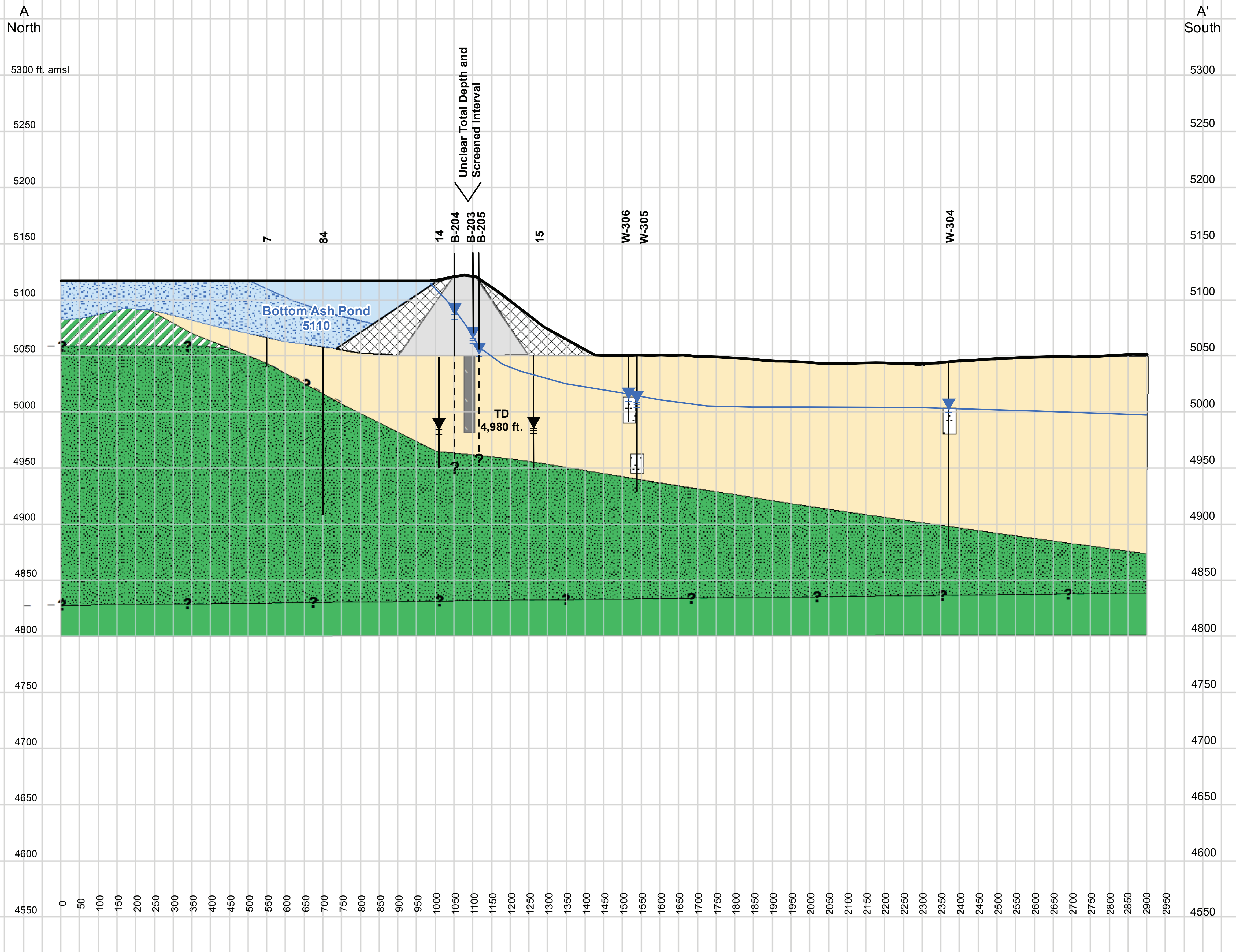
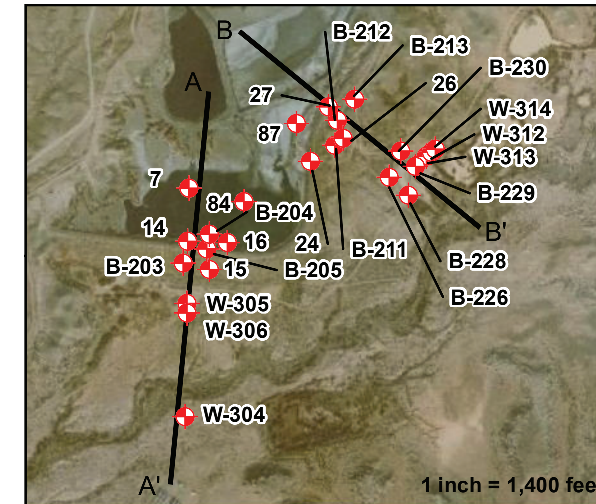
Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure2-10_BottomAshPond_Lithium.mxd





Area of Detail

Legend

- Depth to Water (Sep. 2018)
- Depth to Water During Drilling
- PiezometricSurf...
- Surface Elevation
- Projected Boring Location and Length
- Approximate Contact
- Screened Interval
- Dam Clay Core
- Dam Shell
- Slurry Cutoff Wall
- Bottom Ash Sediment
- Water Elevation at the Bottom Ash Pond

Lithology

- Alluvium
- Holbrook
- Moqui
- Wupatki

Notes:

-Vertical Exaggeration is 3 times the horizontal scale.
-EBASCO boreholes w ere drilled in 1975.
-B-203 Last depth to w ater measured in 2009.
-B-205 Last depth to w ater measured in 2011.

0 137.5 275
Feet

N

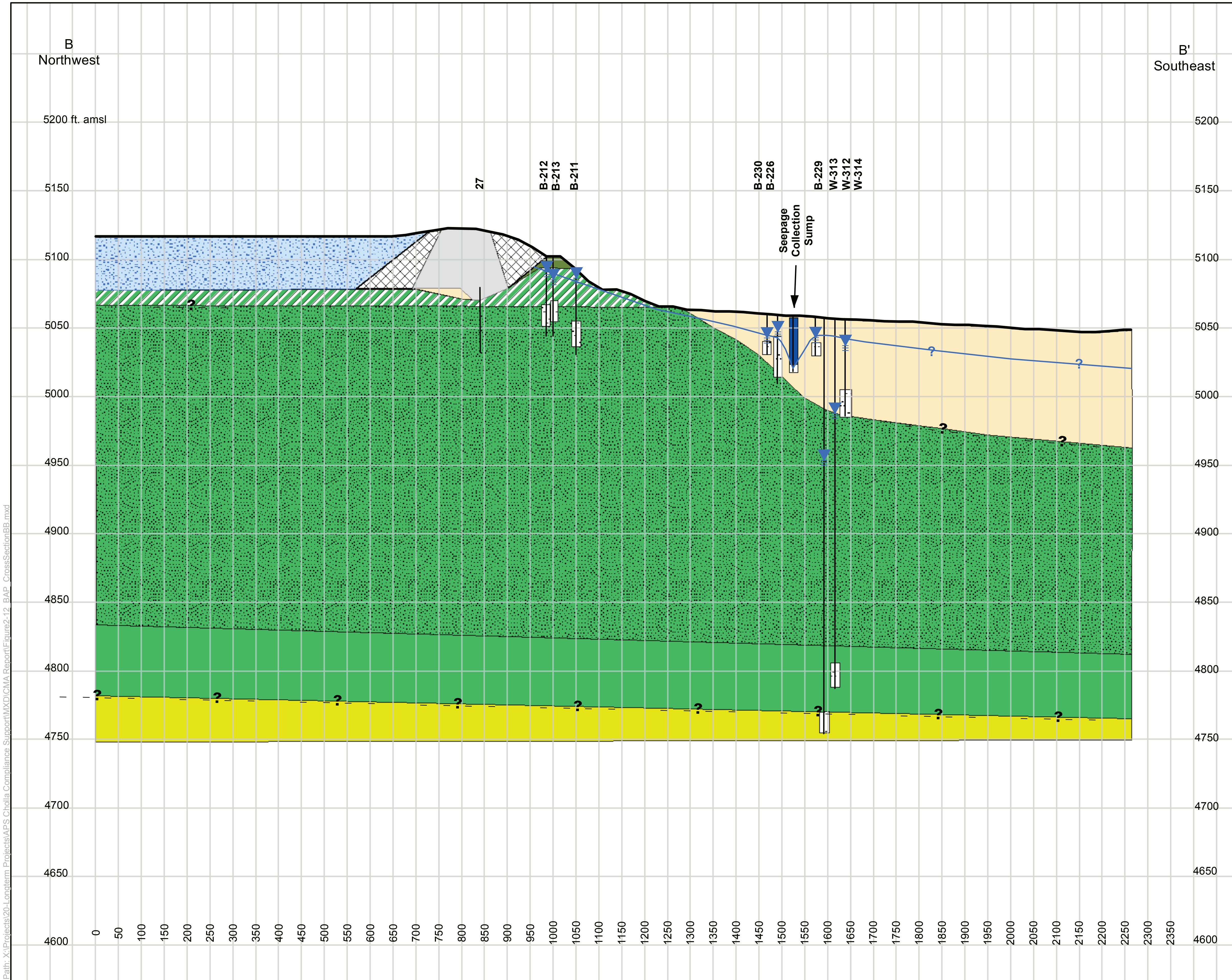
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

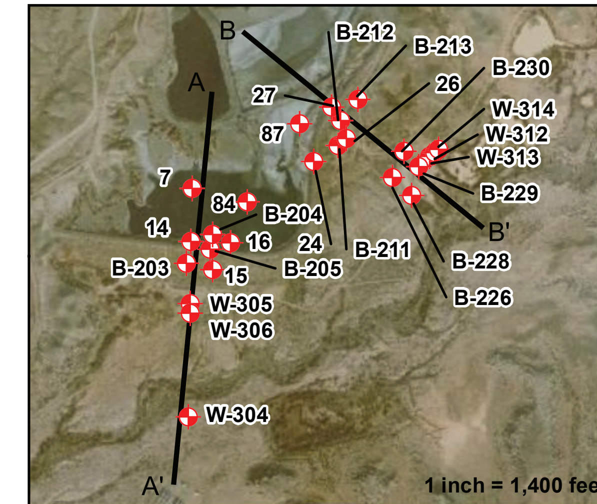
FIGURE 2-11	Bottom Ash Pond Cross-Section A - A'

Job No. 1420182040
PM: NCL
Date: 5/31/2019
Scale: 1"= 275'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure2-11_BAP_CrossSectionAA.mxd





Area of Detail

Legend

- Depth to Water (Sep. 2018)
- Piezometric Surface
- Projected Boring Location and Length
- Approximate Contact
- Surface Elevation
- Screened Interval
- Seepage Collection Sump
- Dam Clay Core
- Dam Shell
- Bottom Ash Sediment

Lithology

- Alluvium
- Chinle
- Holbrook
- Moqui
- Wupatki
- Coconino

Notes:

-Vertical Exaggeration is 3 times the horizontal scale.

-EBASCO boreholes were drilled in 1975.

0 107.5 215 Feet

N

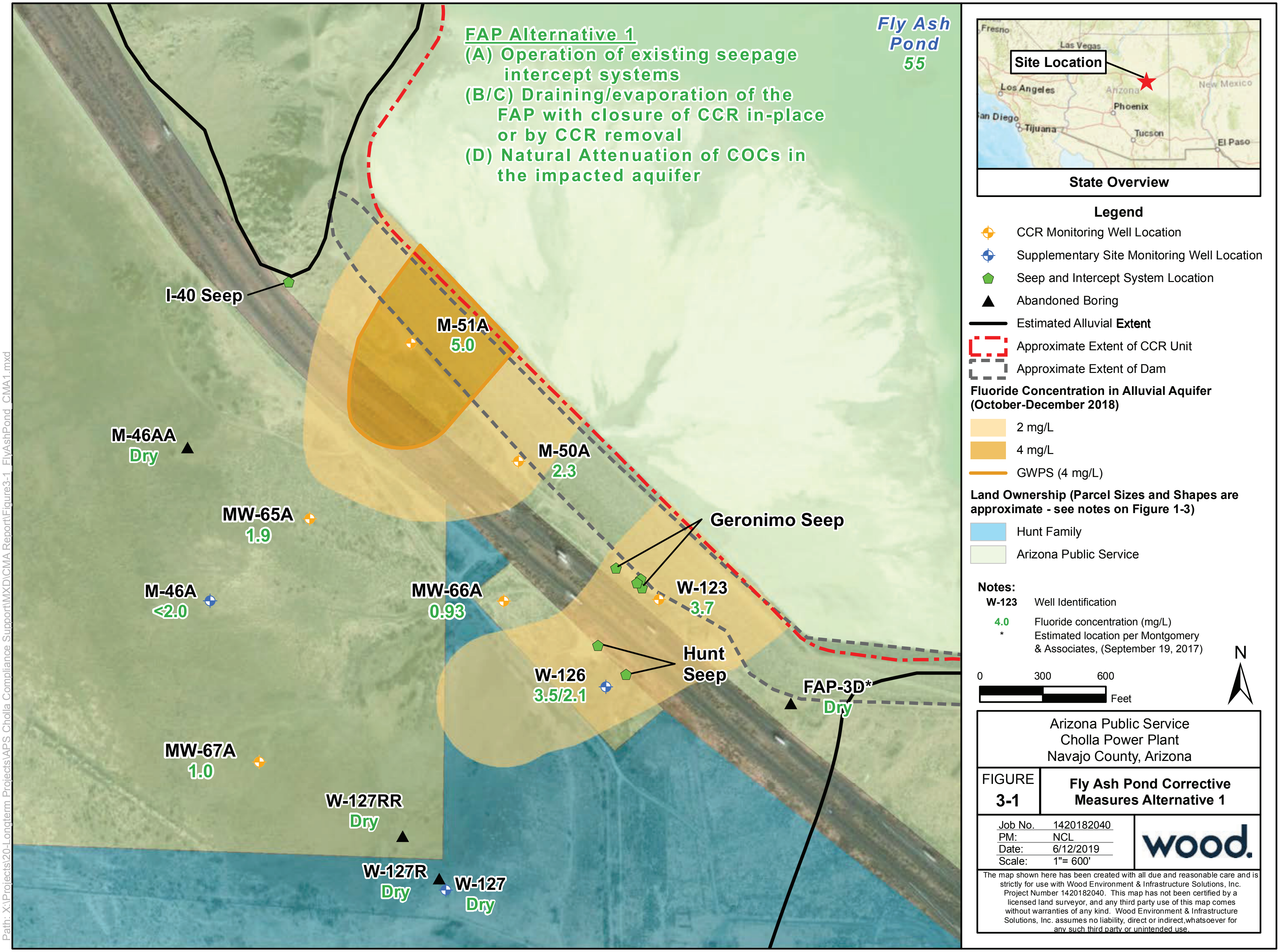
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE **2-12**

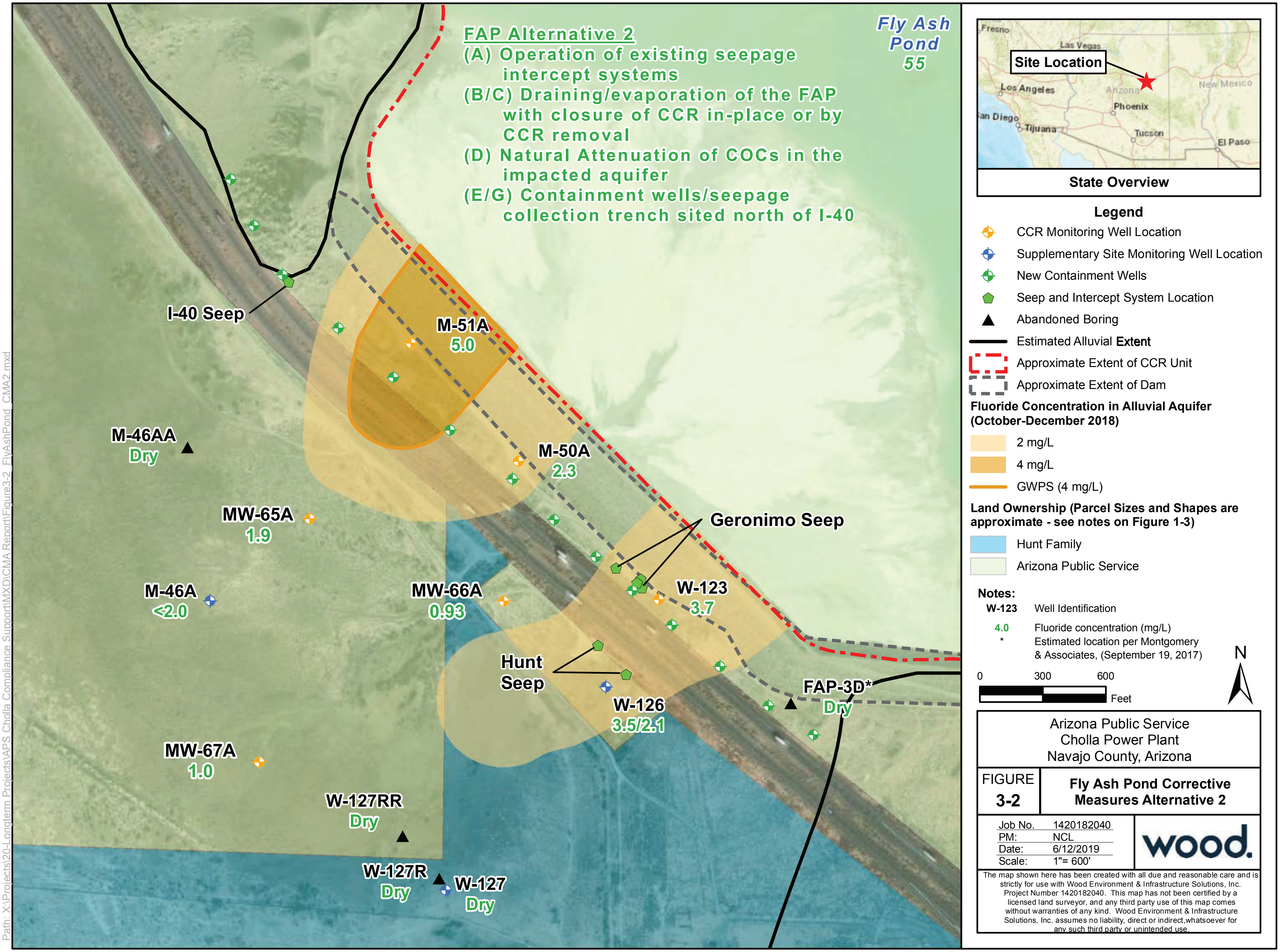
Bottom Ash Pond Cross-Section B - B'

Job No. 1420182040
PM: NCL
Date: 5/31/2019
Scale: 1"= 215'

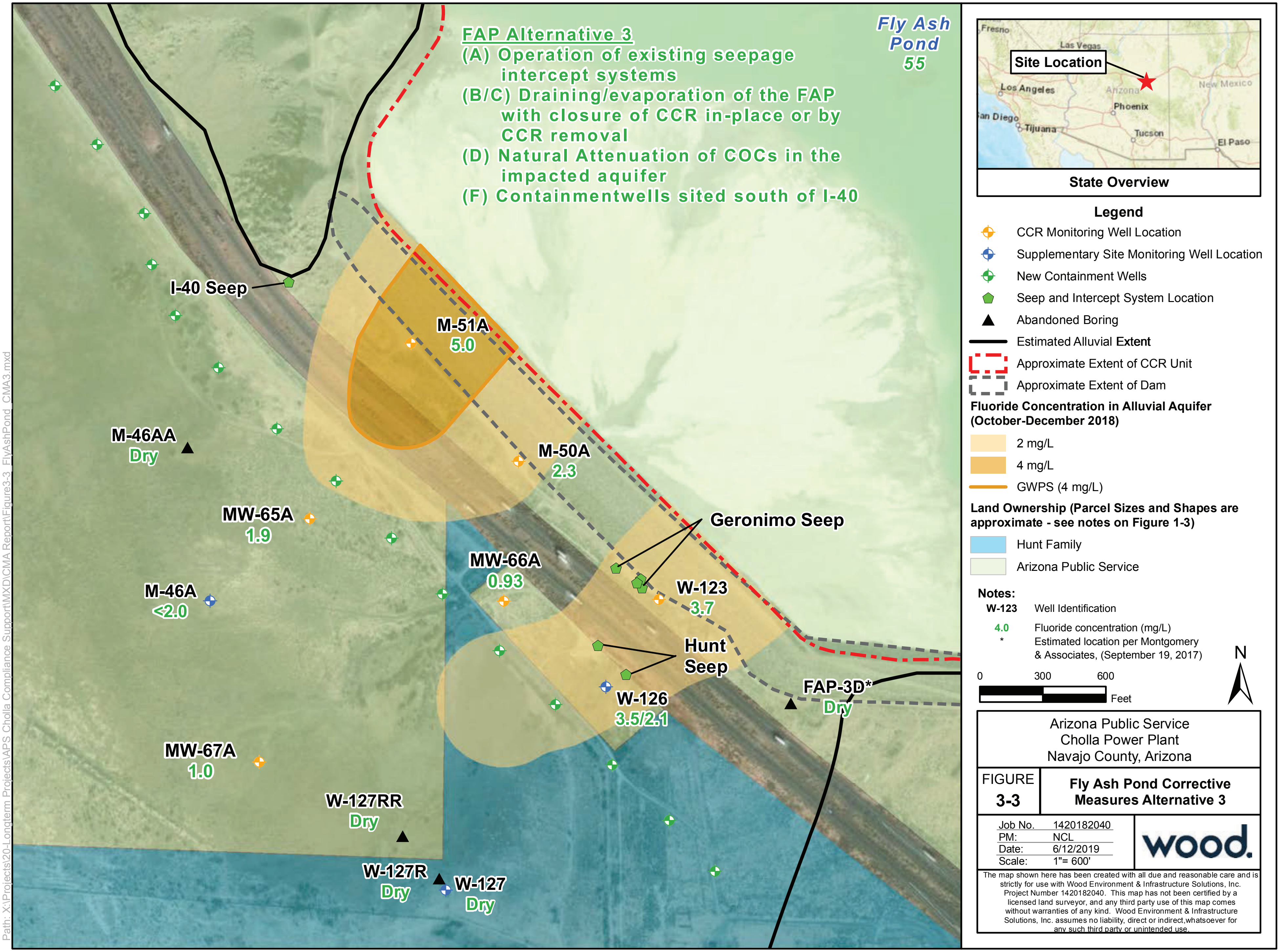
wood.



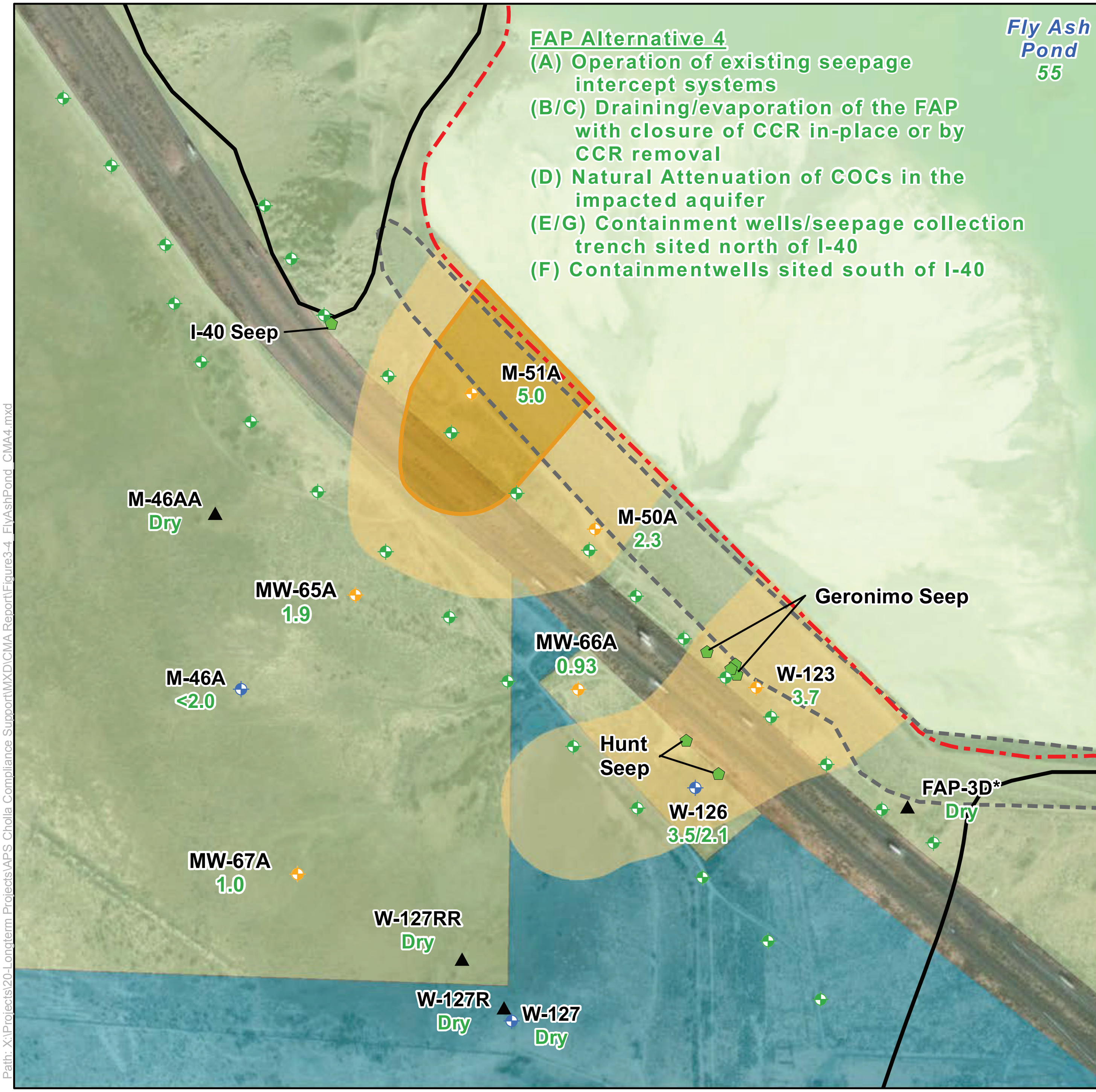
Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure3-1_FlyAshPond_CMA1.mxd



Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure3-2_FlyAshPond_CMA2.mxd



Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure3-3_FlyAshPond_CMA3.mxd



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- New Containment Wells
- Seep and Intercept System Location
- Abandoned Boring
- Estimated Alluvial **Extent**
- Approximate Extent of CCR Unit
- Approximate Extent of Dam

Fluoride Concentration in Alluvial Aquifer (October-December 2018)

- 2 mg/L
- 4 mg/L
- GWPS (4 mg/L)

Land Ownership (Parcel Sizes and Shapes are approximate - see notes on Figure 1-3)

- Hunt Family
- Arizona Public Service

Notes:

W-123 Well Identification

4.0 Fluoride concentration (mg/L)

* Estimated location per Montgomery & Associates, (September 19, 2017)

0 300 600 Feet

N

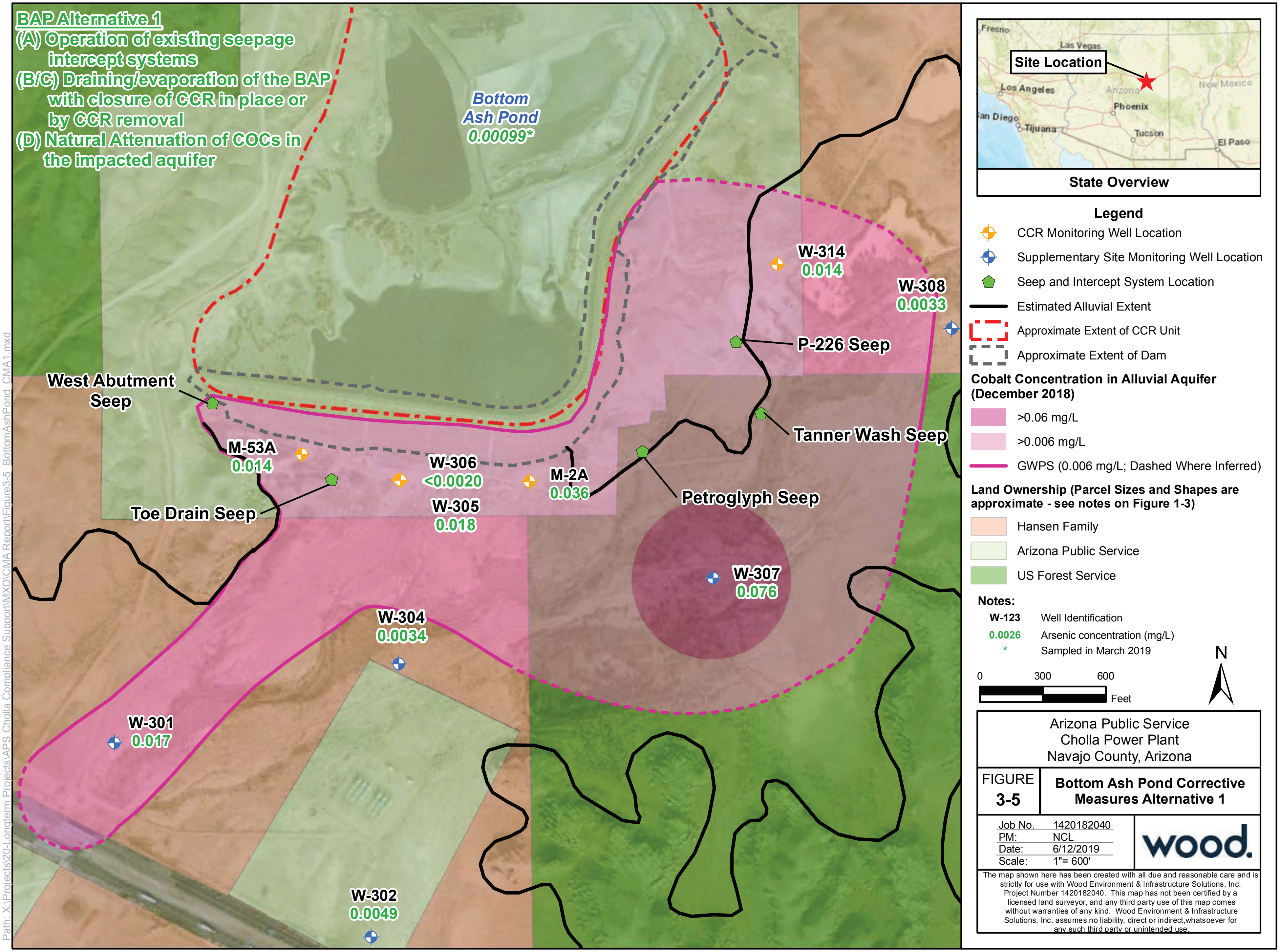
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE **3-4**

Fly Ash Pond Corrective Measures Alternative 4

Job No.	1420182040
PM:	NCL
Date:	6/12/2019
Scale:	1"= 600'

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure3-4_FlyAshPond_CMA4.mxd


BAP Alternative 1
(A) Operation of existing seepage intercept systems
(B/C) Draining/evaporation of the BAP with closure of CCR in place or by CCR removal
(D) Natural Attenuation of COCs in the impacted aquifer
Bottom Ash Pond 0.00099*
W-314 0.014
W-308 0.0033
P-226 Seep
West Abutment Seep
Tanner Wash Seep
M-53A 0.014
W-306 <0.0020
M-2A 0.036
Petroglyph Seep
Toe Drain Seep
W-305 0.018
W-307 0.076
W-304 0.0034
W-301 0.017
W-302 0.0049
Site Location
State Overview
Legend
CCR Monitoring Well Location
Supplementary Site Monitoring Well Location
Seep and Intercept System Location
Estimated Alluvial Extent
Approximate Extent of CCR Unit
Approximate Extent of Dam
Cobalt Concentration in Alluvial Aquifer (December 2018)
>0.06 mg/L
>0.006 mg/L
GWPS (0.006 mg/L; Dashed Where Inferred)
Land Ownership (Parcel Sizes and Shapes are approximate - see notes on Figure 1-3)
Hansen Family
Arizona Public Service
US Forest Service
Notes:
W-123 Well Identification
0.0026 Arsenic concentration (mg/L)
* Sampled in March 2019
0 300 600 Feet
N
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona
FIGURE 3-5
Bottom Ash Pond Corrective Measures Alternative 1
Job No. 1420182040
PM: NCL
Date: 6/12/2019
Scale: 1"= 600'
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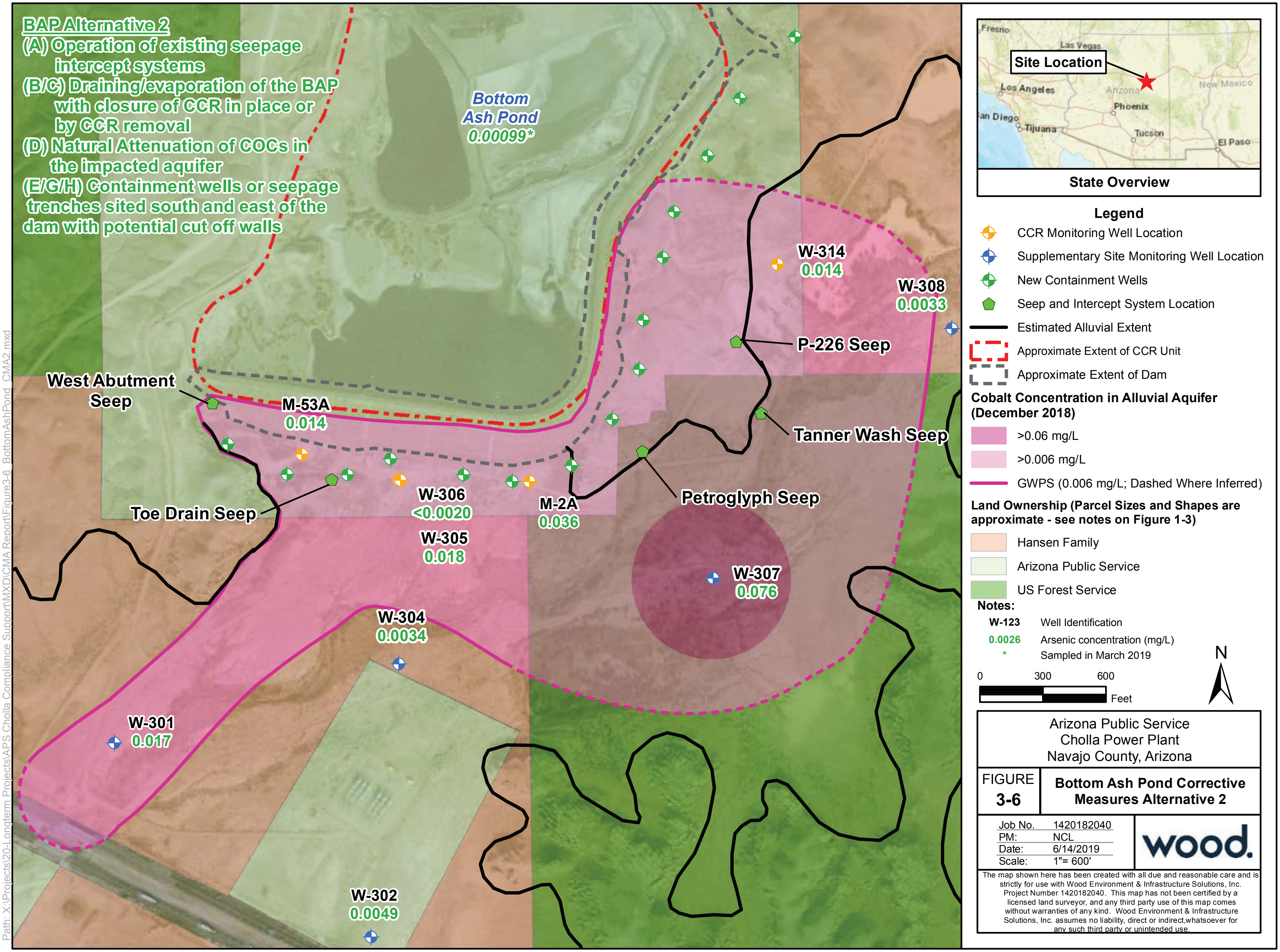

BAP Alternative 2
(A) Operation of existing seepage intercept systems
(B/C) Draining/evaporation of the BAP with closure of CCR in place or by CCR removal
(D) Natural Attenuation of COCs in the impacted aquifer
(E/G/H) Containment wells or seepage trenches sited south and east of the dam with potential cut off walls
Bottom Ash Pond 0.00099*
West Abutment Seep
M-53A 0.014
Toe Drain Seep
W-306 <0.0020
W-305 0.018
M-2A 0.036
Petroglyph Seep
Tanner Wash Seep
P-226 Seep
W-314 0.014
W-308 0.0033
W-307 0.076
W-304 0.0034
W-301 0.017
W-302 0.0049
Fresno
Las Vegas
Site Location
Los Angeles
Arizona
New Mexico
Phoenix
San Diego
Tijuana
Tucson
El Paso
State Overview
Legend
CCR Monitoring Well Location
Supplementary Site Monitoring Well Location
New Containment Wells
Seep and Intercept System Location
Estimated Alluvial Extent
Approximate Extent of CCR Unit
Approximate Extent of Dam
Cobalt Concentration in Alluvial Aquifer (December 2018)
>0.06 mg/L
>0.006 mg/L
GWPS (0.006 mg/L; Dashed Where Inferred)
Land Ownership (Parcel Sizes and Shapes are approximate - see notes on Figure 1-3)
Hansen Family
Arizona Public Service
US Forest Service
Notes:
W-123 Well Identification
0.0026 Arsenic concentration (mg/L)
* Sampled in March 2019
N
0 300 600
Feet
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona
FIGURE 3-6
Bottom Ash Pond Corrective Measures Alternative 2
Job No. 1420182040
PM: NCL
Date: 6/14/2019
Scale: 1"= 600'
wood.
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APPENDIX A

ALTERNATIVE SOURCE DEMONSTRATION FOR LITHIUM AT THE BOTTOM ASH POND

Technical Memorandum

To:	Michele Robertson, RG Pamela Norris	**File No:**	14-2018-2040
From:	Emily LoDolce, PE	**Reviewed by:**	Natalie Chrisman Lazarr, PE Carla Landrum, PhD
Date:	June 6, 2019		

Subject: **ALTERNATIVE SOURCE DEMONSTRATION FOR LITHIUM AT THE BAP**
Arizona Public Service Cholla Power Plant – Navajo County, Arizona

1.0 INTRODUCTION

This technical memorandum (memo) documents an Alternative Source Demonstration (ASD) for lithium in groundwater downgradient of the Bottom Ash Pond (BAP), an existing coal combustion residuals (CCR) unit located at the Arizona Public Service Company (APS) Cholla Power Plant (Site) in Navajo County, Arizona. The memo is an appendix to a report documenting an *Assessment of Corrective Measures for the Fly Ash Pond and Bottom Ash Pond* (the Main Report) prepared by Wood Environment & Infrastructure Solutions, Inc. (Wood).

A full description of the Site location and background, CCR monitoring system, and historical operations is contained within the *2018 Annual Groundwater Monitoring and Corrective Action Report* (Wood, 2019). The BAP is one of four CCR units at the Site. It is a 2,300-acre-foot surface impoundment used to store slurried bottom ash generated at the plant. It was placed into service in 1978. The BAP dam was constructed of earth fill with a central clay core. The BAP is unlined and constructed on alluvium and underlying Moenkopi mudstone (considered an aquitard between the alluvial aquifer and the lower, confined Coconino Sandstone aquifer).

Statistical analyses of Appendix IV constituent data collected from downgradient BAP monitoring wells declare that lithium and cobalt concentrations exhibit exceedances of their respective Groundwater Protection Standards (GWPSs) at statistically significant levels (SSLs). Pursuant to 40 Code of Federal Regulations (CFR) Section (§)257.94(e)(2), the owner/operator is allowed to demonstrate that a source, other than the CCR unit, caused the apparent SSI within 90 days of the official SSI declaration. Potential sources include sampling and analysis errors, statistical method inadequacies and/or natural variation in groundwater quality. Each of these sources are explored within the scope of this memo.

The ASD documented herein only addresses lithium at the BAP and was prepared in association with an assessment of corrective measures; preparation of the ASD within 90 days of declaring an exceedance of the GWPS was not possible because analysis of recently available characterization information was necessary to support this ASD. Cobalt remains a constituent of concern at the BAP.

Wood's approach to conducting the ASD was to systematically review the potential alternative sources noted above to evaluate if any of these causes resulted in the apparent GWPS exceedances of lithium in groundwater downgradient of the BAP.

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2.0 SAMPLING AND LABORATORY CAUSES

To assess potential sampling and laboratory causes, Wood reviewed sampling and analysis procedures as well as the results of laboratory data validation.

Based on a review of sampling procedures, Wood concluded that APS has conducted field sampling activities in accordance with the Groundwater Sampling and Analysis Plan (SAP) developed for the Site (Montgomery & Associates, 2015) to comply with the CCR Rule. On the basis that the SAP is sufficiently detailed and contains appropriate procedures for groundwater level measurement, groundwater sample collection, sample control, laboratory analysis, and data validation, no apparent sampling causes for lithium exceedances were noted.

Wood also reviewed laboratory data validation reports for the CCR groundwater monitoring program. Following receipt of final laboratory reports of analysis, APS contracted with Montgomery & Associates to evaluate the reports and associated sample data collected during detection and assessment monitoring for quality assurance purposes. The scope of the effort was a US Environmental Protection Agency Stage 2A validation. On the basis of Wood's review, there are no apparent issues with field forms or laboratory analyses that would explain the GWPS exceedances for lithium downgradient of the BAP.

3.0 ANTHROPOGENIC SOURCES

Wood reviewed surrounding property uses, historical property uses, and upgradient land uses to evaluate any potential anthropogenic sources for lithium exceedances. The surrounding land uses are undeveloped, rural land. On this basis, there is insufficient evidence to conclude that surrounding anthropogenic sources are the source to the GWPS exceedances for lithium downgradient of the BAP.

4.0 STATISTICAL EVALUATION CAUSE

A statistical evaluation cause refers to the possibility that the current statistical method is invalid for performing statistical comparisons, thereby resulting in a falsely declared GWPS exceedance for lithium. Currently, the Cholla BAP groundwater monitoring system is designed to perform interwell statistical comparisons. An interwell comparison is one where samples collected from two different geographic locations within the same water bearing unit are used to perform the statistical evaluation. One geographic location represents background, or baseline groundwater conditions we expect to see if the BAP is not impacting groundwater, and the other geographic location represents compliance monitoring wells downgradient of the BAP. Sample data collected from the two geographic locations are then statistically compared to assess site compliance. In general, interwell comparisons perform poorly in cases where an adequate and representative background location cannot be established for one or more sample constituents. Factors leading to inadequate or non-representative background can include, for example, spatial heterogeneity in groundwater conditions or discontinuous lithologies between background and compliance monitoring well locations. These inadequacies can cause an interwell statistical comparison to be meaningless and result in false positive or false negative statistical results.

The GWPS for lithium was developed using the data collected from the background monitoring well (M-64A) for the BAP, which was installed in February 2017. The baseline monitoring period for this well spans from February 2017 to September 2018 (for both Appendix III and Appendix IV constituents) plus two rounds of assessment monitoring (for Appendix IV constituents) in February 2018 and May 2018 (Wood, 2018a). The statistical evaluation of the lithium data in the background well resulted in a calculated background threshold value equal to 0.31 milligrams per liter (mg/L) and this value represents the GWPS for this constituent (Wood, 2018a). The statistical methods used to derive this value are detailed in the Statistical Data Analysis Work Plan for the Cholla Power Plant (Wood, 2018b). The background well exhibits lithium concentrations that range between 0.25 mg/L and 0.28 mg/L between February 2017 and May 2018.

The observed lithium concentrations in downgradient compliance wells, which were sampled over a relatively longer period, starting in November 2015 and ending in May 2018, vary by compliance well location and exhibit lithium concentrations ranging between less than 0.2 mg/L (non-detectable concentrations) to 0.78 mg/L. The range of lithium concentrations in the compliance wells are the same order of magnitude as concentrations observed in background.

Several factors can explain the discrepancy in the range of sample concentrations between background and compliance wells at the BAP. For example, previous work underscores that high sampling frequencies (e.g., bi-monthly in some cases) over a relatively shorter sampling period can be one source to the narrow range of lithium concentrations observed in the background well (Wood, 2018b). A high sampling frequency (e.g., less than quarterly) can bias the variability in sample concentrations because each sample is temporally correlated to the next, meaning the sample background data do not represent the true range of variability in background lithium concentrations. Furthermore, the lithium concentrations vary spatially between all monitoring well locations, suggesting that the groundwater system exhibits natural variation in lithium concentrations with respect to geographic location.

The natural variation argument that follows is rooted in the premise that spatial heterogeneity in lithium concentrations at the Site is not adequately represented by data collected from the background well and, as such, the underlying interwell assumptions for lithium are invalid. Therefore, the interwell statistical comparison method for lithium is unreliable in detecting leakage from the BAP. The following section presents statistical and non-statistical lines of evidence that support the conclusion that the lithium concentrations within the alluvial aquifer system beneath the BAP exhibit natural spatial variation and is the cause of the GWPS exceedance for lithium at the BAP.

5.0 NATURAL VARIATION CAUSE

Lithium is naturally present in soil and groundwater, particularly in arid environments, where it is associated with evaporites and precipitates (Cannon et al., 1975). To evaluate natural variation as the cause of the lithium exceedances, three different approaches to reviewing site data were applied. First, a statistical evaluation of lithium and select other constituents was performed to assess variability in observed concentrations. Second, the spatial distribution of lithium was compared to the spatial distribution of a constituent known to be associated with CCR in groundwater downgradient of the BAP (i.e., boron). Finally, the concentration of lithium measured from a surface water sample collected from the BAP was compared to the concentrations of lithium observed in CCR monitoring system groundwater monitoring wells.

5.1 Statistical Evaluation of Natural Variation

The objective of this statistical evaluation was to assess the variability in lithium concentrations, and other constituent concentrations, within the alluvial aquifer downgradient of the BAP. It is hypothesized that the GWPS exceedance declaration for lithium results from the intrinsic spatial variability of naturally-occurring lithium concentrations within the alluvial groundwater.

5.1.1 Data Inputs

Data from six groundwater monitoring wells (M-52A, M-53A, M-55A, W-305, W-306, and W-314) and one background well (M-64A) were used to complete this statistical evaluation. The sampling duration begins in the fourth quarter of 2015 and ends in the second quarter of 2019. The sampling duration is shorter, and the relative sample count is therefore lower, for M-64A because it was installed in 2017. The sampling frequency is inconsistent and ranges between monthly to quarterly.

This evaluation includes five constituents: lithium, cobalt, chloride, sulfate, and pH. Not all constituents were sampled concurrently between wells, which results in sampling gaps for this evaluation depending on the well and the constituent. Non-detect concentrations represent the corresponding reporting limit value.

5.1.2 Methods

The statistical methods employed to evaluate the variability in the data are a review of basic statistics, development of box and whisker plots, and a principal component analysis.

Basic Statistics - **Table 1** summarizes the basic statistics for each monitoring well and constituent. Basic statistics are useful for assessing sample counts and making relative comparisons between statistical measures, particularly the range in sample concentrations, the central tendencies (mean and median), and sample standard deviation. Constituents with a range and standard deviation close to zero are generally indicative of wells that sample a high frequency of non-detectable concentrations. Except for cobalt, the variability in the central tendencies between constituents and monitoring wells vary on the same order of magnitude.

Box and Whisker Plots - **Figures 1** through **5** illustrate the box and whisker plots for each constituent and well grouping. The box and whisker plots are useful for visually comparing the relative distribution of constituent concentrations between wells and provide a good indication of spatial heterogeneity in constituent concentrations between well locations. For each constituent, except for pH, the box plots generally position uniquely according to their central tendency (thick black line within the box) and the range of observed concentrations (area spanning between whiskers flanking the box) between wells. Unique position and lack of general overlap between box and whisker plots between different wells is an indication of spatial heterogeneity within the aquifer system.

The relative constituent concentrations for monitoring wells M-52A and W-306 are notable, particularly the inverse relationship between pH and chloride and cobalt for M-52A and a positive relationship between lithium and sulfate in W-306. These observations are congruent with lithium being associated with evaporates and precipitates and with increased cobalt solubility at lower pH values.

Principal Component Analysis – Principal component analysis (PCA) is a multivariate analysis that integrates all available data to simultaneously study correlations and associations between wells and their constituents (Everitt et al., 2011; James et al., 2013; Jolliffe, 2013). The correlations and associations can lend insight into the spatial heterogeneity of the alluvial aquifer system as it relates to broader geochemistry and other inferential aquifer characteristics that might impact constituent concentrations within the aquifer system (e.g., screened depths and lithologies, etc.).

Since the sample five constituents vary in their magnitude of concentration, the data were standardized prior to performing PCA to account for these differences.

Figures 6 and **7** present the results of the PCA. PCA plots, in general, illustrate how the sample data cluster. The color-coding is used to indicate which monitoring well the data are derived from. Wells that cluster together exhibit synergies in their underlying statistical variation, suggesting the groundwater observed by these wells derive from, or is influenced by the same in situ properties, mechanisms and/or processes. The vectors (arrows) represent each sample constituent. The constituent groupings and their vector magnitudes help explain the correlations between constituents and their overall importance. Using this information as a collective, it is possible to interpret the sources of statistical variation observed in the monitoring well clusters.

The baseline PCA scenario is shown in **Figure 6**, which includes all constituents and monitoring wells. In the baseline PCA scenario, lithium and sulfate strongly associate with sample data within W-306. Monitoring wells M-53A, M-55A, M-64A, and W-314 plot in gradient order along the same vector line (extrapolated) relative to their sulfate and lithium concentrations in comparison to W-306. It is notable that M-55A and M-64A (the background well) plot closest to W-306. Cobalt and chloride cluster together and are inversely related to pH. This inverse relationship indicates that higher cobalt and chloride concentrations associate with lower pH values and vice versa. Cobalt is known to become more mobile in the presence of lower pH values, which helps explain the inverse relationship observed between these two constituents. Data collected from M-52A dominates in explaining this relationship.

A second PCA scenario excludes W-306 to understand well clustering and constituent groupings in the absence of any masking effects produced by this well. **Figure 7** illustrates the results of this PCA scenario. Lithium and sulfate group together and plot closely to the M-55A and M-64A (background well) clusters. Lithium is known to associate with evaporites and precipitates and the occurrence of these constituents plotting closely to M-64A suggests naturally occurring lithium concentrations should be expected within the alluvial groundwater system. It is possible the lithium concentrations observed in W-306 are due to its proximity to a localized pocket of evaporites and precipitates within the aquifer system. Cobalt plots inversely to pH and associates most with data collected from M-52A. Groundwater monitoring data collected from W-314, M-53A, and W-305 associate with pH and inversely associate with cobalt, and to a degree, chloride. Notably, data collected from M-64A do not strongly associate with cobalt or pH in this scenario, suggesting the mechanism driving this described behavior for pH and cobalt might not be intrinsic to what is observed in background aquifer conditions.

5.2 Spatial Distribution

Boron is often used as a potential indicator for CCR because it is typically present in CCR unit leachate, it is non-reactive and mobile in common hydrogeologic environments, and it is not a common anthropogenic contaminant. Boron has been historically present in BAP downgradient monitoring wells at detectable concentrations, and the BAP is suspected to be the source of these concentrations. **Figure 8** shows the spatial distribution of boron concentrations measured in monitoring wells at the site in December 2018. The concentration of boron measured in the BAP in March 2019 was 4.8 mg/L, higher than the concentrations shown in downgradient wells. Wells with the highest concentrations of boron are closest to the BAP, and wells with the lowest concentrations of boron in groundwater tend to be more distant from the BAP.

Lithium is also non-reactive and mobile in common hydrogeologic environments. In contrast to the spatial distribution of boron, the spatial distribution of lithium concentrations measured in monitoring wells at the site in December 2018 (**Figure 9**) show no apparent correlation to proximity to the BAP. Concentrations of lithium in monitoring wells in the Tanner Wash alluvial aquifer (where the BAP is located) are all within the same order of magnitude, and ranged from less than 0.2 mg/L to 0.43 mg/L with the exception of the sample collected at W-306, which indicated a slightly higher concentration of 0.73 mg/L. The shading in **Figure 9** identifies areas of the alluvial aquifer where the concentration of lithium was above the GWPS of 0.31 mg/L. Notable wells with concentrations below the GWPS include monitoring wells M-53A and M-52A, both located adjacent to the south side of the BAP dam.

5.3 Concentrations in the BAP and Downgradient Aquifer

An exceedance of the GWPS is unlikely to be due to release from the facility if the concentration of the constituent in water collected from the CCR unit is not higher than the concentrations in downgradient wells. To evaluate this possibility, APS collected a water sample from the BAP on March 30, 2019 and sent it to TestAmerica Laboratories, Inc. (TestAmerica) located in Phoenix, Arizona, for analysis. TestAmerica is an Arizona Department of Health Services-licensed laboratory (AZ0728). The results of the analysis indicate that the lithium concentration in water collected from the BAP is less than the laboratory reporting limit of 0.20 mg/L, which is lower than the GWPS of 0.31 mg/L and lower than the concentration in many of the monitoring wells shown on **Figure 9**. This is a secondary line of evidence to suggest that the potential exceedance for lithium is not due to a release from the BAP. At this time there is only one water quality sample from the BAP with results for lithium. Including lithium in the list of analytes for future samples collected from the BAP would increase the sample size of representative data and potentially lend confidence to these results.

6.0 FINDINGS AND RECOMMENDATIONS

Natural variation in the aquifer is declared to be the cause of the GWPS exceedance for lithium at the BAP. The primary lines of evidence for this conclusion include:

- The multivariate statistical analysis of lithium and other compounds in the alluvial aquifer which points to the existence of spatial heterogeneity within the alluvial system; and
- The spatial distribution of lithium in the Tanner Wash alluvial aquifer is not consistent with a lithium source area located at the BAP.

Secondary lines of evidence include:

- The water quality sampling results that show concentrations of lithium in the BAP may be lower than lithium concentrations in the downgradient monitoring wells.

These lines of evidence support this ASD prepared in accordance with 40 CFR §257.95(g)(3)(ii) and support the position that the GWPS exceedance for lithium declared on November 14, 2018 was not due to a release from the BAP. Therefore, no further action (i.e., corrective measures analysis) is warranted for this constituent.

Wood recommends developing intrawell statistical comparisons for lithium and any other Appendix III and IV constituents that are determined to be influenced by aquifer heterogeneity at the BAP in the future. Intrawell comparisons are an industry accepted and recommended alternative to interwell comparisons (USEPA, 2009). Intrawell statistical comparisons are detailed in the USEPA Unified Guidance (2009) and in the Statistical Data Analysis Work Plan for the Cholla Power Plan (Wood, 2018b).

7.0 CERTIFICATION

By means of this certification, I certify that I have reviewed this ASD and find the information presented herein accurate and appropriate and meet the requirements of 40 CFR §257.95(g)(3)(ii).

Natalie Chrisman Lazarr
Printed Name of Registered Professional Engineer

Signature

31672	Arizona	14 June 2019
Registration No.	Registration State	Date

8.0 REFERENCES

Cannon, Helen L., Thelma F. Harms, and J.C. Hamilton, 1975. *Lithium in Unconsolidated Sediments and Plants of the Basin and Range Province, Southern California and Nevada*. Geological Survey Professional Paper 918, 1975.

Everitt, B. and T. Hothorn, 2011. *An Introduction to Applied Multivariate Analysis with R*. Springer Science+Business Media. pp 274.

Federal Register, 2018. *40 Code of Federal Regulations Part 257 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule promulgated April 17, 2015 with Amendments to the National Minimum Criteria (Phase One, Part One) effective August 29, 2018.*

James, G., D. Witten, T. Hastie and R. Tibshirani, 2013. *An Introduction to Statistical Learning with Applications in R*. Springer Science & Business Media. pp 426.

Jolliffe, I.T., 2013. *Principal Component Analysis*. Springer Science + Business Media. pp 271.

Montgomery & Associates, 2015. *Groundwater Sampling and Analysis Program, Cholla Power Plant, Joseph City, Arizona.* Prepared for APS. November 30, 2015.

Montgomery & Associates, 2018. *Cholla Power Plant Coal Combustion Residuals Program – Statistical Analysis of Baseline Groundwater Monitoring Data, November 2015 through September 2017. Navajo County, Arizona.* Prepared for APS. January 12, 2018.

Wood Environment & Infrastructure Solutions (Wood), 2018a. *Technical Memorandum, CCR Groundwater Assessment Monitoring Statistical Analysis and Results for the Bottom Ash Pond. Arizona Public Service Cholla Power Plant – Navajo County, Arizona.* October 15, 2018.

Wood Environment & Infrastructure Solutions (Wood), 2018b. Statistical Data Analysis Work Plan. Coal Combustion Residual Rule Groundwater Monitoring System Compliance. Cholla Power Plan, Joseph City, AZ. October, 15, 2018.

Wood, 2019. *Annual Groundwater Monitoring and Corrective Action Report for 2018. Coal Combustion Residual Rule Groundwater Monitoring System Compliance*. Prepared on behalf of Arizona Public Service. January 31, 2019.

TABLES

Table 1. Basic Statistics for Select Wells and Constituents

M-52A	Monitoring Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	19	0.26	0.03	0.25	0.21	0.32	0.11
Cobalt	mg/L	19	0.05	0.01	0.05	0.03	0.07	0.04
Chloride	mg/L	17	4058.82	523.28	4000	3200	5100	1900
Sulfate	mg/L	17	2782.35	184.51	2700	2400	3100	700
pH	S.U.	16	7.06	0.19	7	6.8	7.5	0.7

M-53A	Monitoring Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	19	0.2	0	0.2	0.2	0.21	0.01
Cobalt	mg/L	19	0.02	0	0.02	0.01	0.02	0.01
Chloride	mg/L	17	2435.29	136.66	2400	2200	2800	600
Sulfate	mg/L	17	2976.47	251.32	3000	2500	3400	900
pH	S.U.	16	7.5	0.09	7.5	7.4	7.7	0.3

M-55A	Monitoring Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	16	0.36	0.03	0.36	0.31	0.43	0.12
Cobalt	mg/L	16	0.001	0.0009	0.0008	0.0005	0.004	0.035
Chloride	mg/L	14	3521.43	540.91	3650	2300	4300	2000
Sulfate	mg/L	14	3571.43	143.73	3500	3400	3800	400
pH	S.U.	13	7.42	0.13	7.4	7.3	7.7	0.4

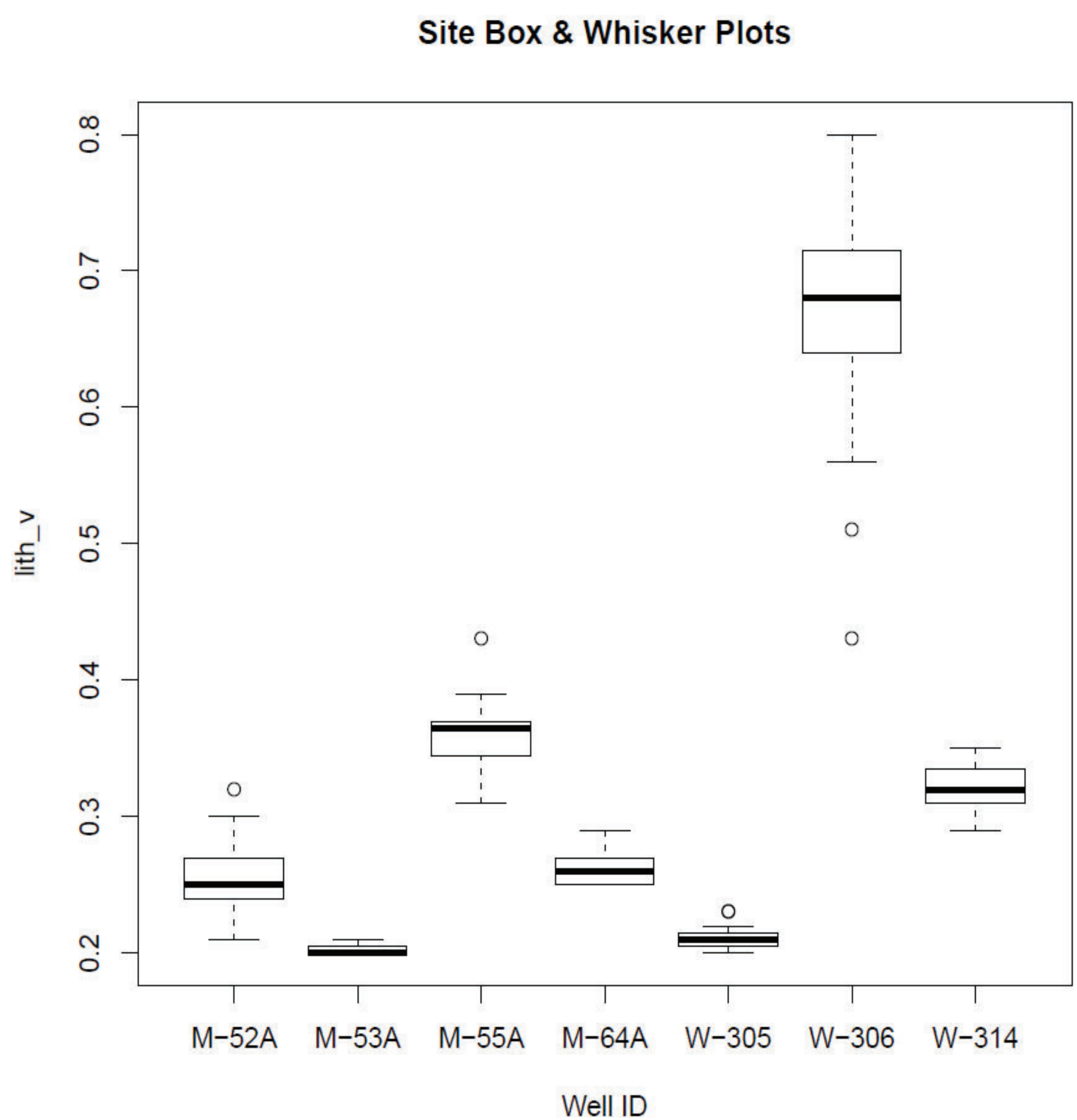
M-64A	Background Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	13	0.26	0.01	0.26	0.25	0.29	0.04
Cobalt	mg/L	13	0.0008	0.0005	0.0006	0.0005	0.002	0.0015
Chloride	mg/L	11	4381.82	464.37	4400	3500	5100	1600
Sulfate	mg/L	11	4381.82	289.2	4400	3700	4800	1100
pH	S.U.	11	7.42	0.11	7.4	7.3	7.6	0.3

W-305	Monitoring Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	19	0.21	0.01	0.21	0.2	0.23	0.03
Cobalt	mg/L	19	0.02	0	0.02	0.01	0.02	0.01
Chloride	mg/L	17	2352.94	162.47	2300	2100	2700	600
Sulfate	mg/L	17	2388.24	131.73	2400	2200	2800	600
pH	S.U.	16	7.41	0.16	7.4	7.05	7.7	0.65

W-306	Monitoring Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	19	0.66	0.09	0.68	0.43	0.8	0.37
Cobalt	mg/L	19	0	0.01	0	0	0.03	0.03
Chloride	mg/L	17	1941.18	173.42	1900	1800	2400	600
Sulfate	mg/L	17	10982.35	2487.03	12000	3600	13000	9400
pH	S.U.	16	7.82	0.24	7.9	7.02	8.2	1.18

W-314	Monitoring Well							
	Units	Sample Count	Mean	Standard Deviation	Median	Minimum	Maximum	Range
Lithium	mg/L	19	0.32	0.02	0.32	0.29	0.35	0.06
Cobalt	mg/L	19	0.01	0	0.01	0.01	0.02	0.01
Chloride	mg/L	17	2776.47	125.15	2800	2600	3000	400
Sulfate	mg/L	17	2241.18	106.41	2200	2100	2500	400
pH	S.U.	16	7.44	0.13	7.4	7.3	7.7	0.4

FIGURES



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Navajo County, Arizona

Box and Whisker Plots for Lithium

FIGURE
1

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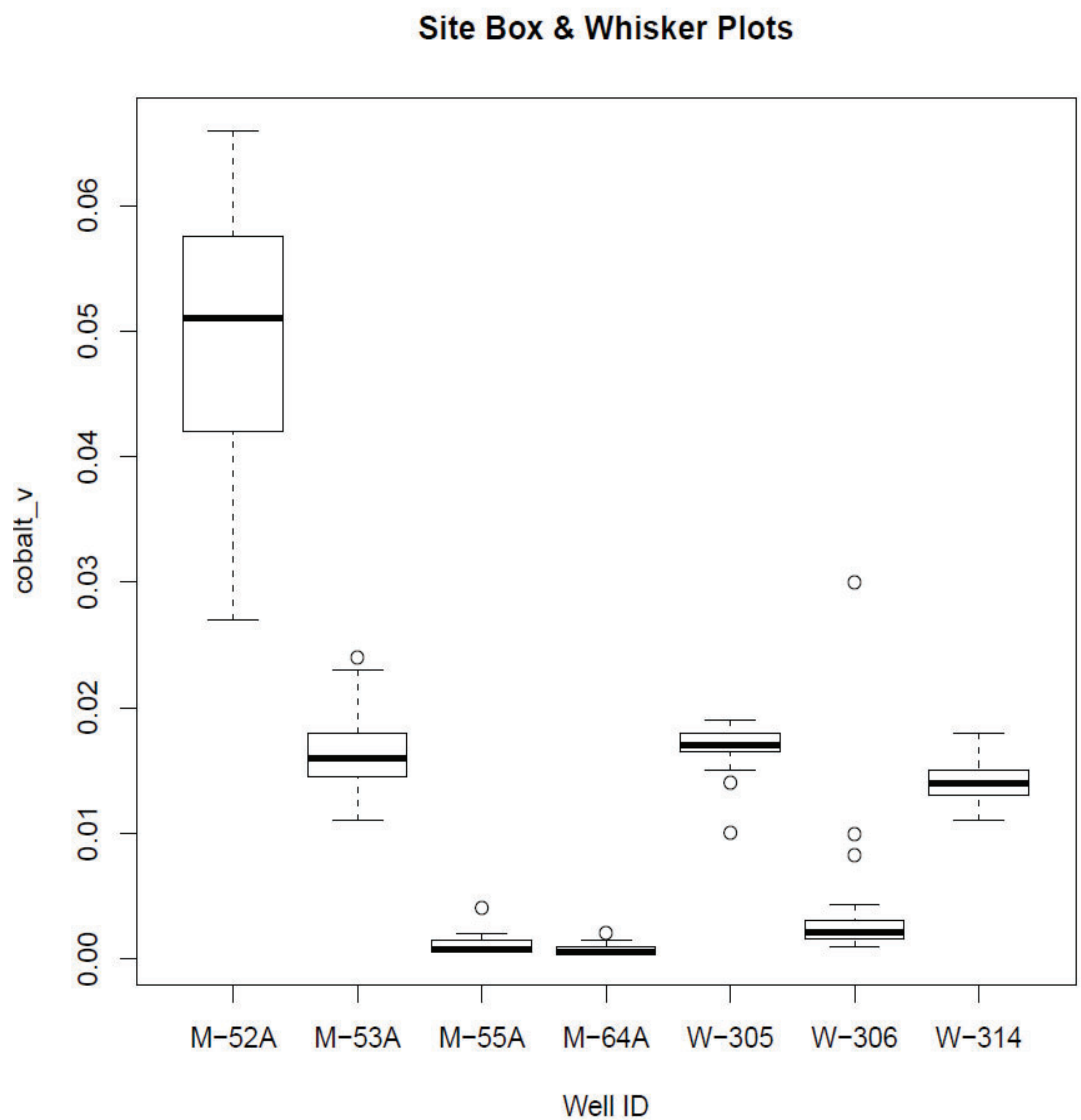

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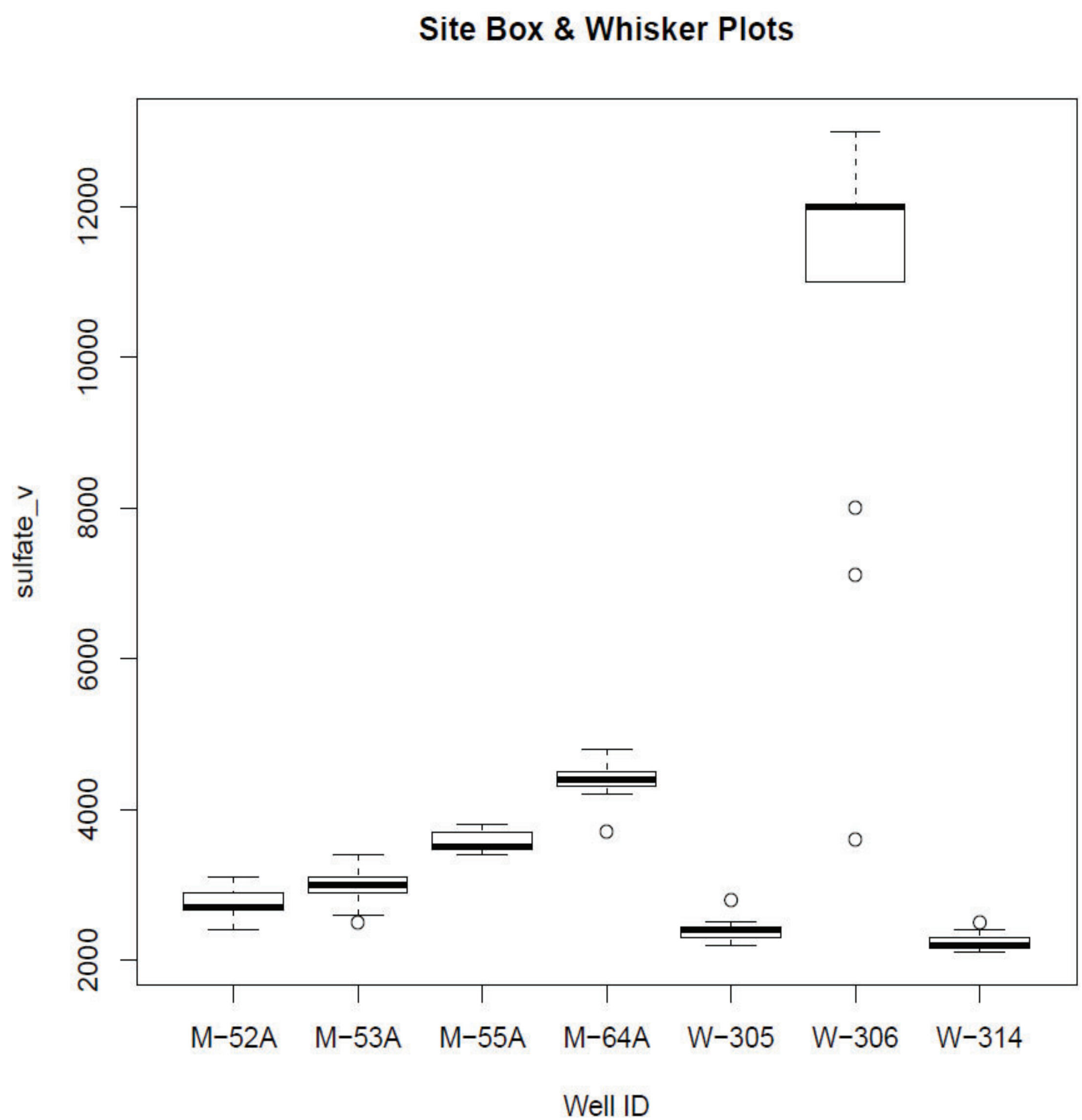
Box and Whisker Plots for Cobalt

FIGURE
2

wood.



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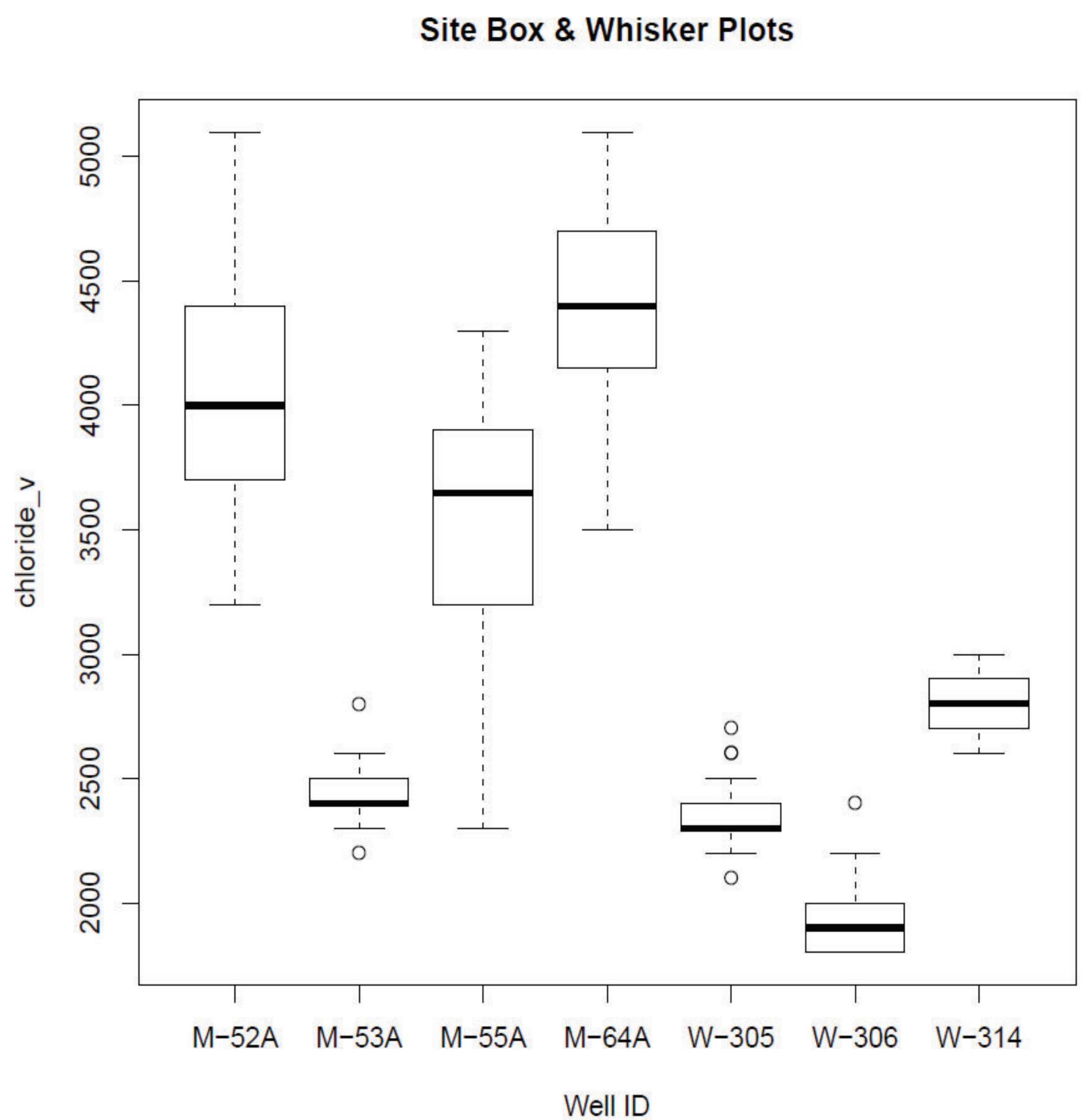
Box and Whisker Plots for Sulfate

FIGURE
3

wood.



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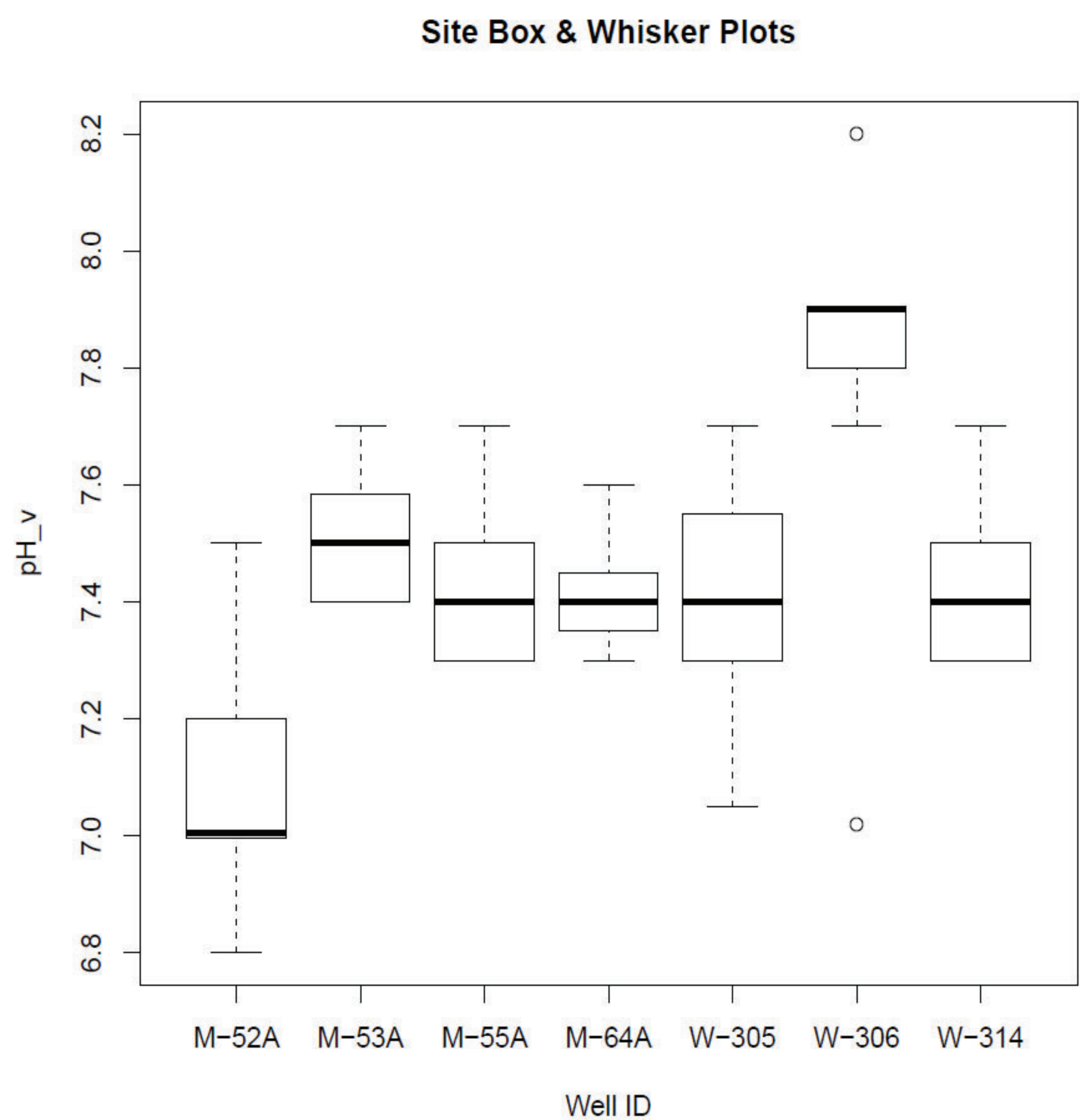
Box and Whisker Plots for Chloride

FIGURE
4

wood.



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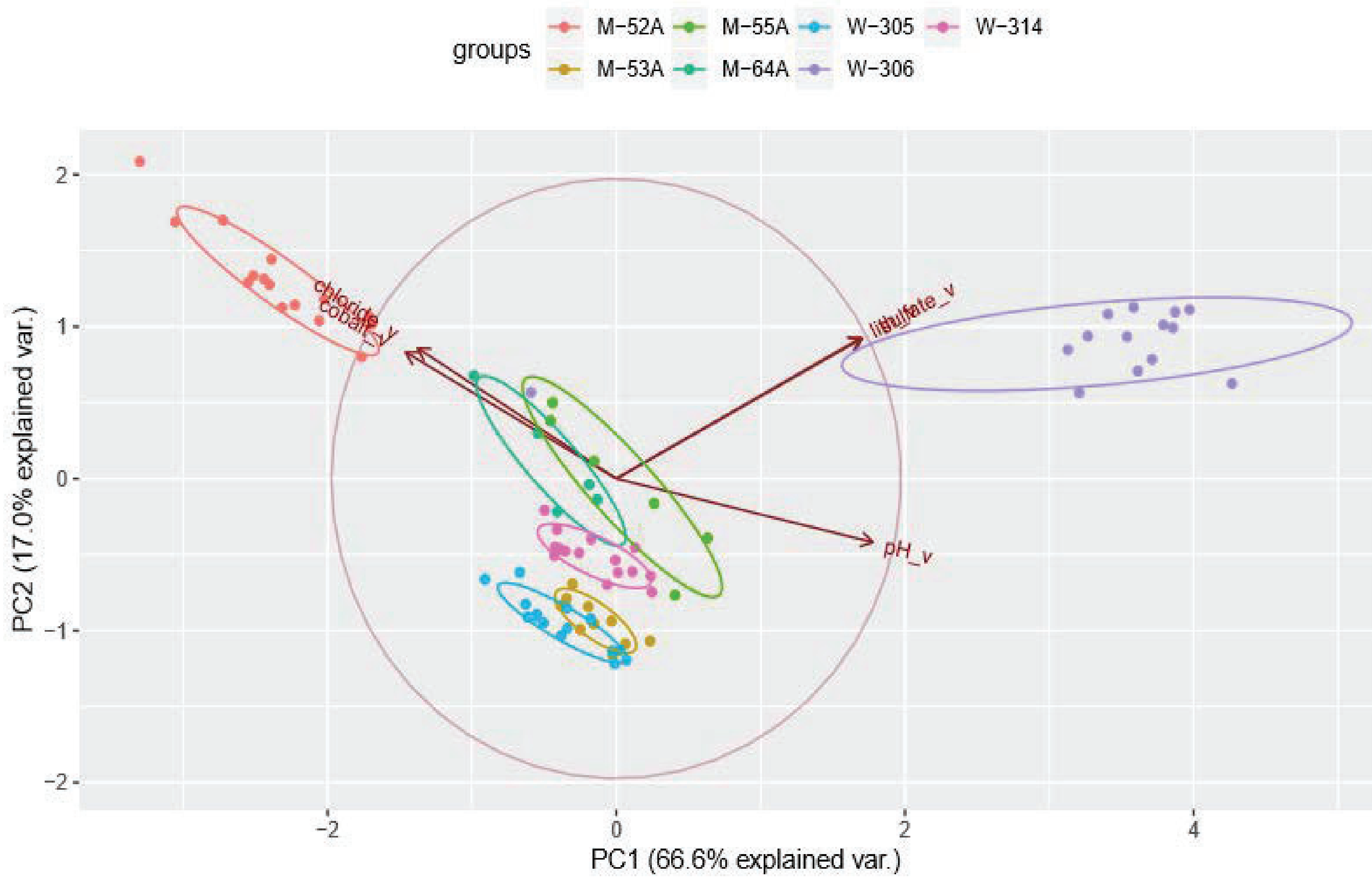
Navajo County, Arizona

Box and Whisker Plots for pH

FIGURE
5

wood.



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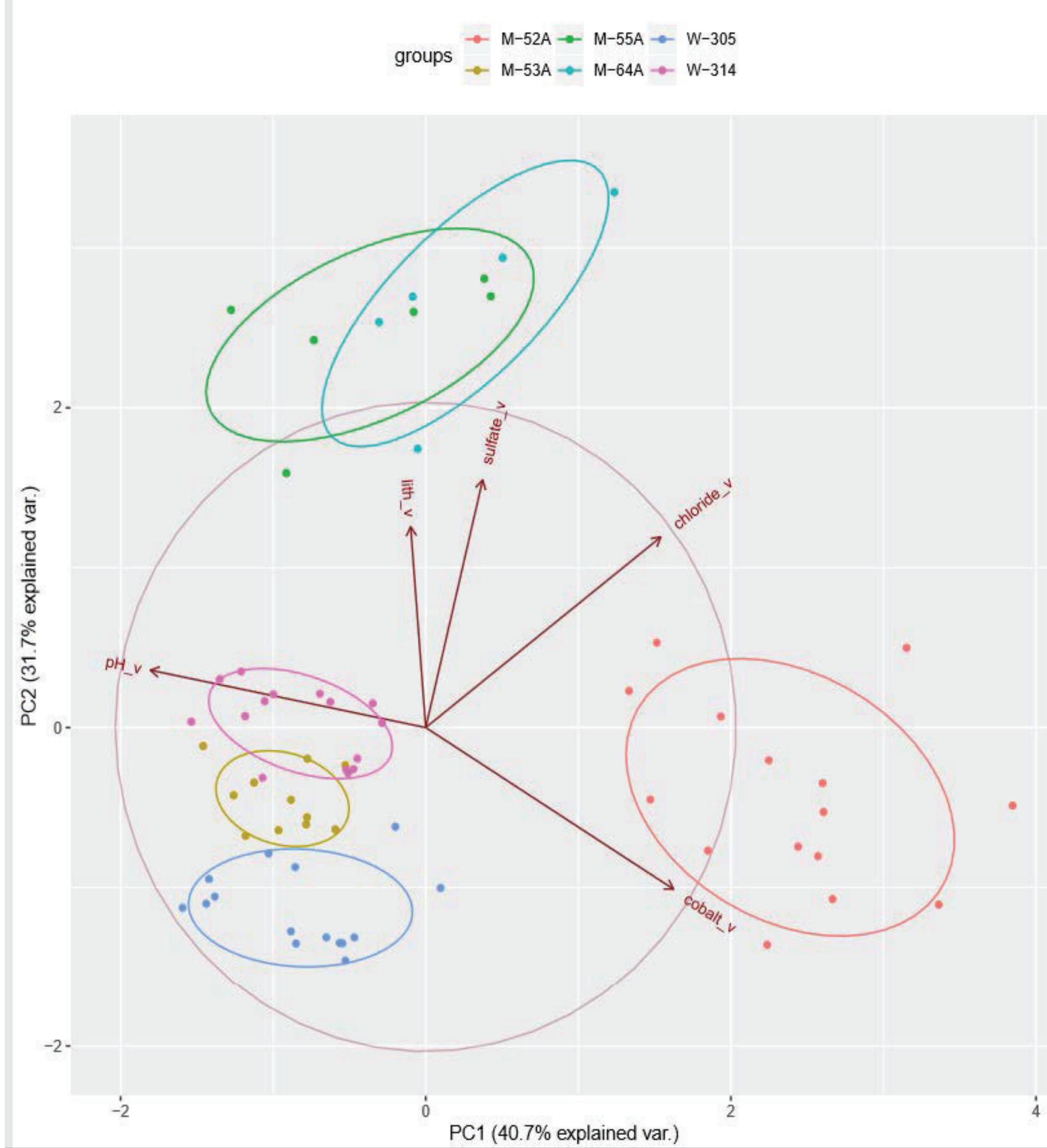
Navajo County, Arizona

Plot for PCA Baseline Scenario

FIGURE
6

wood.



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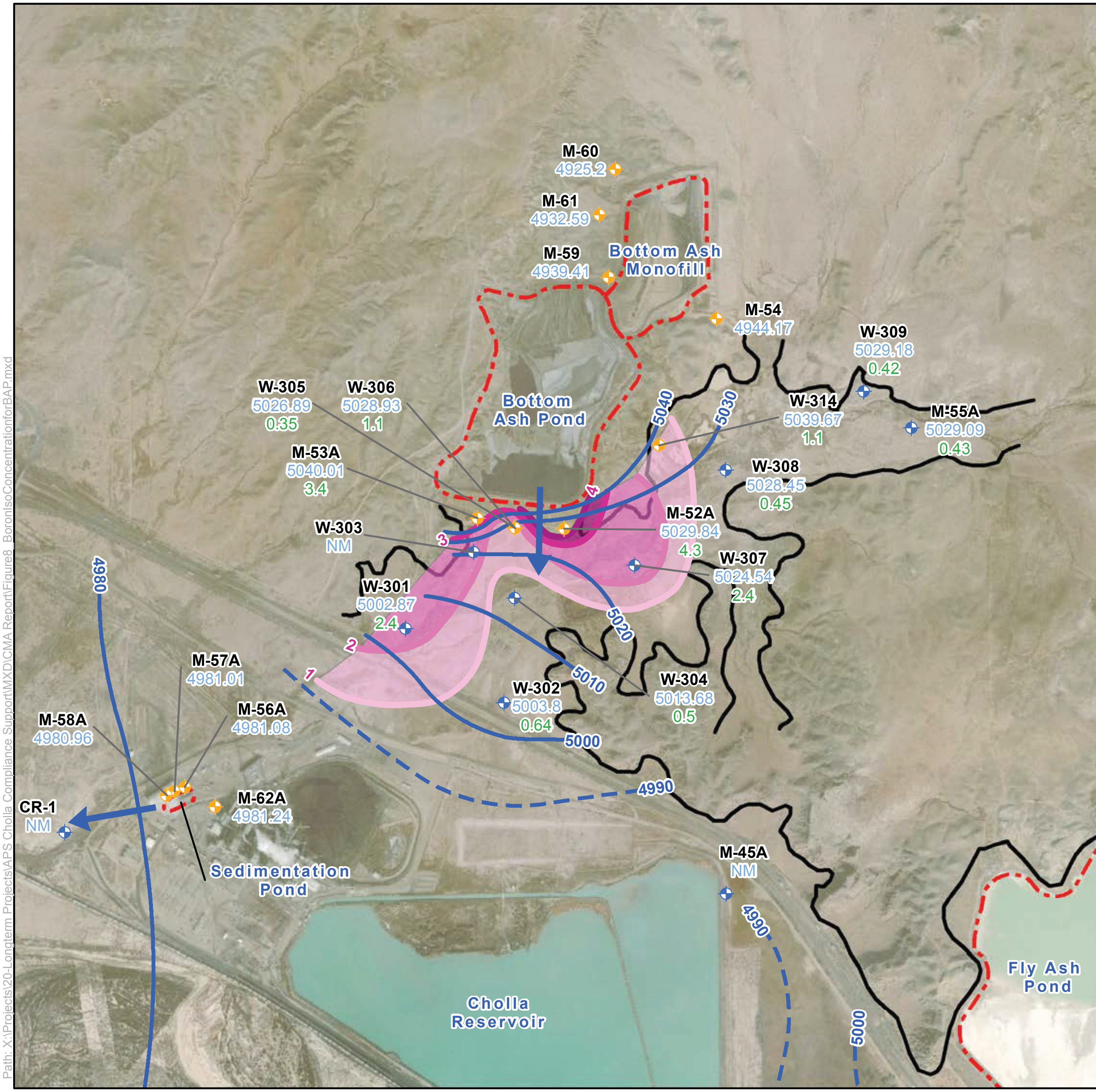
Plot for PCA Baseline Scenario Excluding W-306

FIGURE
7

wood.



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well Location
- Estimated Alluvial Extent
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)
- Groundwater Flow Direction

Boron Concentration in Alluvial Aquifer (December 2018)

- >1-2.0 mg/L
- >2-3.0 mg/L
- >3-4.0 mg/L

Notes:

W-308	Well Identification
5028.45	Groundwater elevation (ft amsl) measured in December 2018
0.45	Boron concentration (mg/L)
NM	Not Measured
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter

0 900 1,800 Feet

N

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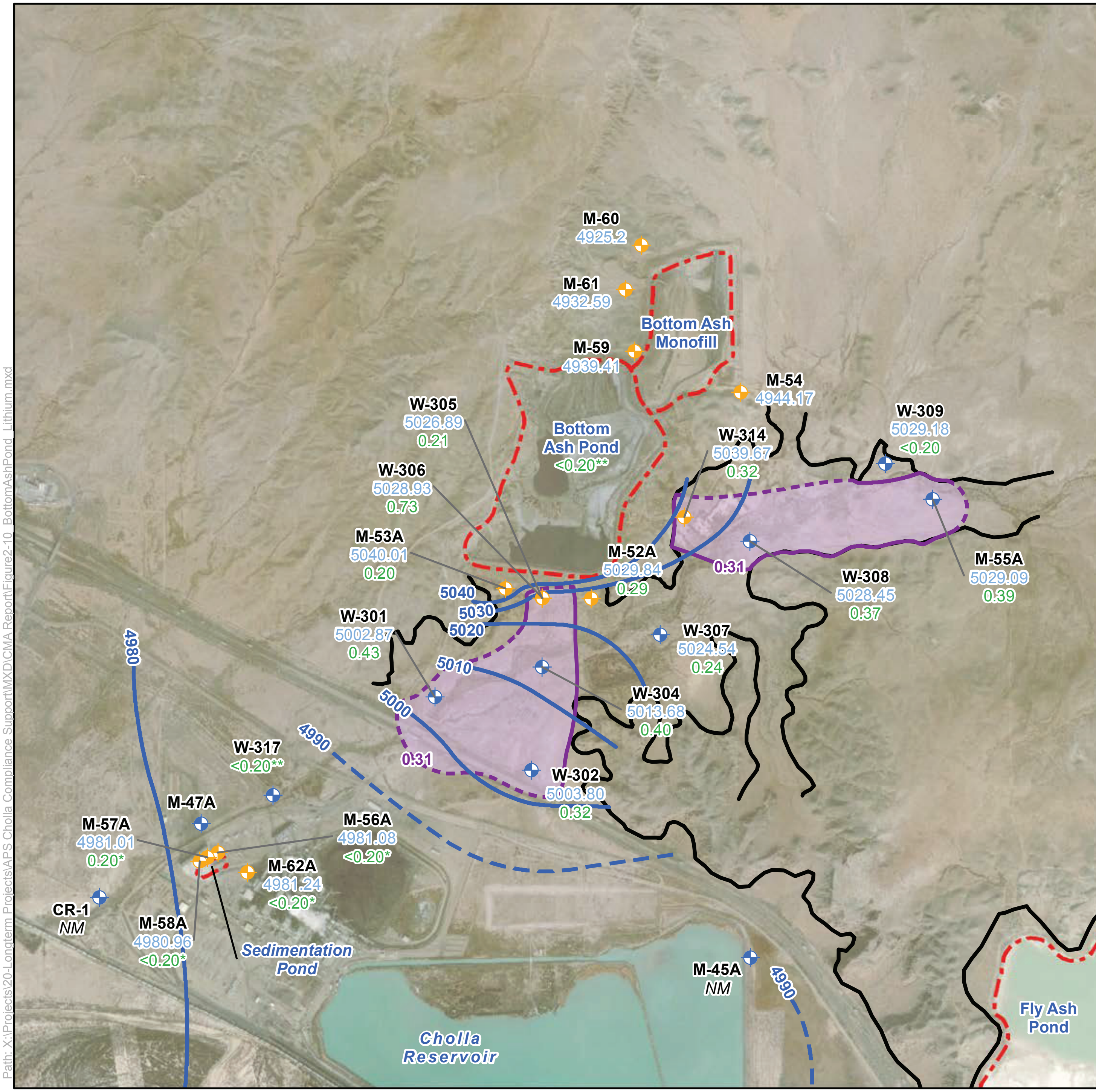
FIGURE 8

Boron Iso-Concentration Map for the Bottom Ash Pond

Job No.	1420182040
PM:	NCL
Date:	6/4/2019
Scale:	1"= 1800'

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Figure8_BoronIsoConcentrationforBAP.mxd



State Overview

Legend

- CCR Monitoring Well Location
- Supplementary Site Monitoring Well
- Estimated Alluvial
- Approximate Extent of CCR Unit

Potentiometric Surface - October 2018

- (Dashed Where Inferred)

Lithium Concentration in Alluvial Aquifer (December 2018)

- >0.31 mg/L
- GWPS (0.31 mg/L; Dashed Where Inferred)

Notes:

W-309	Well Identification
5029.18	Groundwater elevation (ft amsl) measured in October 2018
<0.20	Lithium concentration (mg/L)
*	Sampled in May 2018
**	Sampled in March 2019
ft amsl	Feet above mean sea level
mg/L	Milligrams per liter
NM	Not Measured
GWPS	Groundwater Protection Standard

0 915 1,830 Feet

N

Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

FIGURE 9

Lithium Iso-Concentration Map for the Bottom Ash Pond

Job No. 1420182040
PM: NCL
Date: 6/5/2019
Scale: 1"= 1,830'

APPENDIX B

CORRECTIVE MEASURES ASSESSMENT GROUNDWATER MODEL DOCUMENTATION

Technical Memorandum

To:	Michele Robertson, RG Pamela Norris	**Project No:**	14-2018-2040
From:	Emily LoDolce, PE	**Reviewed by:**	Natalie Chrisman Lazarr, PE Chris Courtney, RG
Date:	June 14, 2019	**cc:**	File

Subject: **CORRECTIVE MEASURES ASSESSMENT GROUNDWATER MODEL DOCUMENTATION**
Arizona Public Service Cholla Power Plant – Navajo County, Arizona

1.0 INTRODUCTION

This technical memorandum (memo) documents the development, calibration, and use of a three-dimensional (3-D) groundwater flow and transport model representing near surface hydrogeologic conditions at the Arizona Public Service (APS) Cholla Power Plant (the Site). The memo is an appendix to a report documenting an *Assessment of Corrective Measures for the Fly Ash Pond and Bottom Ash Pond* (the Main Report) prepared by Wood Environment & Infrastructure Solutions, Inc. (Wood).

The model was developed to serve as a scientific tool to evaluate potential corrective measures to address the elevated concentrations of Coal Combustion Residuals (CCR) Rule constituents observed in the alluvial aquifer downgradient of the Fly Ash Pond (FAP) and the Bottom Ash Pond (BAP). This memo presents the data and specifications for the Cholla Power Plant Groundwater Model (the model), including modeling platform, structure, parameters, conceptual water budget, and calibration data.

2.0 MODELING PLATFORM

Wood developed the model using MODFLOW 2005 (Harbaugh, 2005), a standard and widely-used USGS modeling code, with the PCG2 solver. Contaminant transport was simulated using MT3DMS (Zheng and Wang, 1999) with the finite difference solver, which has the advantage of being mass conservative. Groundwater Vistas Version 7.23 was used as a graphical user interface to facilitate modeling and visualization.

MODFLOW is a program that uses the finite difference method to solve a 3-D groundwater flow equation. The groundwater flow equation uses transmissivity (in unconfined aquifers, this is the product of hydraulic conductivity and saturated thickness), volumetric flux of water, and storage to solve for the change in head over time. MODFLOW solves the groundwater flow equation numerically by dividing the model domain into grid cells and calculating the head at the center of each cell. A complete discussion of the equations used in MODFLOW is available in the USGS open-file report 00-92, "MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process."

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MT3DMS is a program for simulating advection, dispersion/diffusion, and chemical reactions of contaminants in groundwater flow systems under general hydrogeologic conditions. The advection-dispersion equation uses porosity, dispersivity, and groundwater velocity to solve for the change in concentration over time. MT3DMS solves the advection-dispersion equation numerically using the groundwater flow field from the MODFLOW simulation and a finer discretization of time than what is used in the groundwater flow model to calculate the concentration in the center of each cell at each time step.

Groundwater Vistas (Environmental Simulations, Inc., 2017) is a proprietary graphical user interface that facilitates the modeling process by generating the input files required by MODFLOW 2005 and by displaying the modeling environment in a graphical manner. While this software is not required to run the model, the pre- and post-processing tools within this software package allow flow and transport models to be quickly constructed, run, and processed for evaluation. Additional tools for processing and visualizing model input and output data include Microsoft Excel and the ArcGIS (Version 10.3 [ESRI, 2014]) suite of programs, specifically ArcMap.

2.1 Modeling Approach

The approach to modeling the alluvial groundwater system at the Site was to first develop and calibrate a steady state groundwater flow model using groundwater elevations from Site monitoring wells and flow rates from Site seepage intercept systems as calibration data. The calibrated steady state flow model formed the basis for a transient model that was used to simulate groundwater flow and contaminant transport. The transient model was calibrated to observed concentrations of fluoride (at the FAP) and cobalt (at the BAP). Finally, the transient contaminant transport model was used to simulate the future impacts of alternative corrective measures at the Site.

2.2 Model Structure

To solve the groundwater flow equation, it is necessary to define the extent of the area of interest. This section discusses the geometry of the groundwater model, which can be thought of as a 3-D box that is cut out of the earth and isolated. The domain (edges of the box), cell size (partitions within the box), and layering (levels within the box) were developed by Wood in consultation with APS.

2.2.1 Model Domain

The model encompasses 10.9 square miles at the Cholla Power Plant in Navajo County, Arizona. General goals for model boundaries were to encompass the alluvial aquifer and to minimize the impact of model boundaries on the areas of potential corrective measures. Where feasible, this was done by extending the model to the geologic termination of the alluvium (as defined by AMEC Environment & Infrastructure, Inc. [AMEC], 2012 and Montgomery & Associates, 2017). Where no natural boundaries were present, the model domain is extended sufficiently beyond the area of interest to minimize boundary effects as described in Section 2.2.3. **Figure 1** presents an overview of the model domain, grid, and boundaries.

2.2.2 Grid Size, Orientation, and Layering

A grid cell size of 200 feet (ft) by 200 ft was used for the steady state groundwater flow model used to calibrate the flow field (except for the 100 ft by 200 ft cells in the vicinity of the FAP dam), and a grid cell size of 100 ft by 100 ft was used for the contaminant transport model. The grid is rotated 45.8 degrees from north to align with the primary direction of groundwater flow in the area of interest, i.e., the alluvium down-gradient of the FAP and the Tanner Wash alluvium cross- and down-gradient of the BAP (see **Figure 1** for groundwater flow direction arrows). The model consists of three layers with individual model cell thickness varying in accordance to local hydrogeologic stratification at a 200-ft scale.

Layer 1 is unconfined and represents the upper portion of the alluvium, which generally consists of fat clays with low permeability (Wood, 2019 [**Attachment A**]). Ground surface elevation (the top of Layer 1) was defined using 10-meter (m) Digital Elevation Model files (DEMs) from the USGS (USGS, 2013). These are raster files that are a product of satellite imagery, produced at a 10-m resolution which means the raster is pixilated in 10-m by 10-m pixels. Using a mapping and spatial analysis software program called ArcMap, Wood intersected the DEM with the model grid and calculated an average surface elevation for each 200 ft by 200 ft grid cell.

Layer 2 is variably confined and represents the lower portion of the alluvium and is unconfined where Layer 1 is dry and confined where Layer 1 is saturated. Layer 2 consists of a mixture of clays, sands, and gravels, and is generally more permeable than the upper alluvial material. The contact between Layer 1 and Layer 2 was based on boring logs from Site wells. Layer 2 is the primary groundwater bearing alluvial unit of interest at the Site.

Layer 3 represents the Moqui member of the Moenkopi Formation. It is modeled as a confined layer due to the presence of overlying Layers 1 and 2. As documented in the Main Report, the Moqui consists of gypsiferous mudstone and siltstone beds that are expected to have a low vertical permeability but have the potential to have higher lateral secondary permeability through bedding plans, fractures, and joint structures. Initially the groundwater model was conceptualized as representing only the alluvial aquifer. During model development, review of piezometer data near the FAP and the BAP suggested that the Moqui member of the Moenkopi Formation was not as impermeable as previously thought, especially in the vicinity of ponded surface water. Layer 3 was added to represent this relatively transmissive member in the model. The top of Layer 3 was derived using geologic contact elevation contours prepared by AMEC, 2012 and Montgomery & Associates, 2017. Wood used ArcMap to generate a surface raster from the geologic contact elevation contours, calculate an average contact elevation per grid cell, and assign that elevation to the model grid cell. The bottom of Layer 3 was set at 20 ft below the top of Layer 3 to provide sufficient grid cell thickness for the numerical solver.

2.2.3 Boundary Conditions

No-flow boundary cells are inactive cells in the model (i.e., the numerical solver does not solve for head in these cells) and are generally used to define the model domain. In general, no-flow cells correspond to areas in the model domain where the alluvial thickness is zero ft, as mapped by AMEC, 2012 and Montgomery & Associates, 2017.

Constant head boundary cells were used to represent the FAP, the BAP, the inflow from upper Tanner Wash north of the BAP, and inflow from the Little Colorado River alluvial channel. **Table 1** summarizes constant head values in the model.

Table 1. Constant Head Boundaries

Boundary	Constant Head (ft amsl)	Date of Measurement	Justification
Bottom Ash Pond (in Layer 1)	5,110.1	10/23/2018	Representative 2018 water level – closest in time to the measured water levels in the wells
Fly Ash Pond (in Layer 1)	5,088.8	10/23/2018	Representative 2018 water level – closest in time to the measured water levels in the wells
Upper Tanner Wash inflow (in Layers 2 and 3)	5,030.0	N/A	Adjusted during calibration
Inflow from Little Colorado River (LCR) alluvium at eastern boundary (in Layers 1, 2, and 3)	varies	2018	Based on potentiometric surface contour maps produced in 2018

Notes: ft amsl = feet above mean sea level

General head boundary (GHB) cells were used to define the downgradient boundary of the model, west of the power plant. One of the uncertainties in the conceptual model was the amount of underflow exiting the western border of the Site. The measured groundwater elevation in M-64A on October 22, 2018, i.e., 4,966.15 ft above mean sea level (amsl), was assigned to the GHB cells to allow groundwater to flow out of the model domain based on the calculated head difference between the model and the reference point of M-64A. The hydraulic conductivity of the GHB cells was adjusted during model calibration until modeled heads satisfactorily simulated observed heads in nearby monitoring wells.

Drain cells were used to represent seep intercept systems located near the FAP and the BAP. At the FAP, the Hunt A, Hunt B, and Geronimo seep intercept systems are represented. At the BAP, the West Abutment, Petroglyph, P-226, and Tanner Wash seep intercept systems are represented. **Table 2** summarizes drain cell values in the model.

Table 2. Drain Cell Parameters

Seep Intercept System Name	Drain Elevation (ft amsl)	Distance of Drain Elevation Below Top of Layer (ft)	Justification
Geronimo (in Layer 1)	5,037.5	36.43	Adjusted during calibration
Hunt A (in Layer 1)	5,002.0	36.92	Adjusted during calibration
Hunt B (in Layer 1)	5,000.3	38.74	Adjusted during calibration
West Abutment (in Layer 2)	5,042.0	26.60	Adjusted during calibration
Tanner Wash (in Layer 1)	4,983.0	66.33	Adjusted during calibration
Petroglyph (in Layer 2)	5,029.5	41.29	Adjusted during calibration
P-226 (in Layer 2)	5,027.9	34.84	Adjusted during calibration

Notes: ft amsl = feet above mean sea level

3.0 MODEL PARAMETERS

Model parameters used to describe the geology are hydraulic conductivity, specific yield (unconfined layers), porosity, and specific storage (confined layers). Parameter values used in this model were derived from the following sources:

- Soils lab testing of soil from the MW-67A boring (**Attachment B**)
- Literature values (Freeze and Cherry, 1979; Zheng and Bennet, 2002)
- Previous hydrogeologic investigations at the Site (Montgomery & Associates, 2017; AMEC, 2012; Sergent, Hauskins, & Beckwith [SHB], 1973)

Recharge, a common parameter in groundwater models, was not included in the Cholla groundwater model because the plant location is an arid, high-elevation plateau, and what little precipitation occurs is not expected to have a notable recharge effect on the groundwater. However, evapotranspiration was applied to the cells underlying the FAP and the BAP to improve the model calibration and, in the case of the transient fate and transport model, facilitate pond drainage during the modeled plant closure period.

3.1 Hydraulic Conductivity

Hydraulic conductivity is a measure of how freely groundwater can move through a geologic formation. The general distribution of hydraulic conductivity zones within the model was tied to geologic formations, and hydraulic conductivity values were adjusted during the calibration of the steady state model. The ratio of horizontal to vertical hydraulic conductivity was initialized at 10:1 but allowed to vary during calibration (see Section 4) if doing so resulted in a better match to observed heads and seep flux. **Table 3** summarizes the calibrated hydraulic conductivity values for each zone in the model and provides a comparison to literature or measured values.

Table 3. Range of Hydraulic Conductivity for Geologic Formations at the Site

Model Zone	Horizontal Hydraulic Conductivity (ft/day)	Vertical Hydraulic Conductivity (ft/day)	Vertical Anisotropy Ratio (Kv:Kh)	Geologic Unit Represented by this Zone	Comparable Site and/or Literature Value (ft/day) and Source
1	123.83	30.69	0.25	Alluvial material, primarily Layer 2, some Layer 1	0.032 to 7.2 (APS, 1984) 2.8e-3 to 28 (Freeze and Cherry, 1979)
2	0.19	0.99	5.21	Alluvial material near the FAP, Layer 1	0.032 to 7.2 (APS, 1984) 2.8e-3 to 28 (Freeze and Cherry, 1979)
3	0.047	0.27	5.74	Material underlying the FAP, Layers 1 and 3	Calibration parameter
4	8e-4	1e-4	0.13	Clay core earthen dam at FAP, Layers 1, 2, and 3	10e-4 (Woodward-Clyde, 1992)
5	8.01	0.66	0.08	Alluvial material, Layer 2	0.032 to 7.2 (APS, 1984) 2.8e-3 to 28 (Freeze and Cherry, 1979)
6	46.25	0.40	0.01	Alluvial material underlying the FAP, Layer 2 and limited Layer 3	0.032 to 7.2 (APS, 1984) 2.8e-3 to 28 (Freeze and Cherry, 1979)
7	245.74	0.017	7E-05	Alluvial material, Layer 2 and Layer 3 (paleo-channel near plant)	0.032 to 7.2 (APS, 1984) 2.8e-3 to 28 (Freeze and Cherry, 1979)
8	9e-6	8e-5	8.89	Clay core earthen dam at BAP, Layer 2	10e-4 (Woodward-Clyde, 1992)

Model Zone	Horizontal Hydraulic Conductivity (ft/day)	Vertical Hydraulic Conductivity (ft/day)	Vertical Anisotropy Ratio (Kv:Kh)	Geologic Unit Represented by this Zone	Comparable Site and/or Literature Value (ft/day) and Source
9	14.51	5.7e-3	4E-04	Moenkopi throughout the model domain including underlying the BAP, Layer 3	< 3e-4 to 4.5 (Woodward-Clyde, 1992) 3e-6 to 4e-3 (Domenico and Schwartz, 1990)
10	38.99	0.014	4E-04	Little Colorado River (LCR) alluvial material, Layer 1	0.032 to 7.2 (APS, 1984) 2.8e-3 to 28 (Freeze and Cherry, 1979)
11	4.7e-3	6.5e-3	1.38	Tanner Wash alluvial material, Layer 1	0.062 to 0.44 (Woodward-Clyde, 1992) 2.8e-3 to 28 (Freeze and Cherry, 1979)
12	1.98	1.29	0.65	Tanner Wash alluvial material, Layer 2	0.062 to 0.44 (Woodward-Clyde, 1992) 2.8e-3 to 28 (Freeze and Cherry, 1979)
13	54.66	0.12	2E-03	Material underlying the BAP, Layers 1 and 2	Calibration parameter
14	16.5	1.5	0.09	Tanner Wash Moenkopi, Layer 3	< 3e-4 to 4.5 (Woodward-Clyde, 1992) 3e-6 to 4e-3 (Domenico and Schwartz, 1990)

Notes: ft = feet; Kv = vertical hydraulic conductivity; Kh = horizontal hydraulic conductivity

In general, the hydraulic conductivities in the model were within the range of hydraulic conductivities measured at piezometers and boreholes at the Site, or if not, within the larger range of literature values for the given formation (clays, silts, and sands for the alluvium and siltstone for the Moenkopi Formation). Exceptions to this are the alluvial materials, which generally calibrated to a higher hydraulic conductivity than what was measured at the Site or presented in literature.

4.0 CALIBRATION

Model calibration is performed so that simulated hydraulic heads and fluxes satisfactorily approximate real-life observations. A model is considered calibrated when the difference between the observed and modeled heads and/or fluxes is sufficiently small. Calibration criteria for the model were decided with input from APS in advance of constructing the model and are as follows:

- Normalized root-mean-square-error (RMSE) < 10% (industry standard)
- $R^2 > 0.9$
- General direction of groundwater flow in the model matches observations
- General hydraulic gradient (change in head over distance) of groundwater in the model matches observations

The following subsections document the observation data (targets) and calibration statistics.

4.1 Head and Flux Targets

The data used for calibration are groundwater elevations measured at select Site monitoring wells and piezometers and flow rates measured at seepage intercept systems. The time period for head calibration data was between August 2018 and February 2019, as this represents one of the most complete recent datasets for groundwater elevations. For fluxes, the average flow rate in 2018 was used as the target flux. The model has head targets in all three layers based on well logs indicating the depth of the well and the formation in which it was completed. The drain target elevations were placed based on a combination of construction diagrams (if available) and calibration to the observed flow rate.

Table 4 summarizes the calibration targets and modeled residuals. **Figure 2** presents the locations of the calibration targets and the modeled groundwater elevation contours, and **Figure 3** is a graph of the observed versus modeled heads.

Table 4. Summary of Calibration Targets and Results

Well Name	Easting X (ft)	Northing Y (ft)	Layer	Date of Groundwater Measurement	Observed Head (ft amsl)	Computed Head (ft amsl)	Residual (ft)
W-305	662996.3	1437482	2	10/24/2018	5026.89	5032.00	-5.11
W-306	663002.9	1437479	2	10/24/2018	5028.93	5031.77	-2.84
W-307	664492.2	1437014	2	10/24/2018	5024.54	5025.78	-1.24
W-309	667339.2	1439182	2	10/24/2018	5029.18	5030.73	-1.55
W-308	665627.7	1438202	2	10/24/2018	5028.45	5030.56	-2.11
W-303	662488.4	1437178	1	8/7/2018	5021.76	5027.11	-5.35
W-304	662995.6	1436606	2	10/24/2018	5013.68	5014.98	-1.30
W-302	662863.3	1435304	1	10/24/2018	5003.8	4993.04	10.76
W-301	661640.4	1436230	2	10/24/2018	5002.87	4997.48	5.39
W-123	669917.0	1429138	2	8/6/2018	5037.02	5038.50	-1.48
W-126	669664.1	1428723	2	8/6/2018	5026.83	5017.06	9.77
CR-1	657397.9	1433689	1	8/7/2018	4979.51	4978.56	0.95
W-314	664796.7	1438508	2	8/7/2018	5039.44	5031.31	8.13
P-89	671429.6	1428488	3	8/24/2018	5057.66	5045.70	11.96
P-115	671188.6	1428639	3	8/24/2018	5031.82	5045.50	-13.68
P-113	670342.8	1428729	2	8/24/2018	5041.23	5042.05	-0.82
P-110	669907.5	1429674	2	8/24/2018	5087.21	5075.23	11.98
P-103	669028.6	1430008	3	8/24/2018	5017.6	5022.36	-4.76
P-102	668801.3	1430256	3	8/24/2018	5025.53	5027.05	-1.52
P-101	668536.0	1430581	3	8/24/2018	5049.53	5055.44	-5.91
P-100	668408.1	1431034	3	8/24/2018	5079.47	5073.80	5.67
DM-04R	662854.6	1429321	2	8/7/2018	4985.71	4988.04	-2.33
M-43A	666102.6	1430934	2	8/7/2018	4987.18	4990.05	-2.87
M-45A	665632.0	1432931	1	8/7/2018	4988.65	4991.90	-3.25
M-46A	667780.6	1429132	1	8/7/2018	4998.32	5003.18	-4.86
M-50A	669247.0	1429797	2	8/6/2018	5018.53	5024.47	-5.94
M-51A	668736.4	1430358	2	8/6/2018	5031.76	5032.05	-0.29
M-52A	663617.5	1437474	2	10/24/2018	5029.84	5030.04	-0.20
M-53A	662532.6	1437603	2	10/24/2018	5040.01	5040.81	-0.80
M-55A	667937.3	1438729	2	12/7/2018	5029.09	5030.49	-1.40
M-56A	658894.9	1434257	2	10/24/2018	4981.08	4980.68	0.40
M-57A	658761.9	1434200	2	10/24/2018	4981.01	4980.53	0.48

Well Name	Easting X (ft)	Northing Y (ft)	Layer	Date of Groundwater Measurement	Observed Head (ft amsl)	Computed Head (ft amsl)	Residual (ft)
M-58A	658666.7	1434151	2	10/24/2018	4980.96	4980.43	0.53
M-62A	659271.3	1434007	2	10/24/2018	4981.24	4981.31	-0.07
M-63A	665243.3	1427870	2	9/10/2018	4984.71	4990.72	-6.01
MW-65A	668253.2	1429524	2	2/14/2019	5013.21	5006.40	6.81
MW-66A	669177.2	1429131	2	2/14/2019	5004.47	5005.49	-1.02
MW-67A	668013.5	1428365	2	2/14/2019	4991.04	4998.95	-7.91

Notes: ft amsl = feet above mean sea level

In general, the lowest residuals (best match) were observed in wells near the plant area and the highest residuals (worst match) were observed in piezometers adjacent to or within the FAP dam. Near the plant, the change in head over distance (i.e., hydraulic gradient) is low and the geology is relatively homogeneous; therefore, the grid size was sufficient to allow the model to match observed heads with more precision. Near the FAP and the BAP, the hydraulic gradient is relatively steep, and the geology is more complex; therefore, the grid size may not be ideal to allow the model to match observed heads with more precision. Recommendations to further enhance calibration near the FAP and the BAP are provided in Section 8.

Table 5 summarizes the drain calibration targets and residuals. In general, the fluxes from the drain cells are a very good match to the observed fluxes. **Figure 4** is a graph of the observed versus modeled fluxes (drains).

Table 5. Flux Targets (Drain Cells)

Seepage Intercept System Name	Easting (ft) X	Northing (ft) Y	Layer	Observed Flux (gpm)	Computed Flux (gpm)	Residual (gpm)
Geronimo	669811.4	1429240	1	16.14	16.06	0.08
Hunt A	669539.6	1428985	2	3.12	3.01	0.11
Hunt B	669678.5	1428835	2	3.12	3.01	0.11
Tanner Wash	664718.9	1437800	1	5.01	4.56	0.45
Petroglyph	664155.3	1437617	2	7.93	7.75	0.18
West Abutment	662107.3	1437848	2	5.42	5.41	0.01
P-226	664471.6	1438348	2	9.74	9.73	0.01

Notes: ft = feet; gpm = gallons per minute

Steady state groundwater flow model calibration statistics are summarized in **Table 6**.

Table 6. Steady State Calibration Statistics

Statistic	Head Targets	Flux Targets
Residual Mean	-0.31	-34.98
Absolute Residual Mean	4.14	34.98
Residual Std. Deviation	5.57	33.96
Sum of Squares	1,181	16,638
RMS Error	5.58	48.75
Minimum Residual	-13.68	-86.11
Maximum Residual	11.98	-1.01

Statistic	Head Targets	Flux Targets
Number of Observations	38	7
Range in Observations	107.7	2508
Scaled Residual Standard Deviation	0.05	0.01
Scaled Absolute Residual Mean	0.04	0.01
Scaled RMS Error	5.18%	1.94%
Scaled Residual Mean	0.00	-0.01
R^2	0.96	1.00

The model has a normalized RMSE of 5.18% and 1.94% for the head and flux targets, respectively. The R^2 value for the head and flux targets is 0.96 (**Figure 3**) and 1.00 (**Figure 4**), respectively. The general direction of groundwater flow and the general hydraulic gradient in the model matches observations (**Figure 2**) with the exception of groundwater flow in upper Tanner Wash, as discussed in Section 4.2. The steady state flow model meets/surpasses the calibration criteria and as such is considered a suitable model for use as the basis of the transient transport simulations.

4.2 Modeled Water Budget

The modeled steady state groundwater budget (also called mass balance) is shown in **Table 7**:

Table 7. Steady State Groundwater Budget

Flux boundary	Inflow (cfd)	Outflow (cfd)
Storage	0	0
Constant Head	200,602	64,119
Little Colorado River alluvium	*79,538*	*0*
Tanner Wash alluvium	*0*	*64,119*
FAP	*96,764*	*0*
BAP	*24,300*	*0*
Wells	0	0
Drains	0	9,471
Evapotranspiration	0	55,397
GHBs	0	71,616
Total	200,602	200,603
Percent Discrepancy		0.00%

Notes: cfd = cubic feet per day

<u>Water In:</u>

The steady state groundwater budget indicates that water **<u>enters</u>** the model through the following cells:

- Constant head cells representing inflow from the Little Colorado (LCR) alluvium (79,538 cubic feet per day [cfd] / 0.92 cubic feet per second [cfs] / 413 gallons per minute [gpm])
- Constant head cells representing seepage from the FAP (96,764 cfd / 1.12 cfs / 503 gpm)
- Constant head cells representing seepage from the BAP (24,300 cfd / 0.28 cfs / 126 gpm)

<u>Water Out:</u>

Water **<u>leaves</u>** the model through the following cells:

- GHBs at the west edge of the model (71,616 cfd / 0.83 cfs / 372 gpm)

- Drain cells (9,471 cfd / 0.11 cfs / 49 gpm)
- Evapotranspiration (55,397 cfd / 0.64 cfs / 288 gpm)
- Constant head cells intended to represent inflow at the upper edge of Tanner Wash (64,119 cfd / 0.74 cfs / 333 gpm)

In general, the steady state groundwater budget appears to be a reasonable representation of the system. Water leaving the model at a boundary intended to simulate inflow (i.e., the Tanner Wash constant head cells) indicates that the model domain would benefit from being enlarged.

5.0 SENSITIVITY ANALYSIS AND PARTICLE TRACKING

As part of the calibration process, a sensitivity analysis was performed on hydraulic conductivity to assess which zones the model results were most sensitive to. To perform the analysis, horizontal hydraulic conductivity values in each zone were perturbed in increments of 0.1 from 0.5 to 1.5. The model was run and the sum of square residuals was recorded. This process was repeated for each increment and each zone individually. The results of the analysis are shown in graphical format in **Figure 5**. The lower the sum of square residuals, the better that version of the model fit to target values. The higher sum of square residuals, the worse that version of the model fit to target values. Ideally, the values centered around 1 will also be the lowest sum of square residuals. In instances where this is not the case, the modeler may choose to manually adjust that value to assess the change in calibration.

Based on the sensitivity analysis results shown in **Figure 5**, horizontal hydraulic conductivity (Kx = Ky) zones 5, 11, and 13 were adjusted during the calibration process. The other Kx = Ky zones were either already optimized at the current parameter value or changing the parameter resulted in a better overall model calibration but a worse calibration in key areas of the model (e.g. at the toes of dams or drain cells).

As a final exercise to understand the behavior of groundwater in the steady state model prior to converting to a transient model, a particle tracking exercise was conducted. Particles were added to cells adjacent to the constant head cells representing the FAP and the BAP with the intent of verifying that water is moving in the same direction in the model as it is observed to move at the Site. The particle tracking analysis showed that most of the particles exited the model through the GHB cells to the west, as is understood to occur in real life. A few particles exited to the model via the constant head boundary cells in upper Tanner Wash. This confirms what the mass balance shows as discussed in Section 4.2. For the purposes of understanding flow and transport at the FAP, this is likely not significant. ***At the BAP, the gradient reversal is worth noting in the interpretation of results.***

6.0 TRANSLATION TO TRANSIENT WITH CONTAMINANT TRANSPORT

The calibrated steady state model was modified to operate in transient mode to simulate the time-varying aspects of contaminant fate and transport. Developing the transient model involved assigning storage and transport parameters to the model, developing a pattern of stress periods, and performing limited calibration of modeled concentrations to observed concentrations. The stress periods for the transient model represent one-year or longer increments. Select boundary conditions and fluxes were allowed to vary based on stress period. The entire model grid was also re-discretized to 100 ft by 100 ft cells. This was done primarily to reduce the numerical error in the advection-dispersion equation software solver (MT3DMS with the GCG solver).

6.1 Storage and Transport Parameters

Specific storage, specific yield, and porosity are aquifer properties that, in the three-dimensional groundwater flow equation, are dependent on time and therefore not included in a steady-state calculation. These parameters were defined for the transient model. Porosity values were assigned based on a test conducted on a soil core from monitoring well MW-67A (Wood, 2019 and **Attachment B**) or based on literature values for the given geologic formation. **Table 8** summarizes the storage parameters in the transient model.

Table 8. Specific Storage, Specific Yield, and Porosity

Layer	Specific Storage (Ss)	Specific Yield (Sy)	Porosity (n)	Source
1	Not applicable	0.03	0.42	Sy from literature values (Zheng and Bennet, 2002) n from Wood soils lab results
2	0.005	0.03	0.42	Ss from literature values (Freeze and Cherry, 1979) Sy from literature values (Zheng and Bennet, 2002) n from Wood soils lab results
3	0.0005	Not applicable	0.21	Ss from literature values (Freeze and Cherry, 1979) n from literature value for siltstone (Zheng and Bennet, 2002)

Dispersivity is a contaminant transport parameter that allows for chemical dispersion between cells. It is not related to properties of the aquifer matrix or the contaminant; rather, it is adjusted during calibration within an upper and lower bound determined by model grid size. **Table 9** summarizes the dispersivity parameters in the transient model.

Table 9. Dispersivity

Layers	Longitudinal Dispersivity (ft)	Transverse Dispersivity (ft)	Transverse Vertical Dispersivity (ft)	Longitudinal Disperse Transmissivity (ft)
1 – 3	100	10	5	5

Notes: ft = feet

6.2 Initial Concentrations

Initial concentrations in the groundwater model were assigned as follows:

- **<u>At the FAP:</u>** Fluoride concentrations were identified as representative of contamination. Fluoride concentrations measured at the Site between October and December 2018 and shown in Figure 2-2 of the Main Report were processed in ArcGIS to create a raster that was then imported into all three layers of the groundwater model. The resulting distribution of concentration is shown in **Figure 6**.
- **<u>At the BAP:</u>** Cobalt concentrations were identified as representative of contamination. Cobalt concentrations measured at the Site in December 2018 and shown in Figure 2-4 of the Main Report were contoured and imported into all three layers of the groundwater model. The resulting distribution of concentration is shown in **Figure 7**.

6.3 Stress Periods

Stress periods are used to change a stress in the model (e.g. when pumping wells turn on or off, or when the water level in a specified head cell changes). The transient stress periods are presented in **Table 10**. The model uses an annual stress period pattern during the time when water levels in the FAP and BAP are declining. **Figure 8** presents an analysis conducted by AECOM to estimate evaporation rates in the FAP. This figure formed the basis of the water levels used for the FAP in the transient model. Water levels in the BAP are simulated to remain constant until 2025, at which time they decline at a rate of 4.5 ft per year (based on the rate in **Figure 8**). Both ponds are dewatered by the end of 2036.

Table 10. Transient Model Stress Periods

Stress Period (SP) Number	Length (days)	Time Steps	Representative Time Period	Alternative 1 (Natural Attenuation, FAP and BAP)	Alternatives 2 and 3 (FAP) and Alternative 2 (BAP)	Alternative 4 (FAP)
1	2,459	1	Steady state period representing conditions through Dec. 31, 2015	FAP WL = 5097 ft amsl BAP WL = 5110 ft amsl Drains (7) are operational	FAP WL = 5097 ft amsl BAP WL = 5110 ft amsl Drains (7) are operational	FAP WL = 5097 ft amsl BAP WL = 5110 ft amsl Drains (7) are operational
2	366	30	Jan. 1, 2016 to Dec. 31, 2016	No change from SP 1	No change from SP 1	No change from SP 1
3	365	30	Jan. 1, 2017 to Dec. 31, 2017	FAP WL = 5093.5 No change to BAP WL until SP 12	FAP WL = 5093.5 ft amsl No change to BAP WL until SP 12	FAP WL = 5093.5 ft amsl No change to BAP WL until SP 12
4	365	30	Jan. 1, 2018 to Dec. 31, 2018	FAP WL = 5090.5 ft amsl	FAP WL = 5090.5 ft amsl	FAP WL = 5090.5 ft amsl
5	365	30	Jan. 1, 2019 to Dec. 31, 2019	FAP WL = 5088 ft amsl	FAP WL = 5088 ft amsl	FAP WL = 5088 ft amsl
6	366	30	Jan. 1, 2020 to Dec. 31, 2020	FAP WL = 5086 ft amsl	FAP WL = 5086 ft amsl Extraction wells active	FAP WL = 5086 ft amsl Extraction wells active
7	365	30	Jan. 1, 2021 to Dec. 31, 2021	FAP WL = 5083.5 ft amsl	FAP WL = 5083.5 ft amsl	FAP WL = 5083.5 ft amsl
8	365	30	Jan. 1, 2022 to Dec. 31, 2022	FAP WL = 5082 ft amsl	FAP WL = 5082 ft amsl	FAP WL = 5082 ft amsl
9	365	30	Jan. 1, 2023 to Dec. 31, 2023	FAP WL = 5080.5 ft amsl	FAP WL = 5080.5 ft amsl	FAP WL = 5080.5 ft amsl
10	366	30	Jan. 1, 2024 to Dec. 31, 2024	FAP WL = 5079 ft amsl	FAP WL = 5079 ft amsl	FAP WL = 5079 ft amsl
11	365	30	Closure period - Jan. 1, 2025 to Dec. 31, 2025	FAP WL = 5077 ft amsl	FAP WL = 5077 ft amsl	FAP WL = 5077 ft amsl
12	2,922	60	8-yr closure period while FAP dewaters (evaporates) at a rate of 4.5 feet per year – Jan. 1, 2026 to Dec. 31, 2033	FAP WL = 5072.5 ft amsl BAP WL = 5105.5 ft amsl Drain cells remain active for the duration of the simulation	FAP WL = 5072.5 ft amsl BAP WL = 5105.5 ft amsl Drain cells remain active for the duration of the simulation	FAP WL = 5072.5 ft amsl BAP WL = 5105.5 ft amsl Drain cells remain active for the duration of the simulation
13	1,096	30	3-yr period during which the BAP continues to dewater (evaporate) – Jan. 1, 2034 to Dec. 31, 2036	FAP WL = 5035 ft amsl BAP WL = 5070 ft amsl	FAP WL = 5035 ft amsl BAP WL = 5070 ft amsl	FAP WL = 5035 ft amsl BAP WL = 5070 ft amsl
14	4,383	90	12-yr period during which both units are fully dewatered – Jan. 1, 2037 to Dec. 31, 2048	FAP GHB cells deactivated BAP GHB cells deactivated	FAP GHB cells deactivated BAP GHB cells deactivated	FAP GHB cells deactivated BAP GHB cells deactivated
15	36,889	300	100-yr attenuation period in MNA scenario during which both units are fully dewatered – Jan, 1, 2049 to Dec. 31, 2149	No change from SP 14	No change from SP 14 Note the model run time is shortened to end on Jan. 2, 2059	No change from SP 14 Note the model run time is shortened to end on Jan. 1, 2050

Notes: ft amsl = feet above mean sea level; GHB = general head boundary; SP = stress period; WL = water level; yr = year;

6.4 Concentration Calibration

The concentrations of fluoride and cobalt in the transient model were calibrated at select Site wells in order to initialize the model runs with values that were commensurate with Site observations. Dispersivity, porosity, and concentrations in the FAP and BAP were adjusted to achieve a reasonable match to Site data. **Figure 9** and **Figure 10** present graphs showing modeled versus observed concentrations at the FAP and BAP, respectively.

The concentration calibration was guided by a set of qualitative measures:

- Water quality observations from 1984 to 2015 indicate that fluoride concentrations in groundwater wells downgradient of the FAP were generally on the order of 2 to 3 mg/L and did not exceed 3.2 mg/L (the alert level for fluoride in the Cholla Aquifer Protection Permit [ADEQ, 2017]). The fluoride concentration measured in the FAP during that same time period was approximately 15 mg/L. This is evidence to suggest that dilution, attenuation, or immobilization of fluoride occurs as it moves from the FAP into the downgradient alluvial aquifer. In order to simulate this phenomenon in the groundwater model, the specified concentration in the constant head cells representing the FAP was adjusted during calibration until modeled concentrations at select wells approximated observed concentrations (**Figure 9**).
- Concentrations of fluoride in the groundwater downgradient of the FAP were observed to increase within a year of October 2015, which was when Unit 2 at the plant was removed from operation and the fluoride concentration in the water discharged to the FAP subsequently increased. Since then, concentrations have remained relatively stable at levels higher than pre-2015 but lower than observed concentrations in the FAP itself. Based on these data, fluoride concentrations are not anticipated to increase much beyond what is currently observed and were modeled as such.
- The period of record for collected CCR constituent data at the BAP is shorter than for the FAP. The same action of mixing or immobilization in the downgradient aquifer was therefore assumed for the BAP, and the specified concentration of cobalt in the constant head cells representing the BAP was adjusted during calibration until modeled concentrations at select wells approximated observed concentrations (**Figure 10**).

The following observations pertain to the concentration calibration:

- Simulated concentrations match observed concentrations within an order of magnitude and in many cases within 10% of the observation.
- The model appears to show more leakage on the east side of the FAP dam. This may explain why modeled concentrations in M-51A take longer to increase from pre-2015 to post-2015 levels than the rate of increase seen in the observed concentrations.
- The model shows detectable levels of fluoride at M-43A at times when the observed values are non-detectable, suggesting the lateral spread of fluoride in the model may be slightly overestimated.
- Preferential pathways between the BAP and Site monitoring wells may exist at the Site, whereas in the transport model contamination appears to be more uniformly distributed in the aquifer (see **Figure 10** showing simulated concentrations lower than observed concentrations at W-301, a monitoring well a couple thousand feet downgradient of the BAP, compared to simulated concentrations at M-53A, which is adjacent to the BAP).

- The flow model was well-calibrated, lending confidence to the simulated hydraulic conductivity and groundwater flow velocities. These two factors influence the contaminant transport results. Because the hydraulic conductivity is low and groundwater velocity is low, the result showing contamination lingering in the aquifer is not unexpected.
- Long-term concentrations of fluoride and cobalt in the model do not exceed anticipated levels based on the 30-year observation period from 1984 to 2015, and the layer thicknesses are based on Site-specific data (which suggests the overall volume of water in the model is realistic), suggesting that the appropriate amount of contaminant mass is simulated in the aquifer.

These factors support the use of the transient model for corrective measures evaluations.

7.0 CORRECTIVE MEASURES EVALUATION

This section summarizes the model runs used to evaluate potential groundwater corrective actions and their resultant effect on the groundwater resource. The general approach to evaluating the efficacy of the corrective action alternatives is to evaluate the differences between the active management alternatives and a natural attenuation alternative, which can be thought of as a "limited response action" look into the future. Potential corrective action goals for the Site include:

- Water removal at a rate that can be reasonably evaporated in an evaporation pond (generally less than 400 gpm); and
- Remediation of the aquifer to levels below the applicable Groundwater Protection Standards (GWPSs) within 30 years.

Alternatives addressing these goals were developed and compared to results from a natural attenuation alternative for both the FAP and the BAP. In the following section, the structure, details, and results of the FAP and BAP natural attenuation alternatives as well as several hypothetical active management alternatives are presented.

7.1 Alterative 1 – Natural Attenuation

FAP Alternative 1 and BAP Alternative 1 correspond to a transient model run representing the attenuation of fluoride and cobalt in the aquifer downgradient of the FAP and BAP, respectively. The model run is used to estimate when the concentrations will attenuate to less than the GWPSs under these future conditions:

- The seven seep intercept systems continue operating as they are currently operated;
- The surface elevation of the FAP declines as shown in **Figure 6** and goes dry in 2036;
- The surface elevation of the BAP remains at current levels until 2025, at which point it declines linearly until going dry in 2036, and;
- Evaporation cells continue to be active in the cells underlying the FAP and the BAP in order to remove excess water from the model.

In Alternative 1 the model was run for 135 years (from 2015 to 2150). **Figure 11** and **Figure 12** present the results of natural attenuation and the active management alternatives for the FAP and BAP, respectively. These figures show the maximum concentration anywhere in the downgradient aquifer at a given time in the model run. When the maximum concentration is less than the respective GWPS, the aquifer is considered remediated for the purposes of this analysis.

The model results for FAP Alternative 1 indicate that concentrations of fluoride in the aquifer will attenuate below the GWPS by early 2080, or 61 years from the present (**Figure 11**). This assumes the FAP goes dry in 2036, effectively removing the source of fluoride.

The model results for BAP Alternative 1 indicate that concentrations of cobalt above the GWPS will persist in the aquifer through the end of 2150. After the BAP goes dry in 2036, concentrations slowly attenuate and move with the direction of groundwater flow, which in the model is north towards the constant head cells representing Tanner Wash (see discussion in Sections 4.2 and 5.0) and south towards the plant. At the end of the model simulation, the concentrations of cobalt above the GWPS are located at the GHB cells representing underflow leaving the model domain, and close to where the Tanner Wash channel opens up into the LCR alluvium, where the alluvial material pinches out.

7.2 Alternative 2 – Containment Wells Adjacent to Dams

FAP and BAP Alternative 2 consists of:

- Operation of the existing seepage intercept systems;
- Draining/evaporating standing water from the FAP and BAP, and;
- The installation and operation of containment wells sited adjacent to the FAP and BAP dams.

One model run was developed for FAP Alternative 2 and a separate model run was developed for BAP Alternative 2. The locations of the containment wells for the FAP and BAP were developed iteratively and are shown in **Figure 13** and **Figure 14**, respectively. **Table 11** contains the cell locations and pumping rates for the wells for the FAP and BAP scenarios.

Table 11. FAP and BAP Alternative 2 Containment Well Locations

FAP Alternative 2 ***Number of wells: 14*** ***Total pumping rate: 335 gpm***				**BAP Alternative 2** ***Number of wells: 15*** ***Total pumping rate: 375 gpm***			
Layer	**Row**	**Column**	**Pumping Rate (gpm)**	**Layer**	**Row**	**Column**	**Pumping Rate (gpm)**
2-3	64	155	25	2-3	27	41	25
2-3	64	158	25	2-3	31	41	25
2-3	65	142	25	2-3	34	42	25
2-3	65	145	25	2-3	37	43	25
2-3	65	147	25	2-3	39	44	25
2-3	65	150	25	2-3	42	46	25
2-3	65	152	25	2-3	43	47	25
2-3	66	127	25	2-3	46	48	25
2-3	66	131	25	2-3	49	48	25
2-3	66	134	25	2-3	52	47	25
2-3	66	138	25	2-3	53	45	25
3	64	161	10	2-3	55	42	25
3	65	122	25	2-3	57	41	25
3	66	125	25	2-3	59	39	25
-	-	-	-	2-3	60	36	25

Notes: gpm = gallons per minute

The target location for the wells was identified as the area north of I-40 and south of the dam for the FAP. For the BAP, the target location for the wells was as close to the toe of the dam as possible. One difficulty in placing and operating the wells in the model was the low transmissivities in the vicinity of the FAP which leads to dewatering issues. Transmissivities are higher around the BAP; however, modeled wells in both areas still tended to dewater and turn off when pumping rates exceeded their dewatering threshold rates.

The model results for FAP Alternative 2 (**Figure 11**) indicate that concentrations of fluoride in the aquifer will attenuate below the GWPS by 2045, or 25 years from the start of pumping. This assumes the FAP goes dry in 2036, effectively removing the source of fluoride.

The model results for BAP Alternative 2 (**Figure 12**) indicate that concentrations of cobalt in the aquifer will attenuate below the GWPS by mid-2126, approximately 100 years from the start of pumping. A possible explanation for the excessive timeframe is the greater thickness of the Tanner Wash alluvium compared to the alluvium downgradient of the FAP. **Figure 15** highlights this difference, as shown at model row 67, which is the area where Tanner Wash opens up into the larger LCR alluvial plain and where I-40 crosses south of the FAP. The model cells in the area of Tanner Wash are at least twice as thick as the cells in the area of the FAP. This translates to a larger volume of available groundwater, a higher mass of chemicals in the aquifer, and more pumping required to contain the plume when compared to conditions at the FAP.

7.3 Alternative 3 – Containment Wells at the FAP South of I-40

FAP Alternative 3 consists of:

- Operation of the existing seepage intercept systems;
- Draining/evaporating standing water from the FAP, and;
- The installation and operation of containment wells sited downgradient of the FAP dams south of I-40.

The locations of the containment wells for Alternative 3 at the FAP were developed iteratively and are shown in **Figure 16**. **Table 12** contains the cell locations and pumping rates for the Alternative 3 wells.

The model results for FAP Alternative 3 (**Figure 11**) indicate that concentrations of fluoride in the aquifer will attenuate below the GWPS by early 2055, or 35 years from the start of pumping. This assumes the FAP goes dry in 2036, effectively removing the source of fluoride to the aquifer. Alternative 3 required one more well, and a higher pumping rate, in order to contain the plume. This suggests that siting containment wells further downgradient of the FAP is not advantageous as it results in a longer time to remediate below the GWPS.

Table 12. FAP Alternative 3 Containment Well Locations

FAP Alternative 3 Containment Well Locations *Number of Wells: 15* *Total Pumping Rate: 375 gpm*			
Layer	**Row**	**Column**	**Pumping Rate (gpm)**
2-3	68	121	25
2-3	70	123	25
2-3	71	125	25
2-3	71	128	25
2-3	71	133	25
2-3	71	136	25
2-3	71	140	25
2-3	71	144	25
2-3	71	147	25
2-3	71	151	25
2-3	71	155	25
2-3	71	159	25
2-3	71	162	25
3	66	114	25
3	67	117	25

Notes: gpm = gallons per minute

A model run simulating containment wells downgradient of the BAP dam, further south within Tanner Wash, was also developed under Alternative 3. However, after several iterations of well placement and pumping rates failed to produce the desired results within a reasonable amount of time and with feasible pumping rates, modeling this approach to corrective action at the BAP was abandoned.

7.4 Alternative 4 – Containment Wells at the FAP North and South of I-40

FAP Alternative 4 consists of:

- Operation of the existing seepage intercept systems;
- Draining/evaporating standing water from the FAP, and;
- The installation and operation of the containment wells sited adjacent to the FAP dam (from Alternative 2) and the wells downgradient of the FAP dams south of I-40 (from Alternative 3).

The objective of Alternative 4 was to evaluate whether substantial gains in time to remediate could be made by installing and operating containment wells on both sides of I-40. A similar model simulating containment wells adjacent to the BAP as well as further south within Tanner Wash was also developed but abandoned after it became apparent that the number of wells and pumping rates in the model were untenable.

One model run was developed for the FAP Alternative 4. The locations of the containment wells for Alternative 4 at the FAP are shown in **Figure 17**. **Table 13** contains the cell locations and pumping rates for the Alternative 4 wells.

Table 13. FAP Alternative 4 Containment Well Locations

FAP Alternative 4 Containment Well Locations *Number of Wells: 29* *Total Pumping Rate: 710 gpm*							
Layer	**Row**	**Column**	**Pumping Rate (gpm)**	**Layer**	**Row**	**Column**	**Pumping Rate (gpm)**
2-3	64	155	25	2-3	71	133	25
2-3	64	158	25	2-3	71	136	25
2-3	65	142	25	2-3	71	140	25
2-3	65	145	25	2-3	71	144	25
2-3	65	147	25	2-3	71	147	25
2-3	65	150	25	2-3	71	151	25
2-3	65	152	25	2-3	71	155	25
2-3	66	127	25	2-3	71	159	25
2-3	66	131	25	2-3	71	162	25
2-3	66	134	25	3	66	114	25
2-3	66	138	25	3	66	125	25
2-3	68	121	25	3	64	161	10
2-3	70	123	25	3	65	122	25
2-3	71	125	25	3	67	117	25
2-3	71	128	25	-	-	-	-

Notes: gpm = gallons per minute

The model results for FAP Alternative 4 (**Figure 11**) indicate that concentrations of fluoride in the aquifer will attenuate below the GWPS by mid-2041, or 21 years from the start of pumping. This assumes the FAP goes dry in 2036, effectively removing the source of fluoride to the aquifer. This alternative provides the relatively fastest time to remediate the aquifer of the four alternatives considered for the FAP, but at the expense of many more wells and a pumping rate that may not be feasible.

8.0 MODEL LIMITATIONS AND RECOMMENDATIONS FOR FUTURE IMPROVEMENT

The objective of the groundwater model was to provide a planning tool for better understanding the fate and transport of contamination in the aquifer at the FAP and BAP CCR units at the Cholla Power Plant specifically as it relates to future attenuation or remediation of constituents at the FAP and the BAP. The LCR alluvium, Tanner Wash alluvium, and the uppermost portion of the Moqui member of the Moenkopi Formation in the vicinity of the BAP and FAP is the area of interest and focus of the groundwater model, which is a simplification of the aquifer system at Cholla. Given the scale and complexity of the geology at the Site, there are uncertainties in the modeled hydrogeologic properties as well as assumptions related to operations of the BAP and FAP. The model in its present state is appropriate for estimating order-of-magnitude pumping rates and transport/remediation times. Several areas of refinement have been identified that could reduce model uncertainty for future use:

- **Grid cell discretization** – Discretizing the grid in the vicinity of the FAP and BAP dams would potentially allow the model to represent head changes at a smaller scale than it currently is able to, thus improving the calibration in these key areas.
- **Geologic heterogeneity** – The contact surfaces between the alluvium and the Moenkopi Formation were derived from previous investigations and applied to the model using spatial interpolation tools. Refinement to this contact surface using contact elevations from boring logs in key areas,

such as at piezometers in and around both the BAP and FAP dams, could improve the calibration in these locations.

- **Thickness of Layer 3** –Because the contact elevation between the Moqui and the underlying Wupatki has not been defined for the Site, a constant thickness (20 ft) for Layer 3 was applied and the hydraulic conductivity was calibrated to produce an acceptable match to observed heads in the steady state flow model. While this simplification has no impact on the groundwater flow, it has the potential to overestimate the amount of chemical mass in the aquifer because the model effectively treats Layer 3 as another alluvial layer. The relative thinness of Layer 3 is intended to mitigate this effect, but the model is likely conservative in its estimate of mass in the aquifer.
- **Draining of the BAP** – The BAP in the model is assumed to remain at its current elevation until 2025, after which it drains at a rate of 4.5 ft per year, based on a rate previously estimated for the FAP (**Figure 6**). The material in the BAP is coarser than the material in the FAP, and as such it would intuitively be expected to drain faster. It is recommended that a quantitative estimate of the evaporation/drainage rate at the BAP be developed, as this could result in the source of cobalt at the BAP deactivating in the model sooner than it does in the current simulation.
- **Upper Tanner Wash boundary** – The constant head cells representing Upper Tanner Wash allow water to exit the model rather than simulate natural recharge via underflow, as was intended. This suggests that the model domain would benefit from being enlarged to the point where the boundary condition is not interfering with Site features. This is not significant for simulations at the FAP but may have an impact on simulations at the BAP.

9.0 REFERENCES

Arizona Department of Environmental Quality (ADEQ), 2017. Aquifer Protection Permit No. P-100568, Place ID 447, LTF 65132. Arizona Public Service Cholla Power Plant. March 2, 2017.

Arizona Public Service (APS), 1984. Cholla Steam Electric Generating Station Aquifer Test Results. February 26 to March 2, 1984.

AMEC Environment & Infrastructure, Inc. (AMEC), 2012. *Well Completion Report, Installation of Aquifer Protection Permit Monitor Wells, Arizona Public Service Company, Cholla Power Plant, Navajo County, Arizona.* May 7, 2012.

Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology. John Wiley & Sons, New York.

Environmental Simulations, Inc. 2017. Guide to Using Groundwater Vistas, Version 7.

Environmental Systems Research Institute (ESRI), 2014. ArcGIS 10.3.1 for Desktop. Redlands, California.

Freeze, R. Allen and Cherry, John A. Groundwater. Prentice-Hall Inc. Englewood Cliffs, New Jersey. 1979.

Harbaugh, A.W., Langevin, C.D., Hughes, J.D., Niswonger, R.N., and Konikow, L. F., 2017, MODFLOW-2005 version 1.12.00, the U.S. Geological Survey modular groundwater model: U.S. Geological Survey Software Release, 03 February 2017, http://dx.doi.org/10.5066/F7RF5S7G.

Montgomery & Associates, 2017. *Cholla Power Plant Combustion Residuals Program – Design, Installation, and Evaluation of Completeness of Groundwater Monitoring Networks. Arizona Public Service, Navajo County, Arizona.* September 19, 2017.

Sergent, Hauskins, & Beckwith (SHB), 1973. Preliminary Soil and Geological Study Report on Ash Disposal Areas, APS Cholla Plant, near Joseph City, Arizona. December 14, 1973.

United States Geological Survey (USGS), 2013. USGS NED n35w111 1/3 arc-second 2013 1x1 degree ArcGrid raster digital data. Reston, VA. http://ned.usgs.gov.

Wood Environment & Infrastructure Solutions (Wood), 2019. Lithologic Logs for Boreholes MW-65, MW-66, and MW-67.

Woodward-Clyde Consultants (Woodward-Clyde), 1992. Evaluation of Hydrogeologic Conditions. Bottom Ash Pond, Cholla Steam Electric Station. May 22, 1992.

Zheng, Chunmiao and Bennet, Gordon. Applied Contaminant Transport Modeling, Second Edition. John Wiley and Sons, Inc. New York. 2002.

Zheng, Chunmiao, and Wang, P. Patrick. 1999. MT3DMS: A modular three-dimensional multispecies transport model for simulation of advection, dispersion, and chemical reactions of contaminants in groundwater systems; documentation and user's guide," Contract Report SERDP-99-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

FIGURES

Legend

- Grid (200 ft x 200 ft)
- CH in Layer 1
- Drain in Layer 1
- CH in Layer 2
- Drain in Layer 2
- CH in Layer 3
- GHB in Layers 1-3
- No-flow (all layers)
- Inferred Groundwater Flow Direction

Notes:

CH --- constant head
ft --- feet
GHB --- general head boundary

0 0.25 0.5 Miles

N

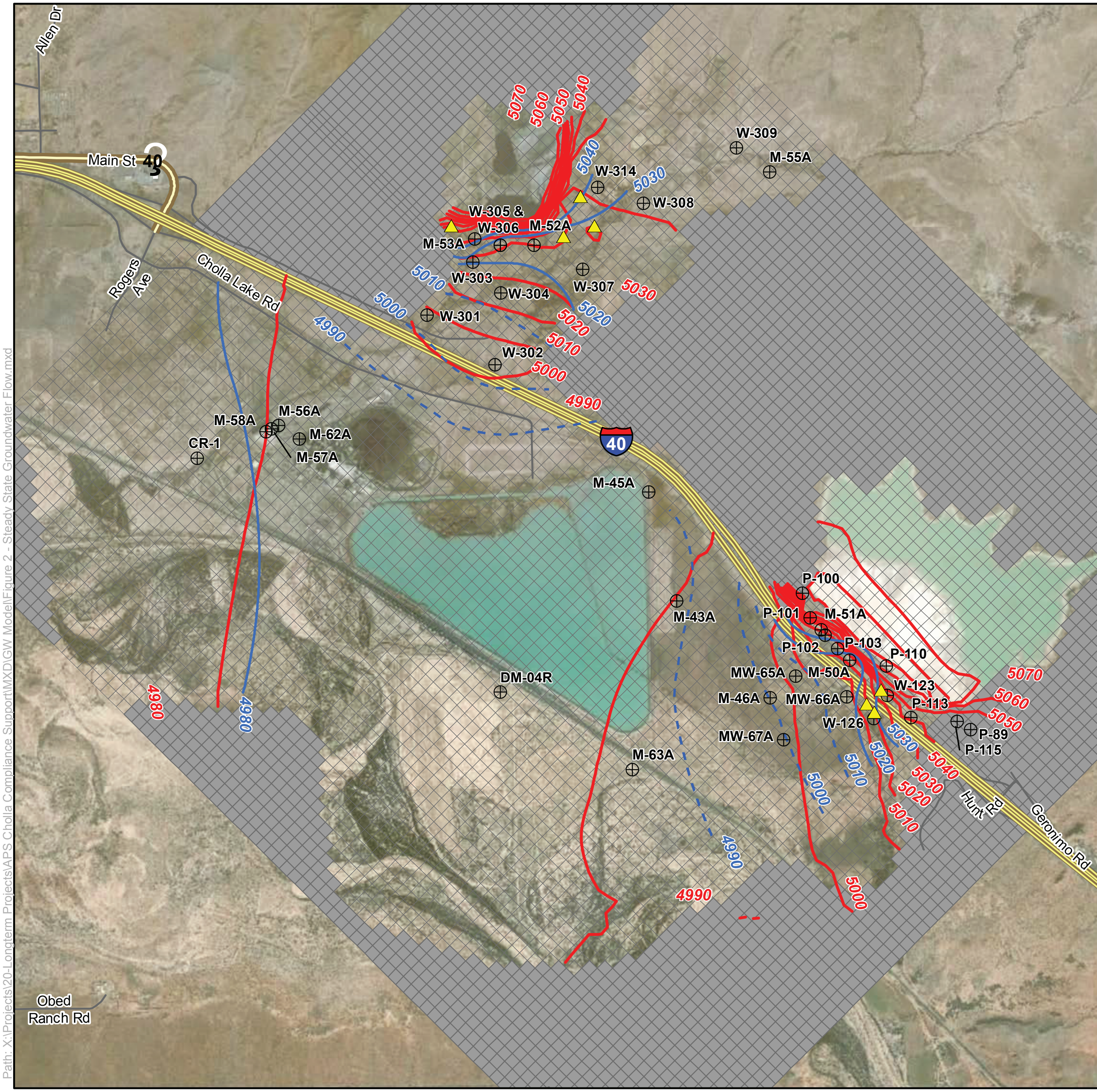
Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 1	**Model Domain, Grid, and Boundaries**

Job No. 14-2018-2040
PM: NCL
Date: 6/4/2019
Scale: 1" = 0.5 miles

wood.

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\GW Model\Figure 1 - Model Domain.mxd



Legend

- Grid (200 ft x 200 ft)
- Noflow (all layers)
- Flux targets
- Head targets
- Modeled groundwater elevation contours (ft amsl)

Observed groundwater elevation contours (ft amsl)

- Inferred
- Known

0 0.25 0.5 Miles

N

Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 2	**Steady State Groundwater Flow**

Job No. 14-2018-2040
PM: NCL
Date: 6/1/2019
Scale: 1" = 0.5 miles

wood.

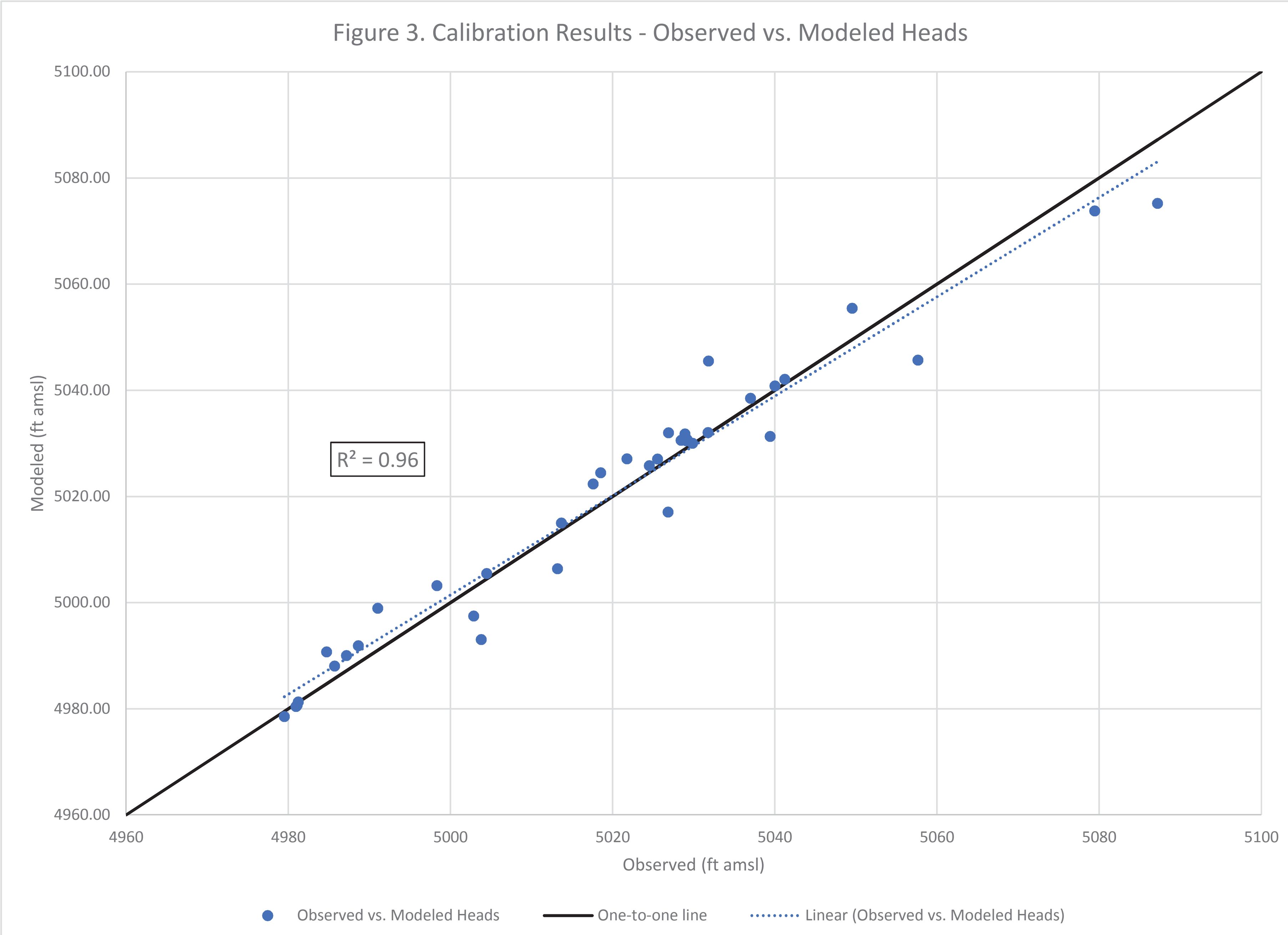


Figure 3. Calibration Results - Observed vs. Modeled Heads
5100.00
5080.00
5060.00
5040.00
5020.00
5000.00
4980.00
4960.00
Modeled (ft amsl)
R^2 = 0.96
4960
4980
5000
5020
5040
5060
5080
5100
Observed (ft amsl)
Observed vs. Modeled Heads
One-to-one line
Linear (Observed vs. Modeled Heads)

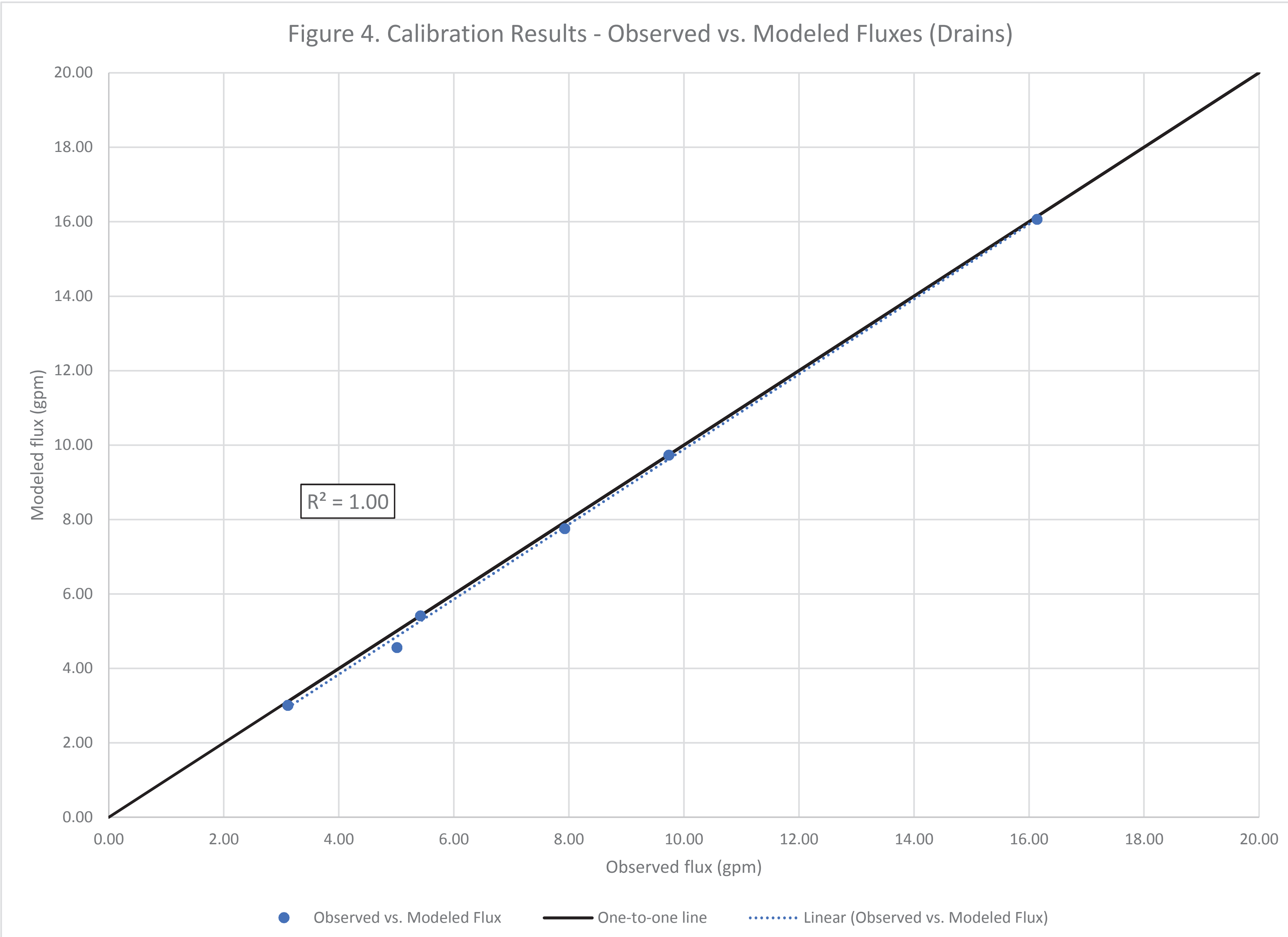


Figure 4. Calibration Results - Observed vs. Modeled Fluxes (Drains)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Modeled flux (gpm)
R² = 1.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Observed flux (gpm)
Observed vs. Modeled Flux
One-to-one line
Linear (Observed vs. Modeled Flux)

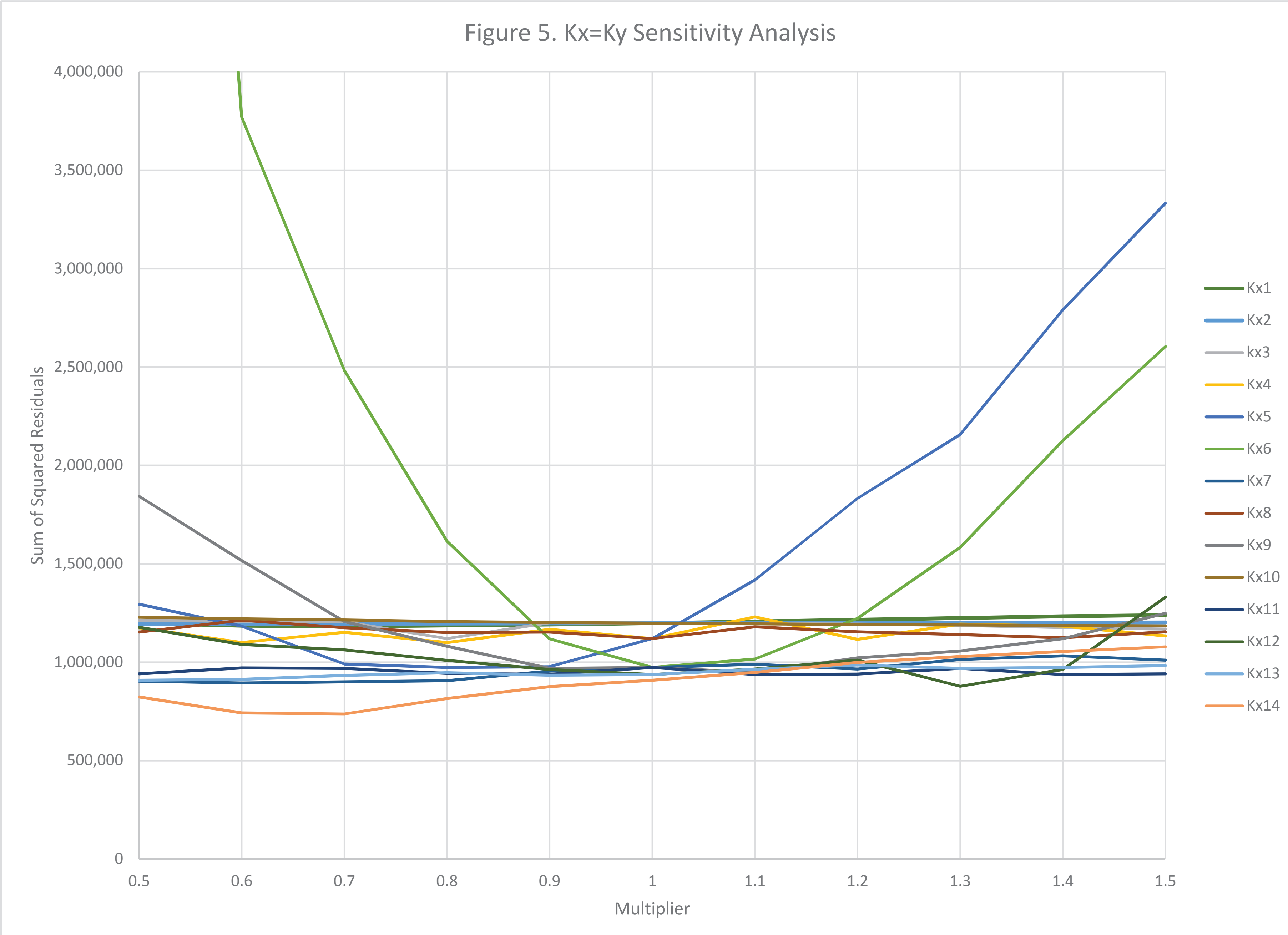
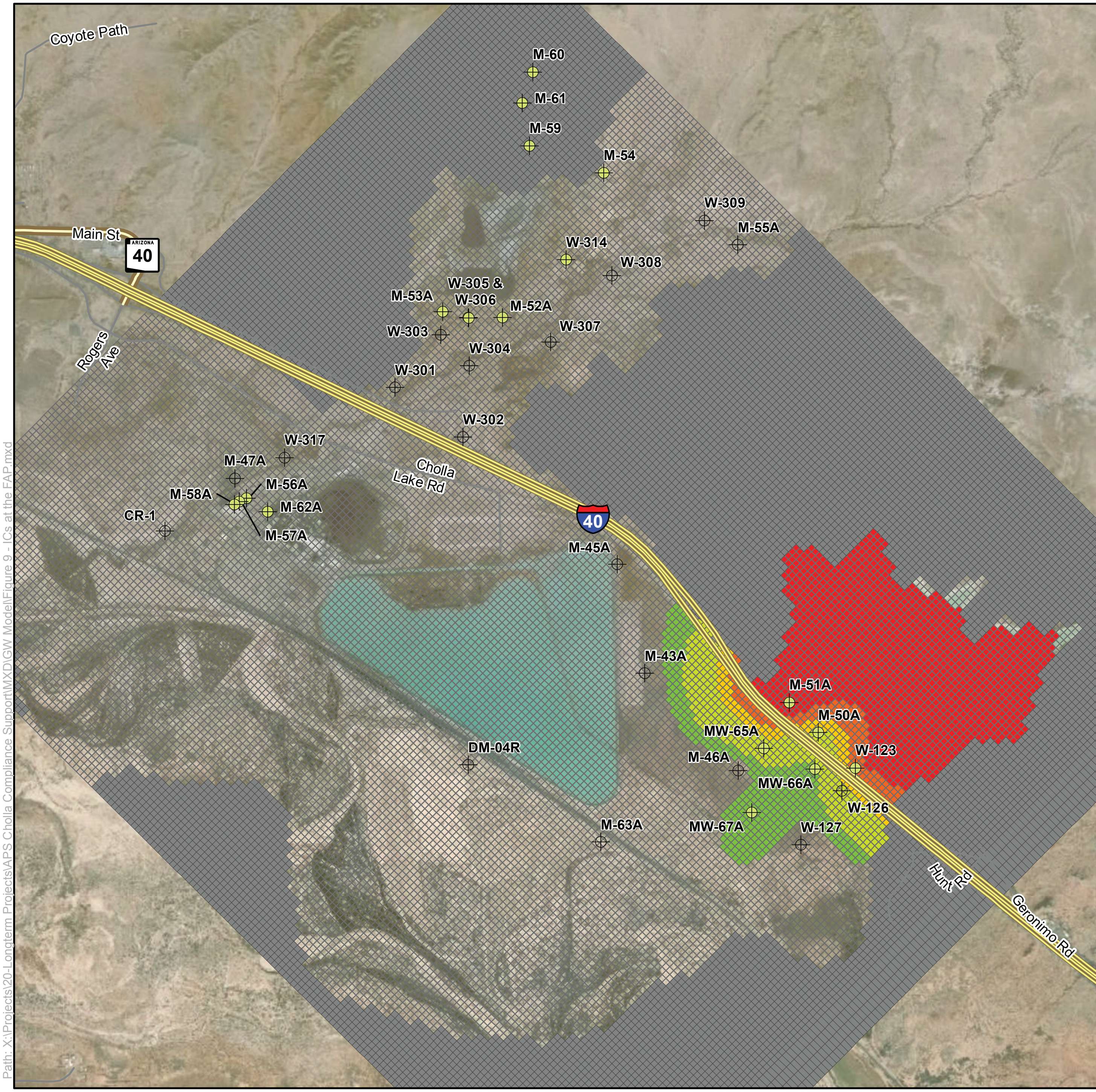


Figure 5. Kx=Ky Sensitivity Analysis
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Sum of Squared Residuals
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
Multiplier
Kx1
Kx2
kx3
Kx4
Kx5
Kx6
Kx7
Kx8
Kx9
Kx10
Kx11
Kx12
Kx13
Kx14



Legend

Site Monitoring Wells

- Supplementary Monitoring Well
- CCR Monitoring Well

Initial Concentration (mg/L)

- 0 to 0.4
- 0.4 to 1
- 1 to 2.5
- 2.5 to 3.2
- 3.2 to 4
- above 4

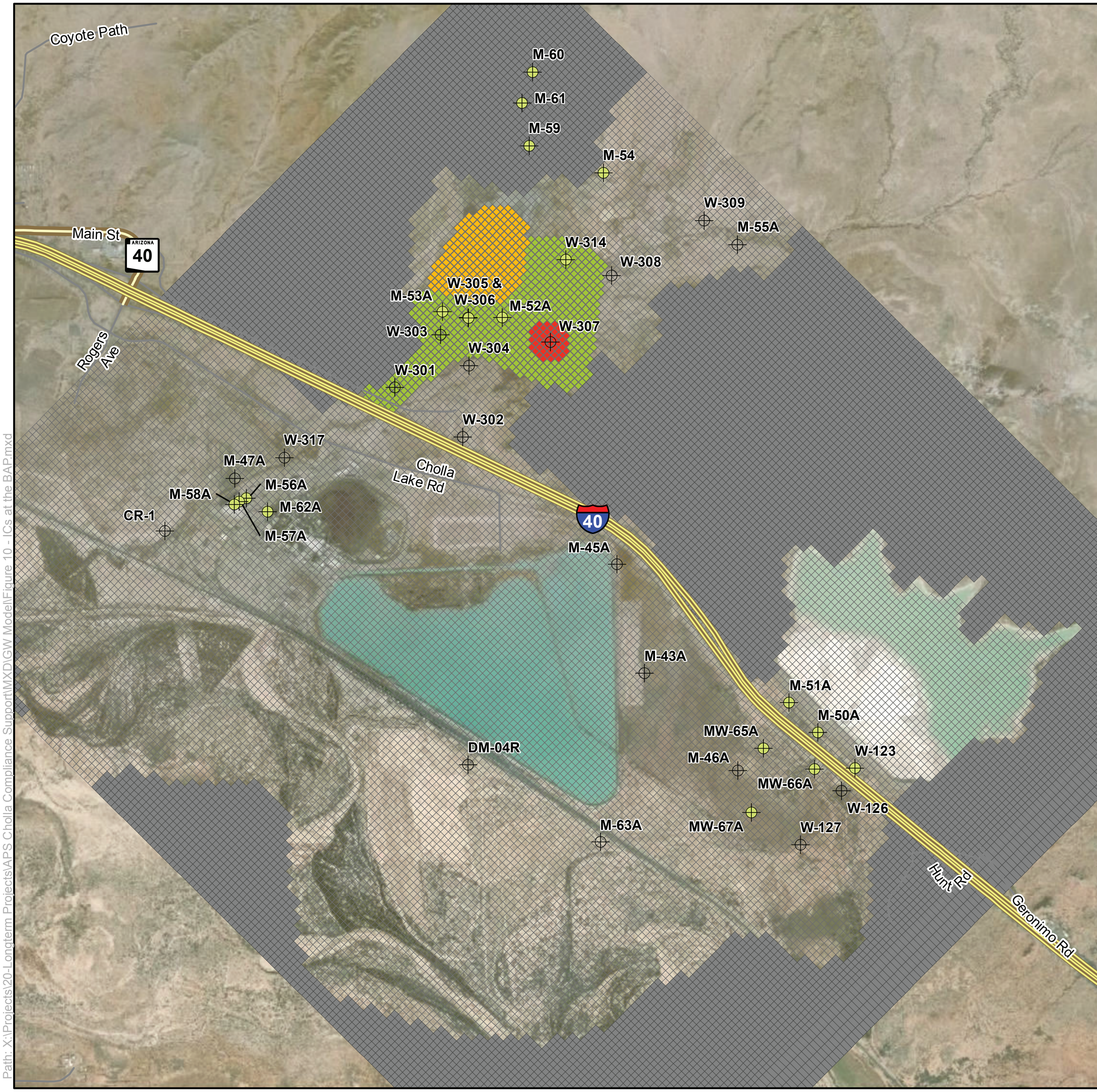
Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 6

Initial Concentrations of Fluoride at the FAP

Job No.	14-2018-2040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 0.5 mi'

wood.



Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\GW Model\Figure 10 - ICs at the BAP.mxd

Legend

Site Monitoring Wells

- Supplementary Monitoring Well
- CCR Monitoring Well

Initial Concentration (mg/L)

- 0 to 0.006
- 0.006 to 0.01
- 0.01 to 0.06
- above 0.06

0 0.25 0.5 Miles

N

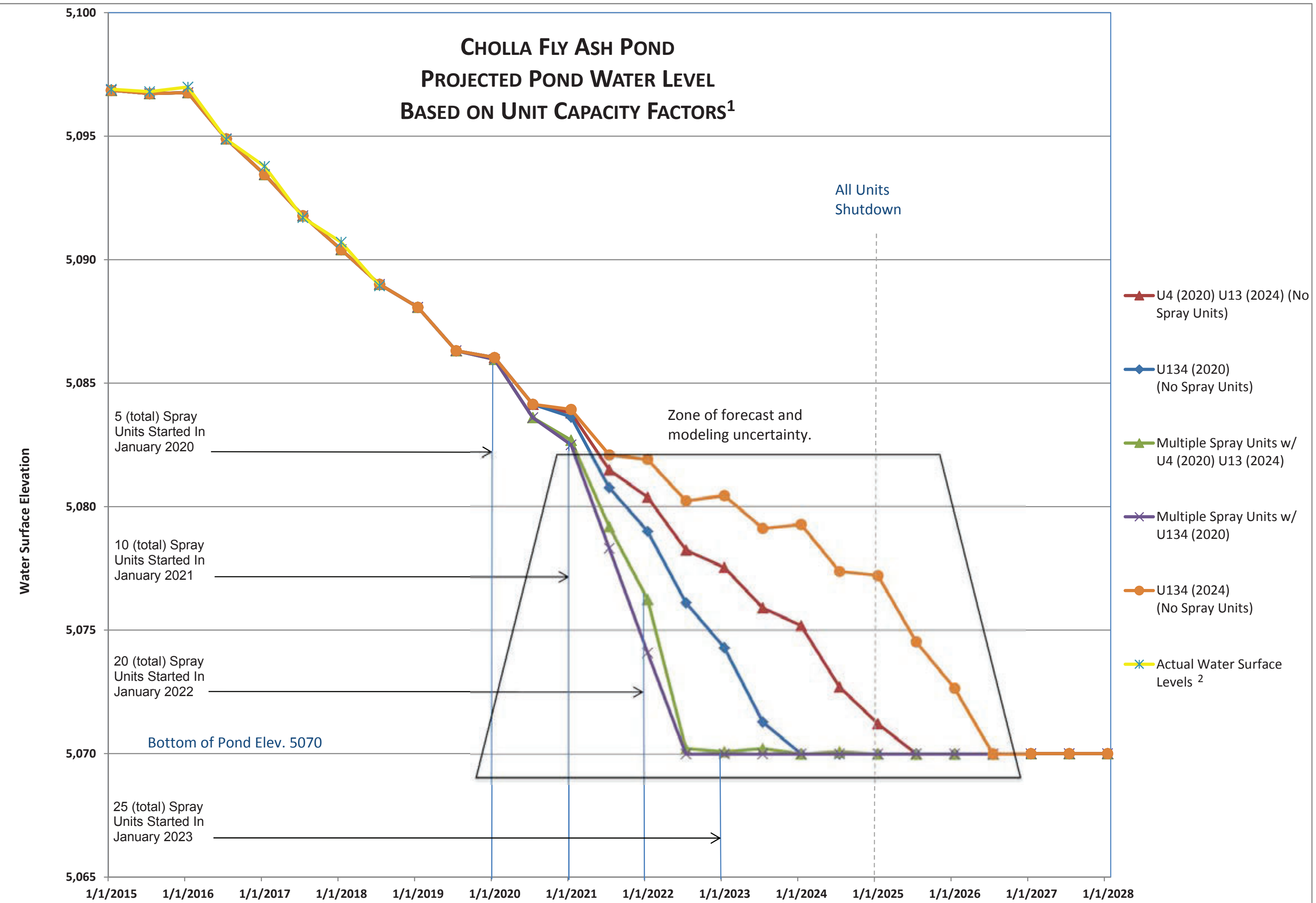
Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 7

Initial Concentrations of Cobalt at the BAP

Job No.	14-2018-2040
PM:	NCL
Date:	5/31/2019
Scale:	1"= 0.5 mi'

wood.



Notes:

1. 09-14-2018 - Chart Revised from Summer Run Only to Using Capacity Factors (CF). CF Data Received in Emails Dated 09-12-2018 and 9-13-2018 for U4 and U1,3, Respectively.
2. 09-14-2018 - Actual Fly Ash Pond Water Surface Levels Added to Graph

AECOM

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\CMA Report\Appendix\Figure8_FAPProjectedPondWaterLevels

Job No.:	1420182040
PM:	NCL
Date:	6/3/2019
Scale:	As Shown

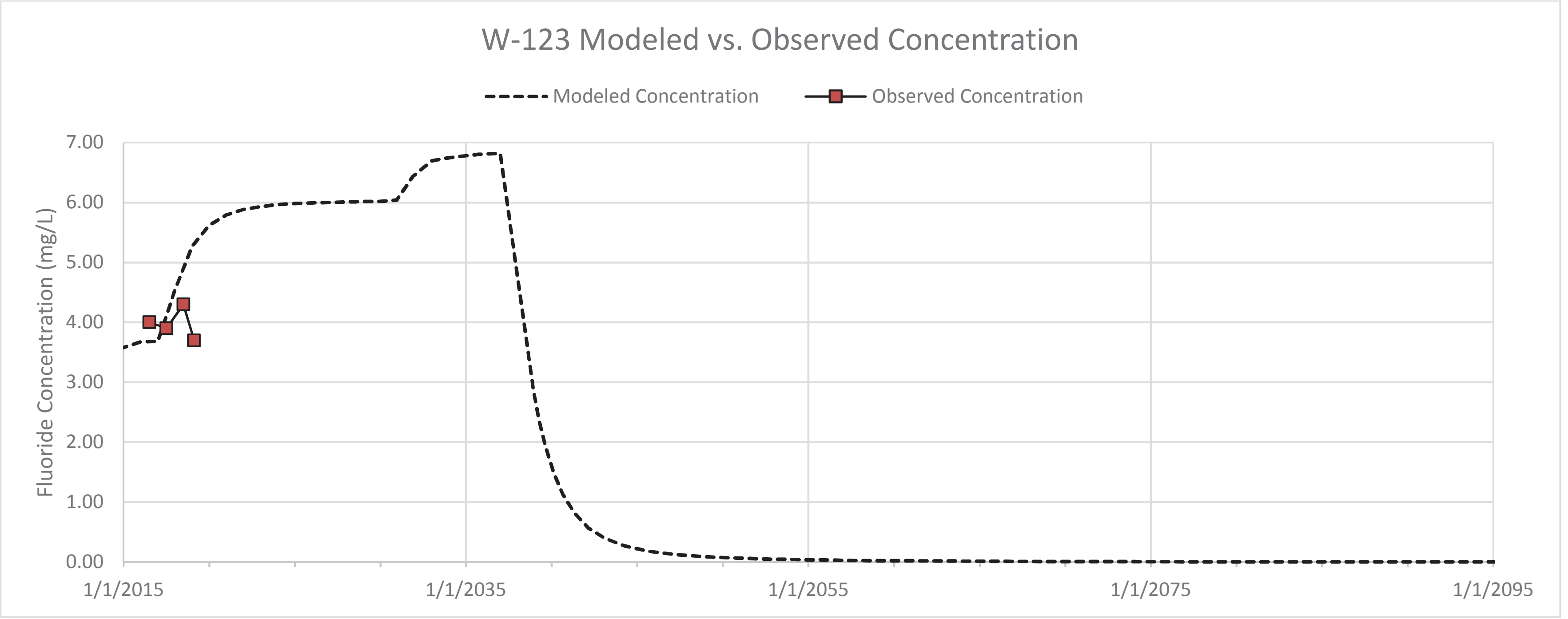
Arizona Public Service
Cholla Power Plant
Navajo County, Arizona

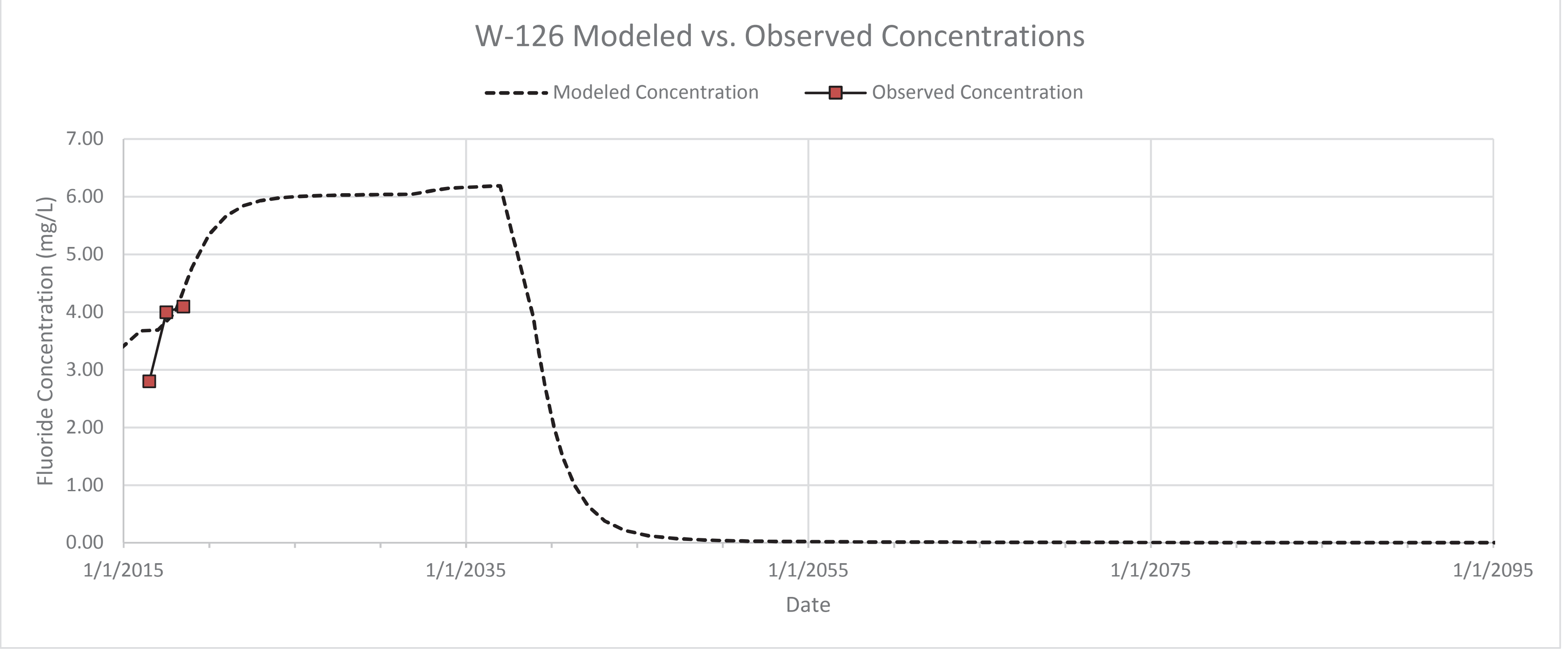
FAP Projected Pond Water Levels

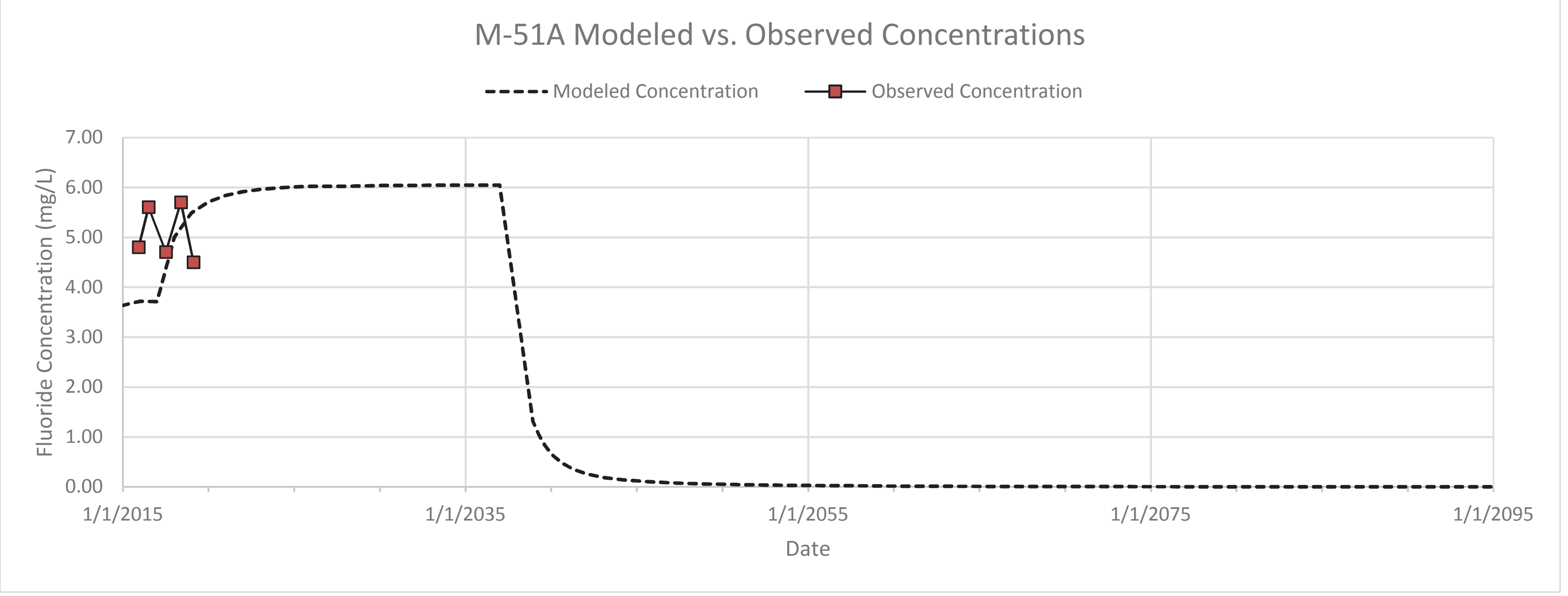
FIGURE
8

wood.

Figure 9. Modeled vs. Observed Concentrations at Select FAP Wells







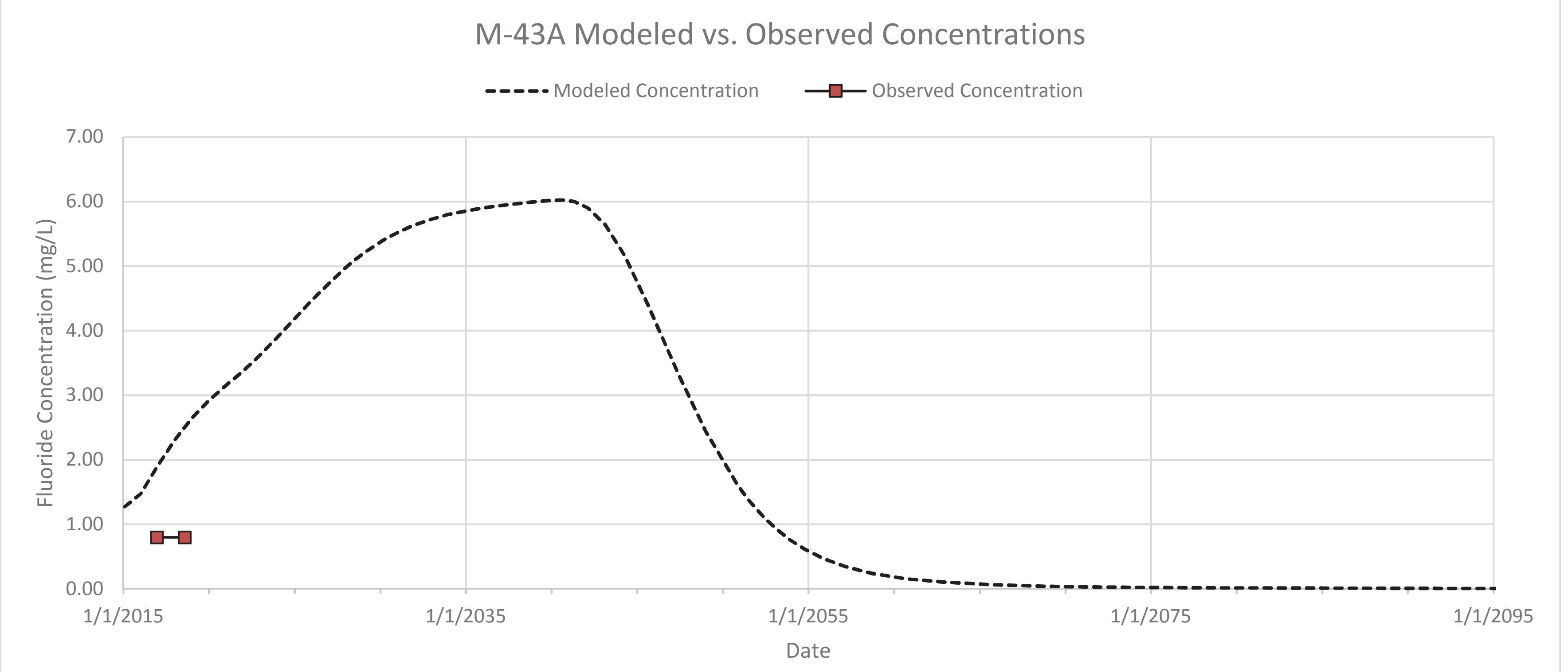
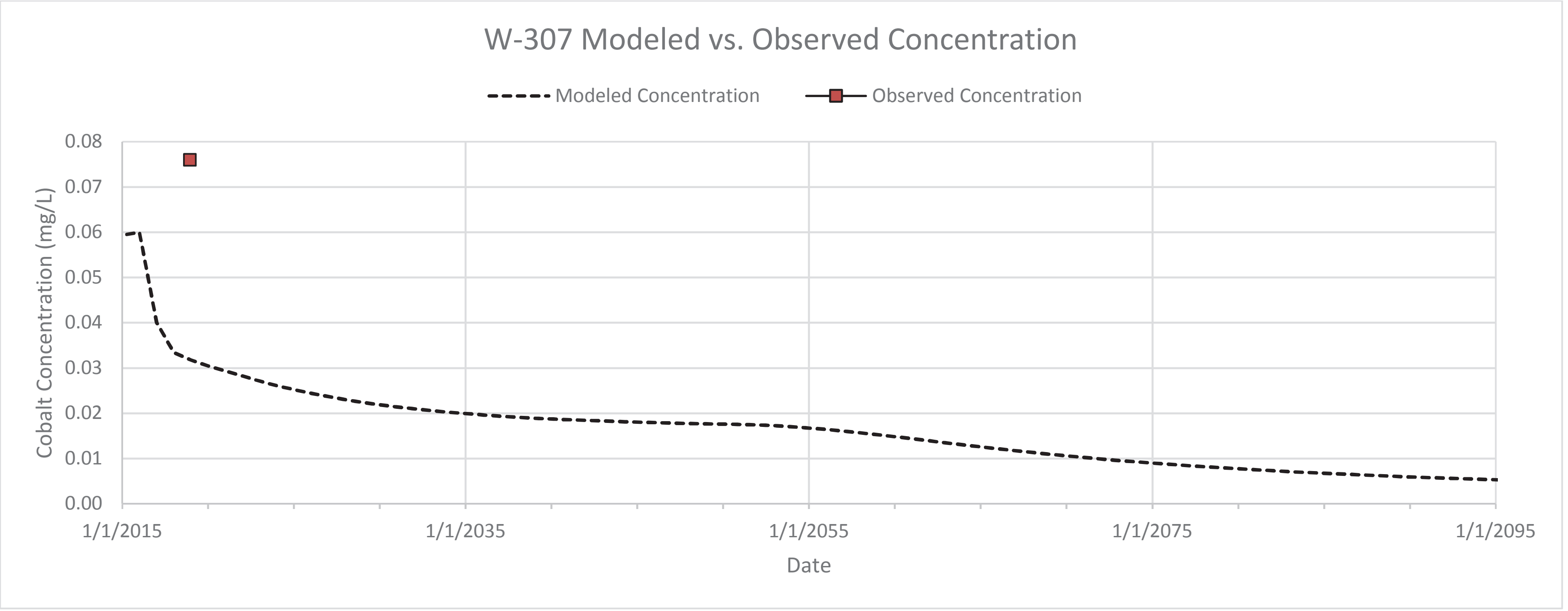
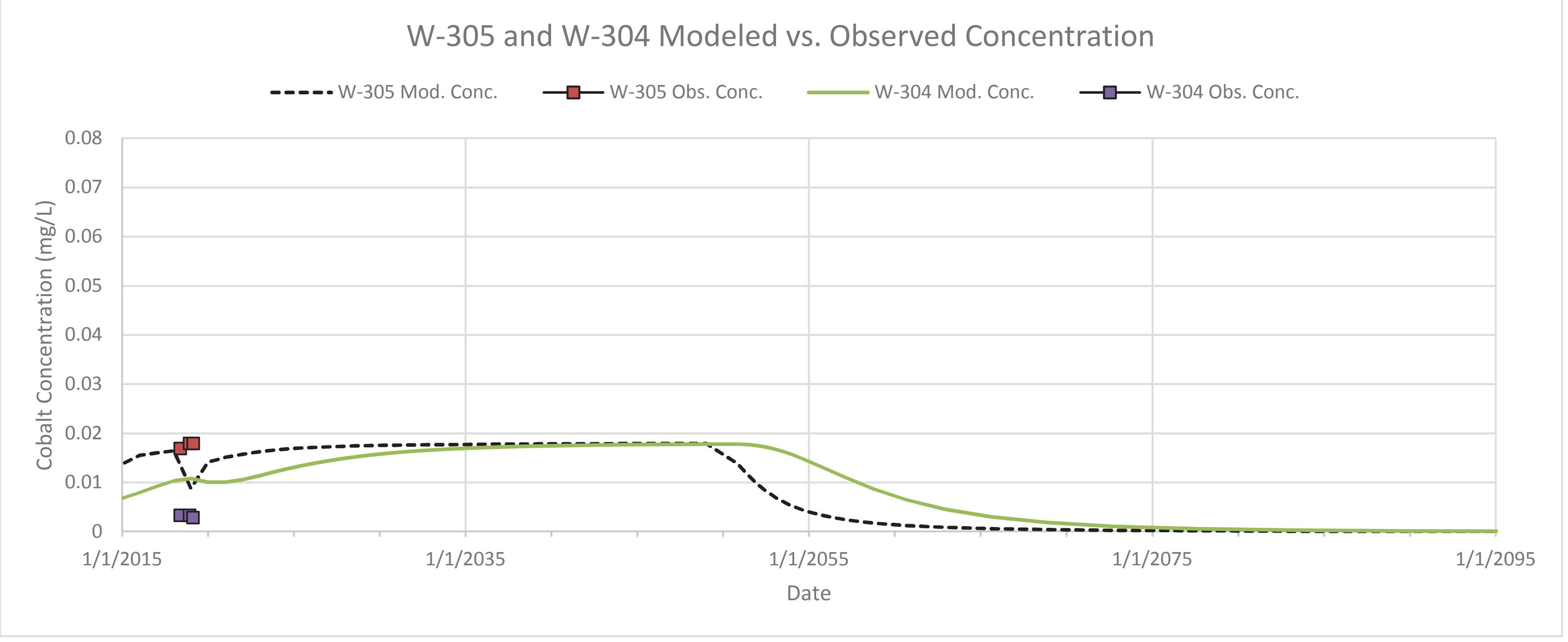
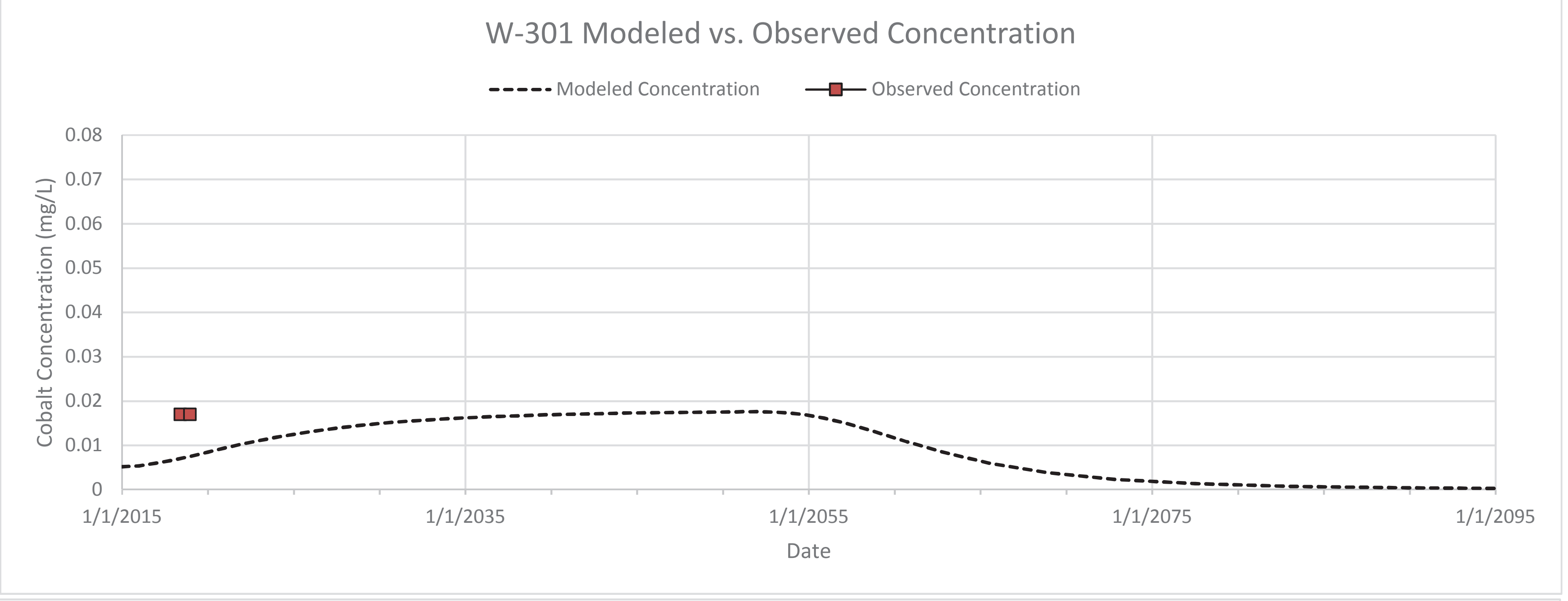
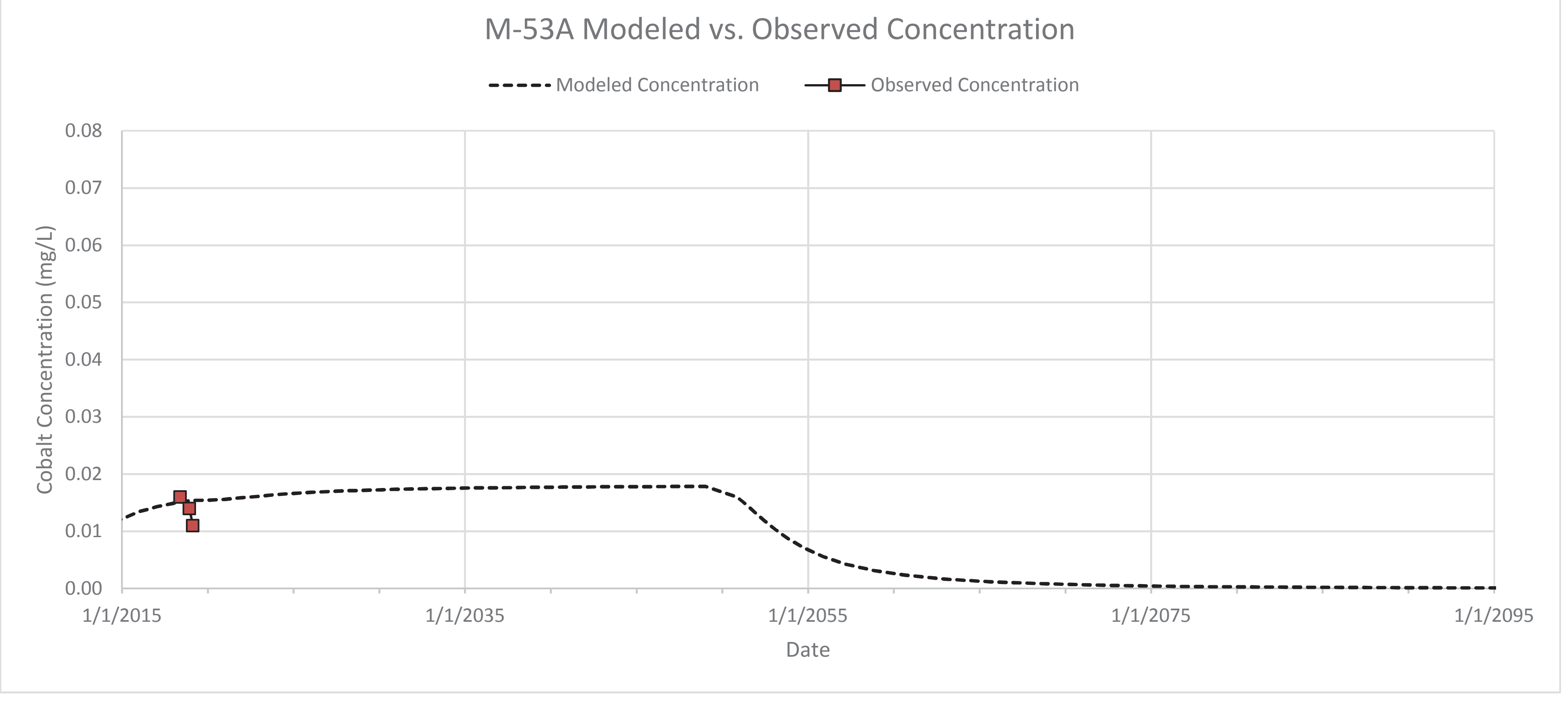


Figure 10. Modeled vs. Observed Concentrations at Select BAP Wells









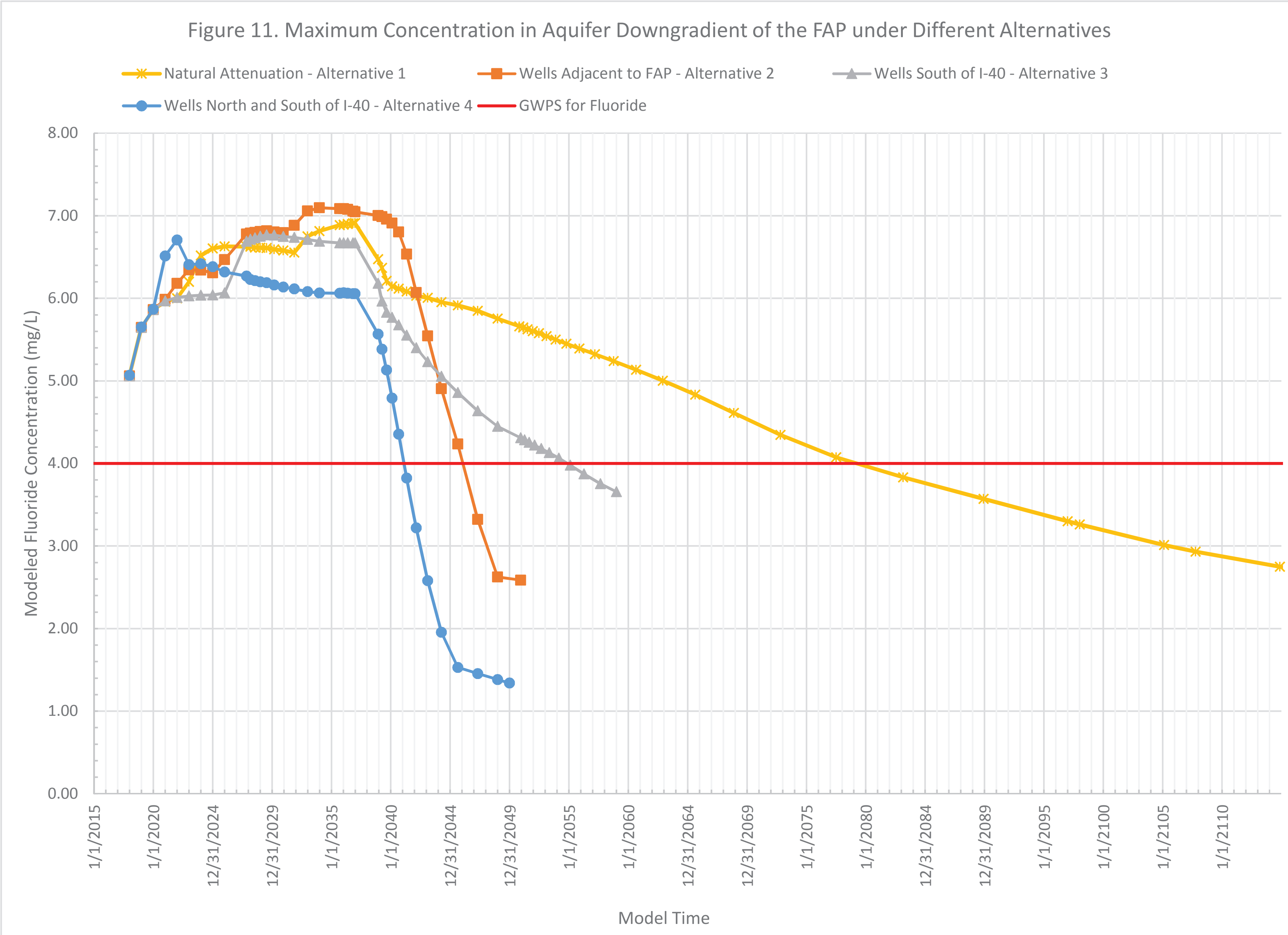


Figure 11. Maximum Concentration in Aquifer Downgradient of the FAP under Different Alternatives
Natural Attenuation - Alternative 1
Wells Adjacent to FAP - Alternative 2
Wells South of I-40 - Alternative 3
Wells North and South of I-40 - Alternative 4
GWPS for Fluoride
Modeled Fluoride Concentration (mg/L)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1/1/2015
1/1/2020
12/31/2024
12/31/2029
1/1/2035
1/1/2040
12/31/2044
12/31/2049
1/1/2055
1/1/2060
12/31/2064
12/31/2069
1/1/2075
1/1/2080
12/31/2084
12/31/2089
1/1/2095
1/1/2100
1/1/2105
1/1/2110
Model Time

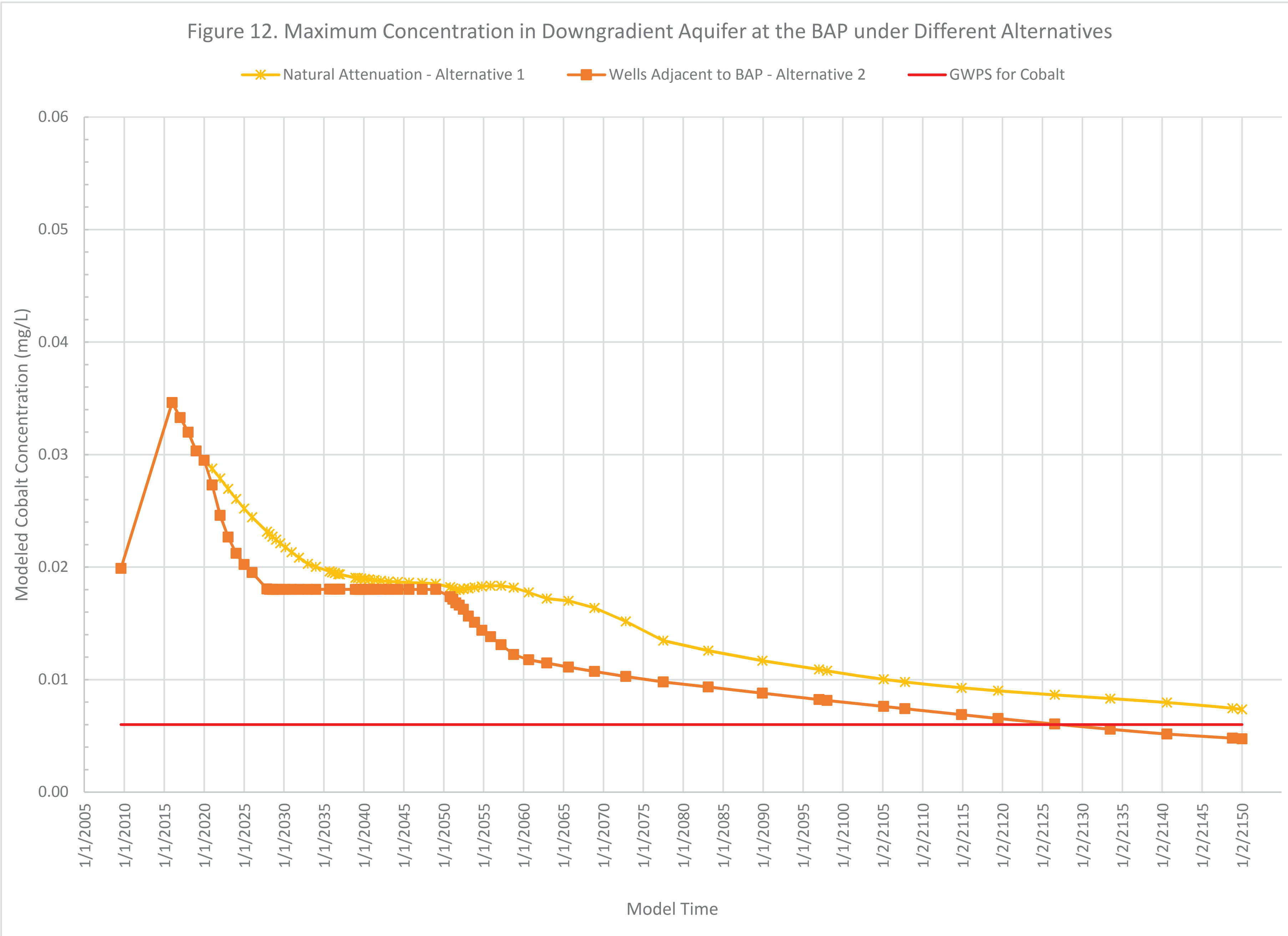


Figure 12. Maximum Concentration in Downgradient Aquifer at the BAP under Different Alternatives
Natural Attenuation - Alternative 1
Wells Adjacent to BAP - Alternative 2
GWPS for Cobalt
Modeled Cobalt Concentration (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1/1/2005
1/1/2010
1/1/2015
1/1/2020
1/1/2025
1/1/2030
1/1/2035
1/1/2040
1/1/2045
1/1/2050
1/1/2055
1/1/2060
1/1/2065
1/1/2070
1/1/2075
1/1/2080
1/1/2085
1/1/2090
1/1/2095
1/1/2100
1/2/2105
1/2/2110
1/2/2115
1/2/2120
1/2/2125
1/2/2130
1/2/2135
1/2/2140
1/2/2145
1/2/2150
Model Time

Legend

Site Monitoring Wells

- Supplementary Monitoring Well
- CCR Monitoring Well

Modeled Wells

- Layers 2 and 3
- Layer 3
- Noflow cells

0 650 1,300 Feet

N

Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 13 — **FAP Alternative 2 Containment Well Placement**

Job No. 14-2018-2040
PM: NCL
Date: 6/1/2019
Scale: 1"= 1300 ft

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\GW Model\Figure 13 - Alt 2 at FAP.mxd

Path: X:\Projects\20-Longterm_Projects\APS Cholla Compliance Support\MXD\GW Model\Figure 14 - Alt 2 at BAP.mxd

Legend

Site Monitoring Wells

Supplementary Monitoring Well

CCR Monitoring Well

Modeled Wells

Layers 2 and 3

Noflow cells

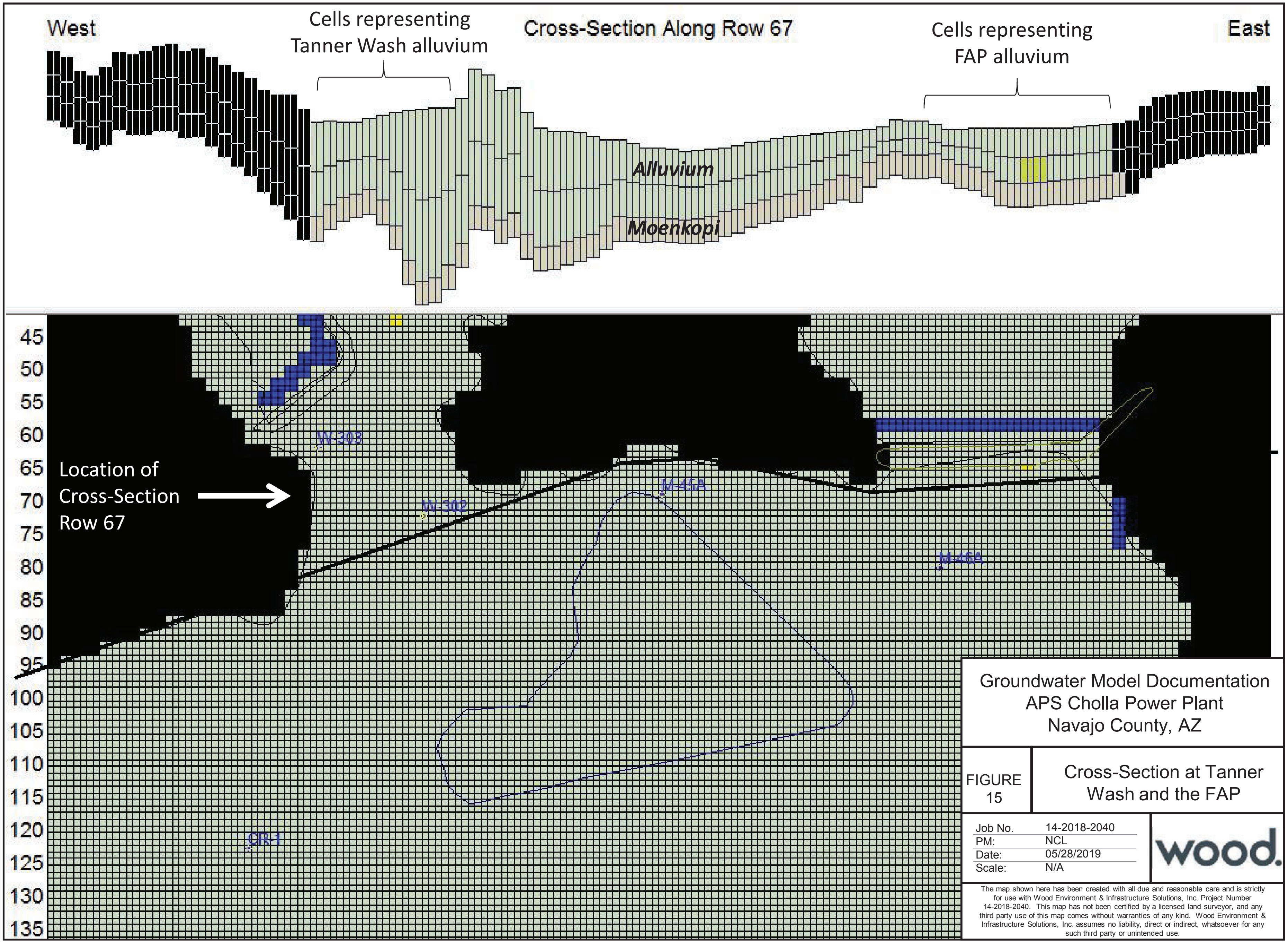
Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 14

BAP Alternative 2
Containment Well Placement

Job No.	14-2018-2040
PM:	NCL
Date:	6/1/2019
Scale:	1"= 1300 ft

wood.



Groundwater Model Documentation
APS Cholla Power Plant
Navajo County, AZ

FIGURE 15

Cross-Section at Tanner Wash and the FAP

Job No.	14-2018-2040
PM:	NCL
Date:	05/28/2019
Scale:	N/A

wood.

Legend

Site Monitoring Wells

- Supplementary Monitoring Well
- CCR Monitoring Well

Modeled Wells

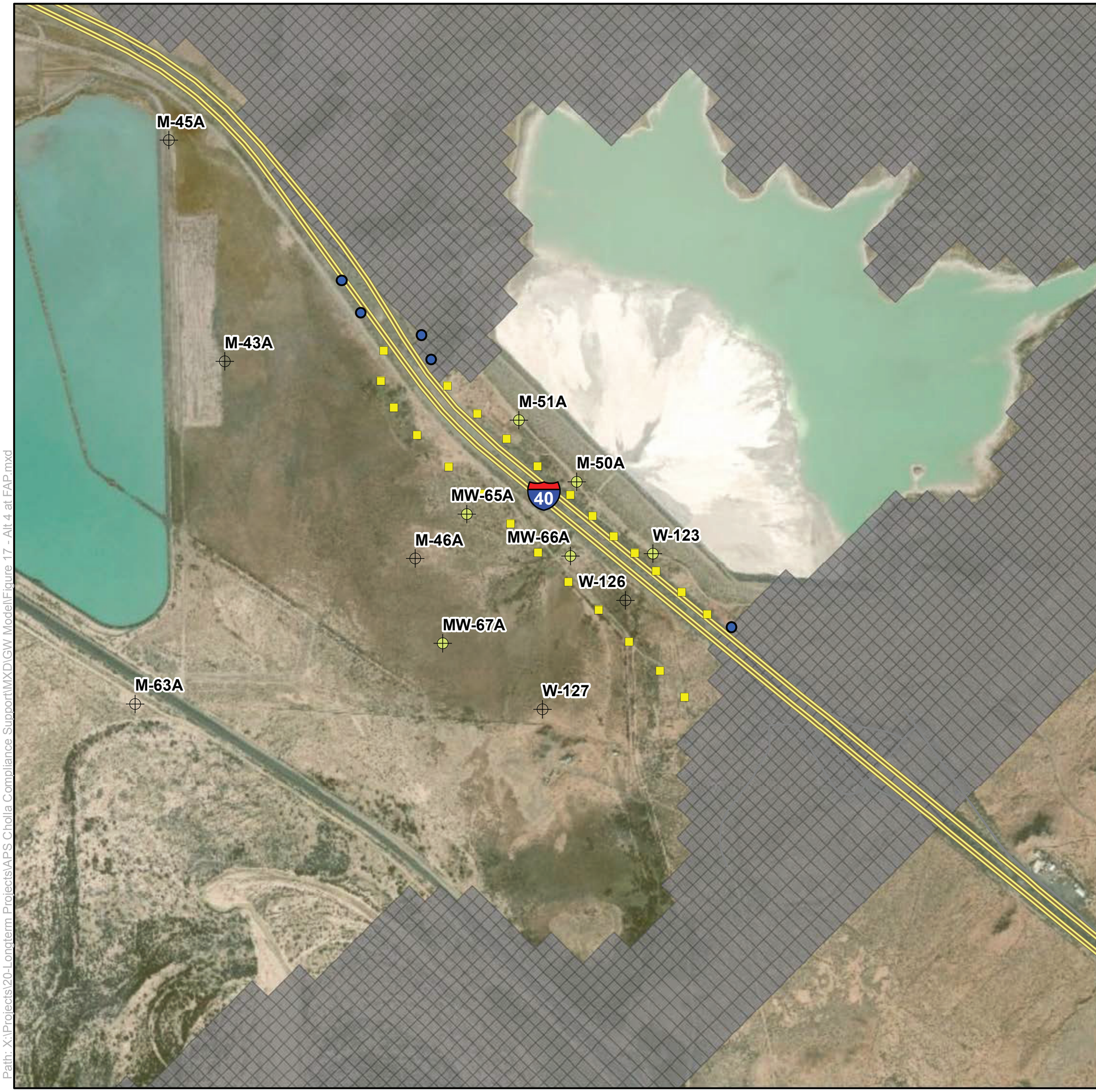
- Layers 2 and 3
- Layer 3
- Noflow cells

Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 16	**FAP Alternative 3 Containment Well Placement**

Job No.	14-2018-2040
PM:	NCL
Date:	6/1/2019
Scale:	1"= 1300 ft

Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\GW Model\Figure 16 - Alt 3 at FAP.mxd



Path: X:\Projects\20-Longterm Projects\APS Cholla Compliance Support\MXD\GW Model\Figure 17 - Alt 4 at FAP.mxd

Legend

Site Monitoring Wells

- Supplementary Monitoring Well
- CCR Monitoring Well

Modeled Wells

- Layers 2 and 3
- Layer 3
- Noflow cells

0 650 1,300
Feet

N

Groundwater Model Documentation
APS Cholla Power Plant, Navajo County, AZ

FIGURE 17

FAP Alternative 4
Containment Well Placement

Job No.	14-2018-2040
PM:	NCL
Date:	6/1/2019
Scale:	1"= 1300 ft

ATTACHMENT A

BORING LOGS FOR MW-65A, MW-66A, AND MW-67A

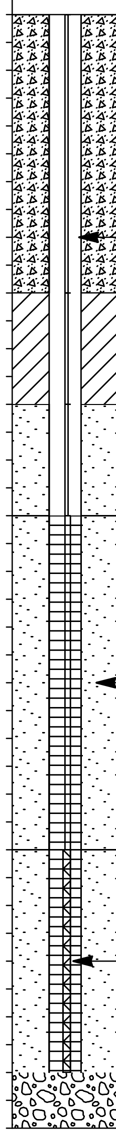
wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-65A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	Isaac Torres	**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	Darius Cervantez	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-922299
RIG I.D.:	- - -	**COORDINATES:**	N1429526.69. E668254.52
RIG TYPE:	Rotosonic	**COORDINATE SYS:**	NAD83 (1982) Arizona State Plane
BORING TYPE:	- - - **BORING DIA.:** 8"	**SURFACE ELEV. (FT):**	5026.21
ORIENTATION:	90°	**MEAS. PT. ELEV. (FT):**	5027.86
HAMMER TYPE:	Not Applicable	**VERTICAL DATUM:**	NAVD88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**COMPLETION DATE:**	11-14-2018 **COMPLETION TIME:** 11:45
START DATE:	11-14-2018 **START TIME:** 11:15		

Elevation in Feet	Depth in Feet	Unified Soil Classification	Sample ID. or Date (Time)	PID Meter Reading (ppm)	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
2026.2	0	ML			**SANDY SILT,** 75% fines, 25% fine to coarse grained, subrounded sand, brown (7.5YR 4/3), nonlithified, granular to angular blocky soil structure, weakly effervescent, nonplastic, slightly moist, loose density, low dry strength, no stains, no odors note: at 2.5' coarse grained sand increases, gradational basal contact
		SW-SM	11-14-18 (11:15)		**WELL GRADED SAND WITH SILT & GRAVEL,** 65% fine to coarse grained, subrounded to subangular sand, 25% fine to coarse grained, subrounded to subangular gravel, 10% fines, brown (7.5YR 4/2), nonlithified, single grain soil structure, weakly effervescent, nonplastic, slightly moist, very loose density, no dry strength, no stains, no odors note: at 5.5' sharp basal contact
2021.2	5	CL	11-14-18 (11:17)		**SILTY CLAY,** 85% fines, 15% fine to coarse grained, subrounded to subangular sand, dark brown (7.5YR 3/3), predominate calcium carbonate filaments, weakly cemented, highly effervescent, thin laminae (<1 mm), nonplastic, slightly moist, very firm to hard, medium to high dry strength, friable, no stains, no odor note: at 10.5' coarse grained sand increase note: from 11' to 12.5' soil is moist, massive, and trace calcium carbonate nodules note: at 13' soil slightly moist, blocky soil, and calcium carbonate nodules increase; gradational basal contact at 13.5'
2016.2	10				
2011.2	15	MH	11-14-18 (11:28)		**SANDY ELASTIC SILT,** 60% fines, 40% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2), lenses with an increase of coarse grained sand (50%) starting at 15', nonlithified, effervescent, wet, low to medium plasticity, soft firmness, medium density, no stains, no odors note: at 14' calcium carbonate nodules abscent; note: at 16.5' lense of coarse grained sand (50%) note: at 17.5' lense of coarse grained sand (50%)
2006.2	20		11-14-18 (11:35)		



WELL INFORMATION (Construction Details and/or Drilling Remarks)

- Steel casing stick up +2', minimum 8" clearance between top of steel casing and top of 4" PVC well casing
- 4000 PSI Concrete Mix from 0 to 5'
- 4" Nominal Diameter Schedule 80 PVC Blank Casing from +1' to 9'
- Bentonite Plug from 5' to 7'
- Filter Pack (8-12) from 7' to 19'
- 4" Nominal Diameter Schedule 80 PVC (0.020" Slot Screen) from 9' to 19'
- Dedicated submersible pump
- Pea Gravel from 19' to 20'

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	13.7	11:55	11/14/18
▼	14.1	10:30	11/17/18

METHOD Not Applicable

(Continued Next Page)

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-65A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922299	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	WELL INFORMATION (Construction Details and/or Drilling Remarks)
2006.2	20			MH	note: at 20.5' olive brown staining near basal gradational contact **SANDY ELASTIC SILT,** continued	(Continued)
		11-14-18 (11:45)			**Trmhm - Moqui Member of Moenkopi Formation (mid-unit), mudstone,** 60% clay, 30% silt, 10% fine grained sand, dark reddish brown (5YR 3/4) with considerable olive brown staining (2.5Y 4/4), thin laminae (<0.5 mm), effervescent, wet, medium plasticity, medium stiff, ductile, no odors note: from 20.5' to 23' core sample is more compact in diameter note: from 22' to 23' gypsum nodules (<5 mm) present near sharp basal contact	Bentonite Chips from 20' to 25'
2001.2	25				**Trmhm - Moqui Member of Moenkopi Formation (mid-unit), silty mudstone,** 55% clay, 40% silt, 5% fine grained sand, dark reddish-brown (5YR 4/4), some filaments of gypsum (at about 23'), predominant lenses of gypsum (23.5' to 25'), thin laminae (<1 mm), weakly cemented, slightly moist, low to medium plasticity, hard, medium dry strength, friable, no odors	Total Depth = 25'
1996.2	30				Total Depth = 25'	
1991.2	35					
1986.2	40					
1981.2	45					

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	13.7	11:55	11/14/18
▼	14.1	10:30	11/17/18
▼			
▼			

METHOD Not Applicable

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-66A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	Isaac Torres	**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	Darius Cervantez	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-922300
RIG I.D.:	- - -	**COORDINATES:**	N1429134.06, E669178.50
RIG TYPE:	Rotosonic	**COORDINATE SYS:**	NAD83 (1982) Arizona State Plane
BORING TYPE:	- - - **BORING DIA.:** 8"	**SURFACE ELEV. (FT):**	5032.46
ORIENTATION:	90°	**MEAS. PT. ELEV. (FT):**	5033.35
HAMMER TYPE:	Not Applicable	**VERTICAL DATUM:**	NAVD88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**COMPLETION DATE:**	11-12-2018 **COMPLETION TIME:** 15:40
START DATE:	11-12-2018 **START TIME:** 09:35		

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5032.5	0				ML	**SANDY SILT,** 80% fines, 15% fine to coarse grained, subrounded sand, 5% fine to coarse grained, subrounded to subangular gravel, brown (7.5 YR 4/3), nonlithified, granular to single grain soil structure, weakly effervescent, nonplastic, slightly moist, loose density, low dry strength, no stains, no odors note: at 2.5' sharp basal contact	0	Steel casing stick up +2', minimum 8" clearance between top of steel casing and top of 4" PVC well casing 4000 PSI Concrete Mix from 0 to 5'
					CL	**SILTY CLAY,** 90% fines, 10% fine to coarse grained, subrounded to subagular sand, dark brown (7.5YR 3/3), predominant calcium carbonate filaments, angular blocky soil structure, weakly cemented, highly effervescent, thin laminae (<1 mm), nonplastic, slightly moist, very firm to hard, low medium dry strength, friable, no stains, no odors		4" Nominal Diameter Schedule 80 PVC Blank Casing from +1' to 24'
5027.5	5		11-12-18 (09:35)				5	
5022.5	10		11-12-18 (09:45)			note: at 13' calcium carbonate filaments absent; gradational basal contact	10	Portland Neat Cement from 5' to 20'
					CL	**CLAY,** 90% to 95% fines, 5% to 10% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/4), massive, effervescent, medium plasticity, moist, soft firmness, medium dry strength, ductile, no stains, no odors		
5017.5	15		11-12-18 (09:58)				15	
			11-12-18 (10:10)					
5012.5	20						20	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	31.9	15:50	11/12/18
▼	29.3	08:00	11/13/18
▼	28.9	07:35	11/14/18
▼	28.5	09:30	11/16/18

METHOD Not Applicable

(Continued Next Page)

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922300	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
5012.5	20			CL	**CLAY,** continued note: at 23' sand decreases; gradational basal contact
		11-12-18 (10:35)		CL	**CLAY,** 98% fines, 2% fine to coarse grained, subrounded to subangular sand, dark brown (7.5YR 3/3), effervescent, medium to high plasticity, moist, soft to stiff firmness, medium dry strength, ductile, no stains, no odors note: at 25.5' sand slightly increases; gradational basal contact
5007.5	25				
		11-12-18 (12:20)		CL	**CLAY,** 95% fines, 5% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2), trace gypsum nodules (~3 mm) and occ filaments (~1 cm), effervescent, medium to high plasticity, moist, medium stiff to stiff firmness, medium dry strength, ductile, no stains, no odors note: at 32.5' gypsum filaments increase in length (~2.5 cm) note: at 33.0' clay decreases while silt increases note: at 37.5' bgs gypsum nodules decrease and no filaments, sand decreases, core sample more compact in diameter; gradational basal contact
5002.5	30				
		11-12-18 (12:40)			
4997.5	35				
		11-12-18 (13:06)		CL	**CLAY,** 98% fines, 2% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/3), occasional gypsum nodules, massive, effervescent, high plasticity, moist, soft to medium stiff firmness, medium dry strength, ductile, no stains, no odors note: at about 40' sand decreases; sharp basal contact
4992.5	40			CL	**SILTY CLAY,** 95% to 98% fines, 2% to 5% fine to coarse grained, subrounded to subangular sand, dark-reddish brown (5YR 3/4), rare gypsum nodules, massive, effervescent, medium to high plasicity wet, soft to medium stiff firmness, medium dry strength, ductile, no stains, no odors note: at about 40' core samples more compact in diameter
4987.5	45				

WELL INFORMATION (Construction Details and/or Drilling Remarks)

(Continued)

Bentonite Plug from 20' to 22'

Filter Pack (8-12) from 22' to 49'

4" Nominal Diameter Schedule 80 PVC (0.020" Slot Screen) from 24' to 49'

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	31.9	15:50	11/12/18
▼	29.3	08:00	11/13/18
▼	28.9	07:35	11/14/18
▼	28.5	09:30	11/16/18

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-66A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922300	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)
4987.5	45	11-12-18 (13:22)		CL	**SILTY CLAY,** continued note: at 47.5' trace gravels (<1 cm), sand increases; gradational basal contact
				CL	**GRAVELLY CLAY,** 75% fines, 20% fine to coarse grained, subrounded to subangular gravel, 5% fine to coarse grained, subrounded to subangular sand, dark-reddish brown (5YR 4/3), nonlithified, massive, slightly effervescent, low to medium plasticity, wet, soft firmness, low to medium dry strength, no odors note: at 52.5' core samples expanded back to normal, lenses of olive-brown staining, gradational basal contact
4982.5	50				
					Trmhm - Moqui Member of Moenkopi Formation (mid-unit), mudstone, 60% clay, 25% to 30% silt, 10% to 15% fine grained, subrounded to subangular sand, dark brown (7.5YR 3/3) with conssiderable lenses of olive brown staining (2.5Y 4/4), lithified, thin laminae (<0.5 mm), highly effervescent, slightly moist, medium to high plasticity, medium stiff, ductile, no odors. note: from 55' to 57' color dark reddish-brown (5YR 4/4), lithified samples in loose soil, trace gypsum nodules (mm), slightly moist, friable note: at 58' sharp basal contact with silty sandstone
4977.5	55				
4972.5	60				Total Depth = 60'
4967.5	65				
4962.5	70				

WELL INFORMATION (Construction Details and/or Drilling Remarks)

Depth in Feet	Remarks
45	(Continued)
	Dedicated submersible pump
50	Pea Gravel from 49' to 51'
55	Bentonite Chips from 51' to 60'
60	Total Depth = 60'
65	
70	

GROUNDWATER

DEPTH(ft bgs)	HOUR	DATE
31.9	15:50	11/12/18
29.3	08:00	11/13/18
28.9	07:35	11/14/18
28.5	09:30	11/16/18

METHOD Not Applicable

wood.
Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-67A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
LOGGED BY:	Isaac Torres	**PROJECT FEATURE:**	Fly Ash Pond
DRILLER:	Darius Cervantez	**WOOD PROJECT #:**	14-2018-2040
DRILLER FIRM:	Boart Longyear	**ADWR REG. #:**	55-922301
RIG I.D.:	- - -	**COORDINATES:**	N1428367.45, E668014.79
RIG TYPE:	Rotosonic	**COORDINATE SYS:**	NAD83 (1982) Arizona State Plane
BORING TYPE:	- - - **BORING DIA.:** 8"	**SURFACE ELEV. (FT):**	5024.05
ORIENTATION:	90°	**MEAS. PT. ELEV. (FT):**	5025.38
HAMMER TYPE:	Not Applicable	**VERTICAL DATUM:**	NAVD88
HAMMER CALIBRATION-ENERGY TRANSFER RATIO:	N/A	**COMPLETION DATE:**	11-15-2018 **COMPLETION TIME:** 10:20
START DATE:	11-14-2018 **START TIME:** 17:12		

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5024.1	0				ML	**SANDY SILT,** 80% fines, 15% fine to coarse grained, subrounded sand, 5% fine to coarse grained, subrounded to subangular gravel, brown (7.5 YR 4/3), nonlithified, granular to single grain soil structure, weakly effervescent, nonplastic, slightly moist, loose density, low dry strength, no stains, no odors note: at 2.5' sharp basal contact	0	Steel casing stick up +2', minimum 8" clearance between top of steel casing and top of 4" PVC well casing 4000 PSI Concrete Mix from 0 to 5' 4" Nominal Diameter Schedule 80 PVC Blank Casing from +<6" to 15'
					CL	**SILTY CLAY,** 95% to 98% fines, 2% to 5% fine to coarse grained, subrounded to subangular sand, dark brown (7.5YR 3/3), considerable to predominate calcium carbonate lenses and filaments, weakly cemented, highly effervescent, thin laminae (<1 mm), low plasticity, slightly moist, hard firmness, medium dry strength, friable to ductile, no stains, no odors note: at 7.5' color slightly changes to dark brown (7.5YR 3/2) sand slightly increases (5%)		
5019.1	5		11-14-18 (17:12)				5	Portland Neat Cement from 5' to 10'
5014.1	10		11-14-18 (17:18)			note: at 10' moderate cementation and high dry strength, increased with depth	10	Bentonite Plug from 10' to 13' Filter Pack (8-12) from 13' to 45'
5009.1	15		11-14-18 (17:33)			note: at 17.5' calcium carbonate filaments decrease (occasional to trace), clay decreases while silt & sand increase; sharp basal contact	15	
					ML	**SANDY SILT,** 85% to 90% fines, 10% to 15% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 4/3), angular blocky soil structure, nonlithified, massive, moderately effervescent, low to medium		
5004.1	20						20	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	35.8	09:30	11/15/18
▼	34.4	09:40	11/15/18
▼	33.9	07:15	11/16/18
▼			

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-67A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922301	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Graphical Log	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
5004.1	20		11-15-18 (07:50)			plasticity, slightly moist, loose to medium density, medium to hard dry strength, friable, no stains, no odors note: at 22.5' calcium carbonate lenses to filaments absent; gradational basal contact	20	(Continued)
					CL	**CLAY,** 95% fines, 5% fine grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2), weakly cemented, effervescent, low plasticity, slightly moist, very firm, high to very high dry strength, ductile, no stains, no odors note: at 26' sand & silt decrease while clay increases; gradational basal contact		
4999.1	25		11-15-18 (08:20)				25	
					CL	**CLAY,** 99% fines, fine grained, subrounded sand, dark brown (7.5YR 3/3), occasional gypsum nodules (<3 mm), massive, effervescent, medium to high plasticity, moist, stiff to very stiff firmness, medium dry strength, ductile, gray staining, no odors		4" Nominal Diameter Schedule 80 PVC (0.020" Slot Screen) from 15' to 45'
4994.1	30		11-15-18 (08:34)				30	
						note: at 35.0' gypsum nodules decrease (rare)		
4989.1	35		11-15-18 (08:53)			note: at 36.0' wet sandy elastic silt lense, ~1.5' (see MW-65A log for unit description) note: at 37.5' sharp basal contact	35	
					CL	**SILTY CLAY,** 99% fines, 1% fine grained, subrounded sand, dark reddish-brown (5YR 3/4), gypsum nodules absent, massive, effervescent, medium to high plasticity, moist to wet, stiff, medium to high dry strength, ductile, rare gray staining, no odors note: from 40' to 43' core samples more compact in diameter note: at ~43' medium stiffness, sand increases, gravel present (0.5-7.5 cm), core sample diameter expanded, and gradational basal contact		
4984.1	40		11-15-18 (09:11)				40	
					CL	**GRAVELLY CLAY,** 70% fines, 20% fineto coarse grained, subrounded to subangular gravel, 10% fine to coarse grained, subrounded to subangular sand, dark reddish-brown (5YR 3/2),		Dedicated submersible pump
4979.1	45						45	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	35.8	09:30	11/15/18
▼	34.4	09:40	11/15/18
▼	33.9	07:15	11/16/18
▼			

METHOD Not Applicable

(Continued Next Page)

wood.

Environment & Infrastructure Solutions, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

BORING LOG I.D.: MW-67A

PROJECT:	APS Cholla Power Plant CCR Compliance	**PROJECT LOCATION:**	APS Cholla Power Plant
ADWR REG. #:	55-922301	**PROJECT FEATURE:**	Fly Ash Pond

Elevation in Feet	Depth in Feet	Sample ID. or Date (Time)	PID Meter Reading (ppm)	Unified Soil Classification	VISUAL CLASSIFICATION (Color, Moist, % by wt., Plasticity, Dilatancy, Toughness, Dry Strength, Consistency)	Depth in Feet	WELL INFORMATION (Construction Details and/or Drilling Remarks)
4979.1	45	11-15-18 (09:40)		CL	nonlithified, massive, effervescent, medium to high plasticity, wet, soft to very soft firmness, medium dry strength, no odors. note: at 45' wet sandy elastic silt lense, ~1.5' (see MW-65A log for unit descrip.) note: at 47' sharp basal contact with siltstone to mudstone	45	(Continued) Pea Gravel from 45' to 47.5' Bentonite Chips from 47.5' to 50'
					Trmhm - Moqui Member of Moenkopi Formation (mid-unit), SANDY SILT WITH SAND & Interbedded mudstone, 65% fines, 25% fine to coarse grained, subangular sand, dark reddish-brown (7.5YR 3/4) with rare olive brown staining (2.5Y 4/4), granular to rounded blocky soil structure, lithified mudstone samples, mudstone with thin laminae (<0.5mm), effervescent, slightly moist, medium plasticity, low to medium dry strength, friable, no odors		
4974.1	50	11-15-18 (10:00)				50	Total Depth = 50'
					Total Depth = 50'		
4969.1	55					55	
4964.1	60					60	
4959.1	65					65	
4954.1	70					70	

GROUNDWATER

	DEPTH(ft bgs)	HOUR	DATE
▽	35.8	09:30	11/15/18
▼	34.4	09:40	11/15/18
▼	33.9	07:15	11/16/18
▼			

METHOD Not Applicable

ATTACHMENT B

SOILS LAB RESULTS FOR CORE FROM MW-67A

PROJECT: Cholla APP & CCR Compliance Support
LOCATION: Joseph City, AZ
MATERIAL: Native Soil

JOB NO: 14-2018-2040.****.01
WORK ORDER NO: 1
DATE ASSIGNED: 11/19/18

DENSITY OF ROCK CORE USING VOLUMETRIC CALCULATIONS

LAB #	BORING	MOISTURE WET WT. (g)	MOISTURE DRY WT. (g)	MOISTURE CONTENT	DIA. (cm)	HGT. (cm)	WET WEIGHT & RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)	SPECIFIC GRAVITY	POROSITY
18-3840-02	MW 67A (11-11.5')	462.0	372.3	24.1%	4.9	13	602.2	138.5	94.4	2.738	0.45
18-3840-03	MW 67A (16-16.5')	558.0	427.9	30.4%	4.9	15	720.1	162.1	92.0	2.773	0.47
18-3840-04	MW 67A (21-21.5')	452.1	406.7	11.2%	4.9	14	615.5	147.0	99.8	2.741	0.42

Wood Environment & Infrastructure Solutions, Inc.
3630 E Wier Ave.
Phoenix, AZ 85040

REVIEWED BY ____________________

Wood Environment & Infrastructure Solutions, Inc.
4600 E. Washington St, Suite 600
Phoenix, Arizona 85034
USA
T: 602-733-6000
www.woodplc.com

July 15, 2019
Wood Reference No: 1420182040
APS WA CHC08903

Arizona Public Service
400 N. 5th Street
Phoenix, Arizona 85004

Attn: Michele Robertson, Byron Conrad and Pam Norris

Re: SEMI-ANNUAL REPORT DOCUMENTING PROGRESS IN REMEDY SELECTION FOR THE FLY ASH POND AND BOTTOM ASH POND
Cholla Power Plant – Navajo County, Arizona

Pursuant to 40 Code of Federal Regulations (CFR) Section (§) 257.97(a) of the Coal Combustion Residuals (CCR) Rule, Arizona Public Service Company (APS) is required to prepare a semi-annual report describing progress selecting a remedy for CCR units that have been identified as potentially impacting groundwater based on a statistical assessement of groundwater data collected at the Cholla Power Plant located in Navajo County, Arizona (the Site). This letter serves as the first semi-annual report prepared after initiatiating corrective measures at the Site Fly Ash Pond (FAP) and Bottom Ash Pond (BAP) on January 14, 2019.

1. Summary of Activities Completed to Date

Following a demonstration of need for a corrective measures assessment extension, dated April 15, 2019, Wood Environment & Infrastructure Solutions, Inc. (Wood) finalized a report presenting an *Assessment of Corrective Measures for the Fly Ash Pond and the Bottom Ash Pond* on June 14, 2019. The assessment documents the development and evaluation of various corrective measures for the two CCR units including:

- Operation of existing seepage collection systems at the FAP and BAP;
- Future dewatering of the ponds with subsequent closure;
- Installation and operation of various arrays of groundwater intercept systems; and
- Monitored natural attenuation of CCR constituents.

2. Future Planned Activities

As identified in the *Assessment of Corrective Measures for the Fly Ash Pond and the Bottom Ash Pond*, additional site characterization is necessary prior to selection and design of the FAP and BAP remedies. Currently planned activities include:

- *Moenkopi Moqui Investigation at the FAP*. At least one new well will be advanced on the south side of I-40 to investigate the presence and quality of groundwater in the Moqui formation downgradient of the FAP.
- *Aquifer Testing Downgradient of the FAP*. Aquifer testing will be conducted at various locations downgradient of the FAP to better understand aquifer properties in this region of the Site.

- *Preparation of Alternative Source Demonstrations (ASDs) for Arsenic and Cobalt at the FAP*. ASDs for these constituents will be prepared to demonstrate whether the source of Groundwater Protection Standard exceedances in groundwater downgradient of the FAP is leakage of arsenic or cobalt mass from the FAP.
- *Stratified Sampling of Water in the BAP*. To assess spatial- and depth-specific variations in cobalt concentrations in BAP water, a water sampling characterization program will be implemented.
- *Leaching Evaluation at the BAP*. Bottom ash as well as distinct geological units found at the BAP (i.e., the alluvium, the Chinle, the Moenkopi Holbrook, and the Moenkopi Moqui) will be sampled and evaluated for CCR Rule constituents and then subject to leach testing in a licensed environmental laboratory to evaluate the potential source of cobalt observed in compliance wells at the BAP.
- *Bottom Ash Pond Dewatering Projection*. A water balance will be developed to project pond dewatering at the BAP.
- *Seepage Intercept System Evaluation, Optimization, and Testing*. Existing systems at both the FAP and BAP will be evaluated and optimization strategies will be investigated. If feasible, testing will be conducted to better understand the influence of these systems in intercepting seepage discharges to the downgradient alluvial aquifer.

The next semi-annual report documenting progress in remedy selection at the Site will be prepared no later than January 15, 2020.

Respectfully submitted,
Wood Environment & Infrastructure Solutions, Inc.

Natalie Chrisman Lazarr, PE
Senior Project Manager
natalie.chrisman@woodplc.com

Reviewed by:

Emily LoDolce, PE
Senior Engineer
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July 15, 2020
Wood Reference No: 1420182040

Arizona Public Service Company
400 N. 5th Street
Phoenix, Arizona 85004

Re: SEMIANNUAL REPORT DOCUMENTING PROGRESS IN REMEDY SELECTION FOR THE FLY ASH POND AND BOTTOM ASH POND
Cholla Power Plant – Navajo County, Arizona

In accordance with 40 Code of Federal Regulations (CFR) Section (§) 257.97(a) of the Coal Combustion Residuals (CCR) Rule, this Semiannual Remedy Selection Progress Report (Semiannual Report) has been prepared on behalf of Arizona Public Service Company (APS) to document progress in selection of remedies for CCR units which have been identified as potentially impacting groundwater at the APS Cholla Power Plant, located in Navajo County, Arizona (the Site). Applicable site CCR units include the Fly Ash Pond (FAP) and the Bottom Ash Pond (BAP). Previous updates documenting remedy selection progress are provided in a Semiannual Report dated July 15, 2019 and in the *Annual Groundwater Monitoring and Corrective Action Report for 2019*, dated January 31, 2020. This Semiannual Report serves as the third update on remedy selection progress at the site and documents activities completed to date in 2020.

1. Summary of Activities Completed in 2020

Activities completed by APS in the first half of 2020 in support of remedy selection for the FAP and the BAP include the following:

- *Evaluation of Seepage Collection Systems at the FAP and BAP*. As indicated in the 2019 GMCAR, Wood Environment and Infrastructure Solutions, Inc. (Wood) has performed field evaluations of the seepage collection systems at the FAP and BAP in support of remedy selection and design at each CCR unit. The evaluation at the FAP has indicated poor lateral influence of the two seepage collection extraction wells, which may be associated with clogging of the extraction well screens. Well rehabilitation activities are planned for the extraction wells and are likely to occur in the second half of 2020. Additionally, the evaluation has prompted a series of cone penetrometer tests (CPTs) at the FAP, which is planned for July 2020 and discussed in Section 2. The assessment of the BAP seepage collection system is partially complete and will be finalized in the second half of 2020. The assessment results for the FAP and BAP seepage collection systems will be summarized in a Technical Memorandum (Tech Memo) for inclusion as an appendix to the Annual Groundwater Monitoring and Corrective Action Report for 2020 (2020 GMCAR).
- *Aquifer Testing at the FAP*. In March 2020, Wood performed several aquifer tests at wells downgradient of the FAP to evaluate aquifer properties in support of remedy selection. Results of the aquifer tests indicate limited connectivity between test wells and observation wells and relatively low sustained groundwater pumping rates at the test wells (e.g., between approximately 0.1 and 2.5 gallons per minute). The aquifer

test results will be incorporated into a Tech Memo with the results of the FAP seepage system collection evaluation and FAP CPT study for inclusion as an appendix to the 2020 GMCAR.

- *Stratified Water Sampling and Leaching Evaluation at the BAP*. As indicated in the 2019 GMCAR, a field investigation was conducted in 2019 to evaluate the cause of elevated cobalt concentrations in groundwater downgradient of the BAP. Results of the investigation are summarized in a Tech Memo which will be included as an appendix to the 2020 GMCAR. The investigation concluded that the elevated cobalt concentrations in groundwater are not directly attributable to the presence of cobalt in BAP water and may be caused by the mobilization of cobalt from the solid matrixes underlying the BAP (e.g., alluvium, bottom ash, and/or Moenkopi Moqui) under reducing conditions. Groundwater sampling at the BAP to evaluate redox conditions was performed by APS in the first half of 2020 and is discussed below.
- *Groundwater Redox Sampling at the FAP and BAP*. Site investigations conducted to date suggest groundwater redox conditions may be responsible for the mobilization of cobalt at the BAP (discussed above) and arsenic at the FAP (discussed in the 2019 GMCAR). Accordingly, groundwater samples collected during the first semiannual CCR monitoring event of 2020 at FAP and BAP downgradient wells have been analyzed for several redox-sensitive constituents to assess groundwater redox conditions at each CCR unit. The results of the redox analysis will be evaluated in the second half of 2020 to inform the selection and design of remedies for the FAP and BAP and will be summarized in a Tech Memo for inclusion as an appendix to the 2020 GMCAR.
- *BAP Dewatering Projection*. As discussed in the 2019 GMCAR, a dewatering projection was developed in 2019 to estimate the duration of time until the BAP no longer has ponded water and seepage from the BAP declines to a steady state level. A Tech Memo documenting the results of the dewatering projection is being finalized and will be included as an appendix to the 2020 GMCAR.

2. Future Planned Activities

APS plans to perform the following activities in support of remedy selection during the second half of 2020:

- *A CPT Investigation at the FAP*. Investigations conducted at the FAP to date suggest the presence of preferential pathways for groundwater migration in the uppermost aquifer. A CPT study at the FAP is planned for July 2020 to delineate preferential flow paths or perched zones of saturation downgradient of the FAP. The results of the CPT investigation will be assessed in the second half of 2020 to inform remedy selection and design for the FAP and will be documented in a Tech Memo for inclusion as an appendix to the 2020 GMCAR.
- *Installation of Monitoring Wells at BAP*. To evaluate localized cobalt migration pathways in the uppermost aquifer immediately downgradient of the BAP, monitoring wells are planned for installation near the southeastern corner of the BAP. Additionally, the installation of a monitoring well screened in the Moqui is planned as a potential background well for the BAP to evaluate background cobalt concentrations for groundwater in the Moqui. The well installation activities are anticipated to occur in the second half of 2020 and will be summarized in a Tech Memo for inclusion as an appendix to the 2020 GMCAR.
- *Public Meeting*. Pursuant to 40 CFR §257.96(e), APS will conduct a public meeting with interested and affected parties at least 30 days prior to selection of remedies for the FAP and the BAP. Once pre-design studies have provided enough information to progress remedy selection activities, APS will explore alternative methods to conduct the public meeting if gatherings are limited as a result of the COVID-19 pandemic.

- *Remedy Selection Reports for the FAP and the BAP*. After a public meeting to discuss the results of the corrective measures assessment occurs, APS will prepare a remedy selection report for each CCR unit which will document how the selected remedy will meet the requirements of 40 CFR §257.97(b).

Respectfully submitted,
Wood Environment & Infrastructure Solutions, Inc.

Dane Andersen, GIT
Hydrogeologist
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Reviewed by:

Maren Henley, PE
Associate Engineer
maren.henley@woodplc.com

AECOM

Submitted to
Arizona Public Service
Generation Engineering
P.O. Box 53999
Phoenix, AZ 85072

Submitted by
AECOM
7720 North 16th Street
Suite 100
Phoenix, AZ 85020
August 26, 2016

Final Summary Report
Structural Integrity Assessment

Fly Ash Pond
Cholla Power Plant
Joseph City, Arizona

Prepared for:
Arizona Public Service

AECOM Job No. 60445840
August 2016

Table of Contents

List of Appendices

Appendix A. Historic Drawings

Appendix B. Safety Factor Calculation

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List of Acronyms

ADWR	Arizona Department of Water Resources
APS	Arizona Public Service
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EAP	Emergency Action Plan
EPA	Environmental Protection Agency
ft	feet
HPC	Hazard Potential Classification
pcf	pounds per cubic foot
PMF	Probable Maximum Flood
USCS	Unified Soil Classification System
USGS	United States Geological Survey

Certification Statement

Certification Statement for:

- **40 CFR § 257.73(a)(2)(ii) – Initial Hazard Potential Classification for an Existing CCR Surface Impoundment**
- **40 CFR § 257.73(d)(3) – Initial Structural Stability Assessment for an Existing CCR Surface Impoundment**
- **40 CFR § 257.73(e)(2) – Initial Safety Factor Assessment for an Existing CCR Surface Impoundment**

CCR Unit: Arizona Public Service Company; Cholla Power Plant; Fly Ash Pond

I, Alexander Gourlay, being a Registered Professional Engineer in good standing in the State of New Mexico, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the initial hazard potential classification, initial structural stability assessment, and initial safety factor assessment as included in the Structural Integrity Assessment Report dated August 26, 2016 was conducted in accordance with the requirements of 40 CFR § 257.73.

Alexander W. Gourlay, P.E.

Printed Name

August 26, 2016

Date

1 Introduction

Arizona Public Service Company (APS) contracted URS Corporation, a wholly owned subsidiary of AECOM, to assist in the initial structural integrity assessment of the existing coal combustion residual (CCR) surface impoundments at the Cholla Power Plant in Joseph City, Arizona. Figure 1-1 shows the location of the CCR Impoundments at the Cholla Power Plant. This Summary Report documents the AECOM structural integrity assessment for the Fly Ash Pond, Arizona Department of Water Resources (ADWR) Dam No. 09.28. Assessments of other CCR Impoundments at the Cholla Power Plant are presented in separate reports.

1.1 Report Purpose and Description

The purpose of this report is to document the initial structural integrity assessment for the Fly Ash Pond located at the Cholla Power Plant. The Fly Ash Pond is an existing CCR surface impoundment owned and operated by APS that is regulated by the Arizona Department of Water Resources (ADWR). In 2015, the United States Environmental Protection Agency (EPA) finalized Federal Rule (Rule) 40 Code of Federal Regulations (CFR) *§* 257.73 (EPA, 2015) regulating CCRs under Subtitle D of the Resource Conservation and Recovery Act. As part of this Rule, owners and operators of existing CCR surface impoundments must complete initial and periodic structural integrity assessments to document whether the CCR unit poses a reasonable probability of adverse effects on health and the environment.

1.2 EPA Regulatory Requirements

Pursuant to Rule 40 CFR *§* 257.73 (EPA, 2015), each existing CCR surface impoundment must have initial and periodic structural integrity assessments to evaluate whether the CCR unit poses a reasonable probability of adverse effects on health and the environment. The assessment must address the following elements:

- *Periodic Hazard Potential Classification Assessment (40 CFR § 257.73(a)(2))* - Document the hazard potential classification of each CCR unit as either a high hazard, significant hazard, or low hazard potential CCR unit.

- *Emergency Action Plan (EAP) (40 CFR § 257.73(a)(3))* - Prepare and maintain a written EAP for high and significant hazard CCR units. The EAP must be evaluated at least every five years and, if necessary, updated and revised to maintain accurate information of current CCR unit conditions. The evaluation and certification of the EAP is provided in a separate report.

In addition, the following elements must be addressed for CCR units, such as the Fly Ash Pond, that have a height of five feet (ft) or more and a storage volume of 20 acre-ft or more, or have a height of 20 ft or more:

- *History of Construction (40 CFR § 257.73(c)(1))* - Compile a history of construction of the CCR unit including elements of operation, location, design, monitoring instrumentation, maintenance and repair, and historic structural instabilities.

- *Periodic Structural Stability Assessment (40 CFR § 257.73(d))* - Document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practice for the maximum volume of CCR and CCR wastewater which can be impounded therein.

- *Periodic Safety Factor Assessment (40 CFR § 257.73(e))* - Document whether the calculated factors of safety for each CCR unit achieve minimum safety factors for the critical cross section of the embankment under long-term, maximum storage pool loading conditions, maximum surcharge loading conditions, seismic loading conditions, and post-earthquake loading conditions for dikes constructed of soils susceptible to liquefaction.

Existing CCR surface impoundments, such as the Fly Ash Pond, are required to have an initial structural integrity assessment within 18 months of publication of the EPA Rule on April 17, 2015 and subsequent periodic assessments performed every five years thereafter.

1.3 Report Organization

This Summary Report has been organized into the following sections:

Report Section	Applicable CFR 40 Part 257 Citation
• Section 1 – Introduction	
• Section 2 – Hazard Potential Classification	§ 257.73(a)(2) Periodic hazard classification assessments
• Section 3 – History of Construction	§ 257.73(c)(1) History of construction
• Section 4 – Structural Stability Assessment	§ 257.73(d) Periodic structural stability assessment
• Section 5 – Safety Factor Assessment	§ 257.73(e) Periodic safety factor assessment
• Section 6 – Conclusions	
• Section 7 – Limitations	
• Section 8 – References	
• Figures	
• Appendix A – Historic Drawings	
• Appendix B – Safety Factor Calculation	

1.4 Facility Description

The Cholla Power Plant is an electric generating station located in the town of Joseph City, Navajo County, Arizona. The station consists of four coal-fired units. Units 1, 2 (decommissioned), and 3 are owned by APS and Unit 4 is owned by PacifiCorp. CCR generated at the power plant are disposed of at two major surface impoundments located off-site; the Fly Ash Pond located about one-and-a-half miles east of the plant and the Bottom Ash Pond located about two miles north of the plant. Figure 1-1 shows the location of the Fly Ash Pond and Bottom Ash Pond in relation to the power plant. This assessment evaluates the structural integrity of the Fly Ash Pond.

The Fly Ash Pond receives discharges from the following sources: Slurry Disposal; General Water Sump; Fly Ash Pond Seepage Collection System; Sedimentation Pond Solids; Unit 3 and Unit 4 Cooling Tower(s) Basin Solids; General Water Sump Solids; Unit 1, 2, 3, and 4 Oil Water Separator Solids; WARP Solids; CCR Wastes; Flue Gas Desulfurization Wastes; and Fly Ash Pond Area Stormwater. The CCR and other wastes are pumped as slurry through three 6-inch diameter pipes into the impoundment where the solids settle out and the remaining water evaporates. There is no means to return the excess water to the plant for reuse.

The Fly Ash Pond has a total surface area of about 420 acres and storage capacity of about 16,500 acre-feet when at its permitted maximum storage pool water level of EL 5,114 ft (ADWR, 1986). The impoundment is surrounded on its west, north, and east sides by natural topography consisting of rock outcrops of mudstones, siltstones, and sandstones. On the south side, the impoundment is enclosed by the Fly Ash Pond Dam, ADWR Dam No. 09.28, which spans the width of a natural wash. The Fly Ash Pond has been classified under ADWR regulations as a high hazard impoundment due to the probable loss of human life at the nearby U.S. Interstate 40 (I-40), Cholla Power Plant, freight railroad line, and downstream residences, in the event of a dam breach.

The Fly Ash Pond Dam is an earthen, zoned embankment dam consisting of a central clay core surrounded by an outer sand and gravel shell (random material zone). Construction began on the dam in 1976 and it started receiving CCR materials in 1978. The dam is approximately 4,580 ft in length and is composed of two linear segments. The western most segment starts at the right abutment and extends approximately 3,100 ft to a rock outcropping referred to as Geronimo Knob. At Geronimo Knob the dam centerline pivots approximately 40 degrees to the north forming the second linear segment which extends to the left abutment. The maximum height of the dam occurs between the right abutment and Geronimo Know with a maximum toe to crest height of 80 ft and crest width of 24 ft. The top of crest elevation is 5,120 ft producing 6 ft of total freeboard above the maximum permitted storage pool water level. Both the upstream and downstream slopes are inclined at a three horizontal to one vertical (3H:1V) angle with riprap facing to prevent erosion.

To limit seepage beneath the foundation, the central clay core of the Fly Ash Pond Dam extends to bedrock at relatively shallow depths, less than 20 ft. In the center portion of the dam where the depth to bedrock is greater than 20 ft, a slurry cutoff wall extends from the clay core to into the bedrock. The Fly Ash Pond Dam has no internal drain system; however, where seepage has been observed downstream of the dam, sumps have been installed to collect surface and groundwater and return it to the pond. These include systems for the Geronimo and Hunt Seeps that collect and return the water back to the Fly Ash Pond and the I-40 Seep that collects the water for evaporation.

The Fly Ash Pond has no intake or outlet water work structures. Water levels within the pond are controlled by varying the pumping rate from the plant and seepage collection system to balance with seepage and evaporation from the pond. Sluiced fly ash is pumped from the plant to the pond through three 6-inch diameter pressured discharge lines. The lines pass underneath of I-40, proceed up the downstream face of the embankment, pass over the dam crest, and empty into the pond basin. The dam was constructed without an overflow spillway channel. To prevent overtopping during the design storm event, defined as the probable maximum flood (PMF), the pond was constructed to fully contain the storm runoff on top of the maximum permitted storage pool water level. This water level, defined as the maximum surcharge pool water level, is estimated at EL 5,116 ft based on an expected water level rise of 2.0 ft during the PMF (Ebasco, 1976).

Piezometers, settlement monuments, flow measurement devices, and water level gauges are installed at the Fly Ash Pond to monitor the performance of the dam. Measurements from the monitoring instruments are reviewed and documented annually in a data report. Starting on October 19, 2015, the piezometer, survey monuments, and flow totalizers are read at intervals not exceeding 30 days per the requirements of 40 CFR § 257.83(a)(1)(iii). The locations of the monitored piezometers, survey monuments, and flow totalizers are shown on Figure 1-2.

Inspections of the Fly Ash Pond are performed by a qualified person at intervals not exceeding seven days. The inspections examine the Fly Ash Pond for actual or potential conditions that could disrupt the operation or safety of the impoundment and documents the results of the inspection in the facility's operating record. In addition, a more detailed annual inspection is performed by a qualified professional engineer. The annual inspection includes a review of available information on the dam, including the past year of monitoring data, a field inspection of the dam, abutment, and downstream toe and documentation of findings and recommendations in a dam safety inspection report. The most recent annual inspection of the Fly Ash Pond was performed on October 16, 2015 (AECOM & APS, 2016).

2 Hazard Potential Classification

This section summarizes the initial Hazard Potential Classification (HPC) for the Fly Ash Pond. This initial HPC is intended to meet the requirement for periodic hazard potential classification assessment of existing CCR surface impoundments per Rule 40 CFR *§* 257.73(a)(2).

2.1 Methodology and Design Criteria

Per the Rule, the hazard potential classification provides an indication of the possible adverse incremental consequences that result from the release of water or stored contents due to failure or mis-operation of the CCR surface impoundment. The classification is based solely on the consequences of failure. As such, it is not dependent of the condition of the embankment or the likelihood of failure. Classifications per the Rule are separate from relevant and/or applicable federal, state or local dam safety regulatory standards, which may also include hazard classification definitions, and are not intended to substitute for other regulatory hazard potential classifications.

Rule 40 CFR § 257.53 defines three hazard potential classifications as follows:

High hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation will probably cause loss of human life.

Significant hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

Low hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment's owner's property.

The hazard potential of the Fly Ash Pond was assessed qualitatively, per the above definitions. The qualitative assessment process is generally performed in a step-wise manner by first determining whether the pond could be classified as low hazard potential, based on immediately obvious factors such as proximity to property lines and/or surface water bodies. After determining that a structure does not meet the criteria for a Low Hazard Potential classification, the structure is assessed to determine whether it meets the criteria for High Hazard Potential. The potential for loss of life differentiates between high and significant hazard potential in the Final CCR Rule; therefore, if the Dam does not meet the criteria for high hazard potential, it would be classified as a Significant Hazard Potential structure.

The potential for downstream loss of life is assessed by reviewing land use in areas downstream (to the south) from the Dam, where inundation is likely in the event of a release. No quantitative dam break or inundation studies were performed. The United States Geological Survey (USGS) 7.5-Minute Quadrangle topographic map of Joseph City, Arizona and associated digital orthoimage data (USGS, 2013) were used to review downstream areas for existing permanent and temporary land use. Permanent land uses include permanently inhabited dwellings and worksite areas that would likely contain workers on a daily basis (public utilities, power plants, water and sewage treatment plants, private industrial plants, sand and gravel plants, farm operations, fish hatcheries). Temporary land uses include primary roads, established campgrounds, or other recreational areas.

2.2 Hazard Potential Classification Results

Inspection of the Fly Ash Pond Dam and its immediate surrounding based on review of the USGS 7.5-Minute Quadrangle topographic map of Joseph City, AZ (USGS, 2013) identifies that the downstream toe of the Fly Ash Pond Dam is located within 100 ft of Interstate 40 (I-40), a major east-west route of the Interstate Highway System. A catastrophic and unexpected failure of the Fly Ash Pond Dam would likely inundate the travel lanes of I-40 and could result in loss of life. The Fly Ash Pond is therefore classified as a High Hazard Potential CCR surface impoundment.

3 History of Construction

This section summarizes the history of construction for the Fly Ash Pond. This information is intended to meet the requirement for compilation of the history of construction for each CCR surface impoundment per Rule 40 CFR § 257.73(c)(1).

3.1 Methodology

AECOM reviewed available documents obtained from APS, the ADWR Document Repository, or in-house resources for information regarding the history of construction for the Fly Ash Pond. Per the Rule, the compiled history of construction should include, to the extent feasible, the following information:

- Information identifying the CCR Unit, its purpose and the name and address of the owner/operator;
- The location of the CCR unit on the most recent USGS or other topographic map;
- Name and size of the watershed within which the CCR unit is located;
- A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit was constructed;
- A description of the type, size, and physical and engineering properties of each embankment zone;
- Provide detailed engineering drawings;
- A description of the type, purpose and location of existing instruments;
- Area-capacity curves for the CCR unit;
- A description of spillway and diversion design features;
- Construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit; and
- Any record of knowledge of structural instability.

3.2 Fly Ash Pond Construction Summary

The history of construction dating back to the original construction that began in 1976 is summarized in Table 3-1 below.

Table 3-1. History of Construction for Cholla Fly Ash Pond

Item	As-Constructed/ Current	Comments	Reference Document
Name and Address of Owner	Arizona Public Service Company (APS): P.O. Box 53999, Phoenix, Arizona 85072	---	---
State ID No.	09.28	---	ADWR License of Approval dated October 8, 1986
Size Classification	Intermediate	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Hazard Classification	High	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Construction Date	Original: 1976 to 1977 Seepage Collection System: 1993	---	• Ash Pond Construction Memorandum (Temchin, 1977) • As-built Drawings APS No. G-44557 and G-44558 (Ebasco, 1977) • Seepage Intercept System Drawings No. D-114438, Sheets 1, 3 and 4 of 4 (APS, 1993)
Location on USGS Quadrangle Map	Joseph City Quadrangle: Section 24/19 and 25/30, Township 18 North, Range 20 East	See Figure 3-1	Joseph City Quadrangle (USGS, 2013)
Statement of Purpose	Fly ash containment		Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975).
Name of Watershed	---	---	---
Size of Watershed (ac)	1,230	---	• Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975) • Flood Routing Report (Ebasco, 1976)
Area Capacity Curve	See Figure 3-2	---	Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975)
Embankment Type	Zoned earth fill dam consisting of a clay core and shell	---	As-built Drawing APS No. G-44558 (Ebasco, 1977)
Embankment Maximum Height (ft)	80	---	As-built Drawing APS No. G-44558 (Ebasco, 1977)
Design Total Freeboard (ft)	6	Minimum residual freeboard following PMP event is 4 ft	Summary of Review of Plans and Specifications (AWC, 1976)

Item	As-Constructed/ Current	Comments	Reference Document
Embankment Length (ft)	4,580	---	Drawing No. G-558, Rev. No. 7 (Ebasco, 1977)
Embankment Crest Elevation (ft)	5,120		As-built Drawing APS No. G-44558 (Ebasco, 1977)
Embankment Crest Width (ft)	24	---	As-built Drawing APS No. G-44558 (Ebasco, 1977)
Embankment Slopes	3H:1V (downstream & upstream)	---	As-built Drawing APS No. G-44558 (Ebasco, 1977)
Slope Protection	Riprap and random rock		As-built Drawing APS No. G-44558 (Ebasco, 1977)
Maximum Operating Storage Level (ft)	5,114	Previous maximum storage levels were: 5,116 ft (1981)	• Summary of Review of Plans and Specifications (AWC, 1976) • ADWR License dated October 8, 1986
Storage Capacity (ac-ft)	Original design: 16,500	Storage at EL 5,116 ft	Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975)
Surface Area (ac)	440	Area at EL 5,116 ft	• Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975) • Flood Routing Report (Ebasco, 1976)
Clay Core Properties			
Physical Properties	The clay core consists of compacted sandy lean clay and sandy fat clay.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • Safety Inspection Report (Harza, 1987) • Evaluation of Dam Embankment Crack (Dames & Moore, 1999)
Engineering Properties	• Moist Unit Weight = 120 pounds per cubic foot (pcf) • Saturated Unit Weight = 125 pcf • Effective Cohesion = 0 pounds per square foot (psf) • Effective Friction Angle = 28^{o} • Undrained strength ratio = 0.38	---	
Shell (Random Zone) Properties			
Physical Properties	The shell consists of compacted silty or clayey sand and sandy lean clay.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • Safety Inspection Report (Harza, 1987) • Evaluation of Dam Embankment Crack (Dames & Moore, 1999)
Engineering Properties	• Moist Unit Weight = 125 pcf • Saturated Unit Weight = 130 pcf • Effective Cohesion = 0 psf • Effective Friction Angle = 33^{o}	---	

<table>
<tr><th>Item</th><th>As-Constructed/ Current</th><th>Comments</th><th>Reference Document</th></tr>
<tr><td colspan="4">Foundation Conditions</td></tr>
<tr><td>Physical Properties</td><td>The embankment is founded on an engineered keyway consisting of the compacted clay core extending to competent bedrock. The exposed bedrock was cleaned and treated with grout or concrete prior to placement of fill material. Where bedrock is deeper than 20 ft, a soil-bentonite cutoff wall extends through the alluvium to bedrock or stiff clay. The alluvium is a Quaternary age wash deposit consisting of unconsolidated clays, silts, and sands. The underlying bedrock consists of mudstone, siltstone, and sandstone associated with the Chinle and Moenkopi Formations.</td><td>---</td><td rowspan="2">• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975)
• Various Construction Reports (Ebasco, 1977)
• Safety Inspection Report (Harza, 1987)
• Evaluation of Dam Embankment Crack (Dames & Moore, 1999)</td></tr>
<tr><td>Engineering Properties</td><td>Alluvium:
• Moist Unit Weight = 120 pcf
• Saturated Unit Weight = 120 pcf
• Effective Cohesion = 0 psf
• Effective Friction Angle = 26^{o}
Bedrock:
• Moist Unit Weight = 150 pcf
• Saturated Unit Weight = 150 pcf
• Effective Cohesion = 1,000 psf
• Effective Friction Angle = 65^{o}
Cutoff Wall:
• Moist Unit Weight = 106 pcf
• Saturated Unit Weight = 106 pcf
• Effective Cohesion = 0 psf
• Effective Friction Angle = 28^{o}
• Undrained Strength = 10 psf</td><td>---</td></tr>
</table>

Item	As-Constructed/ Current	Comments	Reference Document
	Abutment Conditions		
Physical Properties	The abutments consist of bedrock comprising mudstone, siltstone, and sandstone associated with the Chinle and Moenkopi Formations. A clay blanket was placed along a 250-foot section of the right abutment.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • As-built Drawings No. G-557 and G-558 • Safety Inspection Report (Harza, 1987) • Evaluation of Dam Embankment Crack (Dames & Moore, 1999)
Engineering Properties	• Moist Unit Weight = 150 pcf • Saturated Unit Weight = 150 pcf • Effective Cohesion = 1,000 psf • Effective Friction Angle = 65^{o}	---	
Spillway	None	The impoundment has sufficient storage volume above the maximum storage pool water level to store the IDF (PMF) and maintain at least four ft of freeboard.	Summary of Review of Plans and Specifications (AWC, 1976)
Construction Specifications	Clay Core: • Fines content ranging from 50% to 100% • No particle sizes greater than 3 inches • Initial plasticity index range from 15 to 50; changed to 10 to 50 in July 1977 • Fill lift thickness = 8 inches • Initial minimum degree of compaction = 90% (modified Proctor); changed to 95% (standard Proctor) in June 1977. • Test frequency = 60,000 ft^2/test Shell (Random Zone): • Maximum rock fraction greater than 3 inches = 10% • Fill lift thickness = 12 inches • Minimum degree of compaction = 100% (standard Proctor) • Test frequency = 60,000 ft^2/test	---	Ash Pond Construction Memorandum (Temchin, 1977)

Item	As-Constructed/ Current	Comments	Reference Document

Construction Specifications (continued)	<u>Cutoff Wall:</u>
	• Preparation:
	  ○ Minimum unit weight = 1.02 grams/cubic centimeter (g/cm^3)
	  ○ Minimum viscosity = 35 sec-marsh
	  ○ Maximum filtration loss = 30 cm^3
	  ○ Minimum pH = 8
	• In Trench:
	  ○ Unit weight range between 1.05 and 1.4 g/ cm^3
	• Backfill Mix at Trench:
	  ○ Slump ranging between 3 and 6 inches
	  ○ Percent passing 3/8-inch between 70 and 100%
	  ○ Percent passing No. 20 sieve between 40 and 80%
	Fines content between 10 and 35%
		---	Ash Pond Construction Memorandum (Temchin, 1977)

Detailed Drawings	See Appendix A for drawings	---	• Original As-built (Ebasco, 1977) • Seepage Interception System (APS, 1993)
Existing Instrumentation			
Type and Purpose of Instrumentation	• Open standpipe piezometers and wells installed for monitoring the phreatic levels in the embankment, foundation, and surrounding area. • Settlement monuments for monitoring movement of the embankment. • Water level gauge for monitoring water level in reservoir. • Flowmeters measuring seepage rates.	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)

Item	As-Constructed/ Current	Comments	Reference Document
Location of Instrumentation	• Open standpipe piezometers and wells located in and around the embankment. • Movement monuments located along the embankment crest. • Water level gauge located in the reservoir. • Seepage monitoring systems located along the downstream toe.	See Figure 1-2	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Provisions for Surveillance, Maintenance and Repair	• Visual inspections of the dam by a qualified person on a frequency not exceeding seven days. • Visual inspections of the dam conducted annually by a qualified professional engineer. • Phreatic level behavior from piezometric measurements and reservoir water level from gauge collected on a frequency not exceeding 30 days. • Embankment settlement using movement monuments survey data collected on a frequency not exceeding 30 days. • Seepage monitoring at the downstream toe on a frequency not exceeding 30 days.	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Record of Structural Instability (See Section 4 for more details)	• Historic seepage at downstream toe and right abutment. Seepage areas near the downstream toe are identified as Hunt Seep and Geronimo Seep, and I-40 Seep. • Crack within clay core near Geronimo Knob, generally between survey monuments M6 and M7.	See Figure 1-2 for the Hunt and Geronimo Seeps. The seepage areas are captured and monitored by a seepage interceptor system near the downstream toe.	• Transverse Crack Evaluation (URS, 2001) • Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)

Notes: 1) Site elevations use National Geodetic Vertical Datum (NGVD) 1929

4 Structural Stability Assessment

This section summarizes the structural stability assessment for the Fly Ash Pond. This information is intended to satisfy the requirement of Rule 40 CFR *§* 257.73(d).

4.1 Foundation and Abutments

Per the requirements of 40 CFR *§* 257.73(d)(1)(i), an existing CCR impoundments must be assessed for "*Stable foundations and abutments*."

The Fly Ash Pond Dam is founded on alluvium overburden associated with a local wash with both abutments resting on bedrock consisting of mudstone, siltstone, and sandstone associated with the Chinle and Moenkopi Formations. Review of the as-built design drawings of the dam (Ebasco, 1977) and construction inspection reports prepared by ADWR (formerly the Arizona Water Commission) indicate a cut off trench was excavated at the abutments to extend the clay core to bedrock. When the depth to bedrock was greater than 20 ft, a soil-bentonite slurry cut-off wall was installed to the bedrock which extended to a maximum depth of about 40 ft below the original ground surface. In addition, an approximately 250-ft long clay blanket was installed on the upstream slope of the right abutment directly adjacent to the embankment to help control seepage through the surrounding Moenkopi bedrock formation. Review of construction records indicates that where the cutoff trench was excavated to bedrock, loose rock was scaled from the foundation, dental concrete was applied to irregularities to create a relatively level surface, and a thin lift of wet cement tack coat was applied to the bedrock surface before placement of the clay core. For the shell of the dam, which is founded on alluvium overburden soils, the alluvium foundation was proof-compacted using a heavy dynamic compactor and surface stringers of sandy soils that crossed the dam foundation were removed.

Several seepage locations have been observed downstream of the dam since the Fly Ash Pond went into operation. These seeps are thought to occur due to a combination of normal flow through the embankment, discontinuities in the foundation near the groin of the abutment at Geronimo Knob, and flow through gypsum seams in the Moenkopi Formation. Drain systems have been installed at most of the seepage locations, typically consisting of underground French drains connected to a collection sump. Two sumps have been installed at the following seeps: the Geronimo Seep and the Hunt Seep. The locations of the seeps are shown in Figure 1-2. Flow from the sumps and weir installed at the seeps are monitored and presented in the annual dam inspection reports. Flow rates ranging from 6 to 40 gallons per minute over the last ten years were measured at the sumps (AECOM & APS, 2016), indicating low to moderate flow. The turbidity of the seep water observed at the sumps was low. The long-term steady and low to moderate flow rate, combined with the lack of turbidity, indicate a low potential of internal erosion of the dam embankment or foundation.

Review of the measured displacements of the survey monuments at the crest of the Fly Ash Pond Dam, as presented in the 2015 annual dam inspection report (AECOM & APS, 2016), indicates total settlements along the crest of the dam of four to seven inches and horizontal movements of four inches or less in the last ten years. Settlement rates appear relatively consistent over the last ten years at about one half of an inch per year, except in 2010 when recalibration of the survey base point appears to have increased the reported settlement by one additional inch. The relatively small settlement and horizontal movements measured at the Fly Ash Pond Dam are an indication of stability in the dam foundation and abutments.

4.2 Slope Protection

Per the requirements of 40 CFR *§* 257.73(d)(1)(ii), an existing CCR impoundments must be assessed for "*Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown*."

A review on the as-built drawing of the Fly Ash Pond Dam (Ebasco, 1977), indicates the dam was constructed with a two foot thick layer of random rock fill (riprap) to protect the upstream and downstream slopes against erosion. No specifications for riprap size were shown on the drawings; however, visual observations performed during dam inspection suggest they are cobble to boulder sized. The 2015 annual dam inspection report (AECOM & APS, 2016) reported no significant erosion of the dam slopes indicating the riprap slope protection is performing adequately. Based on the inspection report and experience with similar riprap slope protection designs, the Fly Ash Pond has adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.

4.3 Dike Compaction

Per the requirements 40 CFR *§* 257.73(d)(1)(iii), an existing CCR impoundments must be assessed for "*Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit*."

Based on review of a memorandum summarizing construction of the Fly Ash Pond Dam (Temchin, 1977), the dam (or dike) was constructed by placement of soils in mechanically compacted thin lifts of a foot or less. Construction control of the compaction process was maintained using a method procedure where the soil preparation, placement, watering, blading, final watering, rolling, and lift thickness are specified based on the results of test fill pads conducted prior to start of earthwork (Ebasco, 1977).

In addition to the method controls discussed above, quality control testing consisting of comparison of in-situ measurements of soil density to Standard Proctor maximum dry density, American Society for Testing and MaterialsD 698, was performed at intervals of once every 60,000 square ft of material placed. Results of quality control testing are summarized in Ebasco Drawing APS-2742-SK-CH-J13 (Temchin 1977). The drawing indicates 622 tests were conducted on Clay Core materials with 609 of the tests measuring densities greater than 95 percent of the Standard Proctor maximum density and a mean percent compaction of all tests of 98.9 percent of the standard proctor maximum density. The drawing indicates 811 tests were conducted on the outer shell materials with 748 of the tests measuring densities greater than 100 percent of the Standard Proctor maximum density and a mean percent compaction of all tests of 101.7 percent of the Standard Proctor maximum density.

Based on the compaction method described in the construction summary memorandum and the quality control test results presented in Drawing APS-2742-SK-CH-J13, the Fly Ash Pond Dam has been mechanically compacted to a density sufficient to withstand the range of loading conditions expected at the Fly Ash Pond site.

4.4 Slope Vegetation

Per the requirements 40 CFR *§* 257.73(d)(1)(iv), an existing CCR impoundments must be assessed for "*Vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection*." Note that the United States Court of Appeals for the District of Columbia Circuit remanded with vacatur the phrase "*not to exceed a height of six inches above the slope of the dike*" from this subsection of the Rule.

As noted in Section 4.2, the dam was constructed with a two foot thick layer of random rock fill (riprap) slope protection; therefore, the dam is excluded from the vegetated slope requirements since it uses an alternate form of slope protection.

4.5 Impoundment Capacity

Per the requirements 40 CFR *§* 257.73(d)(1)(v), an existing CCR impoundment must be assessed for "*A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this sections. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section*."

The Fly Ash Pond Dam was constructed without a spillway or other water release structure. To manage flow during the design storm event, the Fly Ash Pond has been designed, constructed, operated, and maintained with sufficient storage volume over and above the maximum permitted storage pool water level at EL 5,114 ft to store the PMF storm water inflow at EL 5,116 ft and to maintain an additional four ft of freeboard; therefore, the Fly Ash Pond impoundment is capable of adequately managing (containing) the flow during and following the peak discharge from the PMF event as required for high hazard potential CCR impoundments.

4.6 Hydraulic Structures

Per the requirements 40 CFR *§* 257.73(d)(1)(vi), an existing CCR impoundments must be assessed for "*Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structures*."

No hydraulic structures are present that underlie the base of the Fly Ash Pond or pass through the Fly Ash Pond Dam.

4.7 Downstream Water Body

Per the requirements 40 CFR *§* 257.73(d)(1)(vii), an existing CCR impoundments must be assessed as follows "*For CCR units with downstream slope which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body*."

No structural stability deficiencies are presently associated with inundation of the downstream slope of the Fly Ash Pond Dam by an adjacent body of water since no pool of water, such as a river, stream or lake, is present downstream of the dam which could inundate the downstream slope.

4.8 Other Issues

In July 1998, transverse and longitudinal cracking was observed along the Fly Ash Pond Dam crest in the vicinity of the Geronimo Knob, the rock outcropping near the center of the dam. A subsequent study of the cracks, consisting of exploration trenches and borings along the crest of the dam, exposed thirty-one (31) visible cracks with six (6) cracks considered "significant" (defined as cracks with widths equal to or greater than ½-inch.) Crack depths ranged from 0.5 to 12 ft below the top of crest (Dames & Moore, 1999). The study postulated the cracking was due to differential settlement of the dam embankment on the sloping bedrock foundation created by the Geronimo Knob (URS, 2001). The dam crest was repaired by re-compaction of the clay core spoils excavated during the trenching. As an additional precaution, the discharge to the impoundment was changed so that deposited fly ash would create a beach that would prevent free water from ponding within 300 ft of the crack area. Since 2002, continued monitoring of the dam crest has noted only minor cracking, most likely associated with surface desiccation typical for embankments in the arid US Southwest. While monitoring of the dam crest for cracking is still performed during the annual dam inspections, the Geronimo Knob crack is considered to have been mitigated by the changed deposition plan, has not reappeared, and it is not considered a continuing dam safety concern or structural integrity deficiency.

No deficiencies were identified for the Fly Ash Pond that could affect the structural stability of the impoundment. However, during the most recent dam inspection (AECOM & APS, 2016), observations of excessive vegetation consisting of small to medium sized desert brush and small animal burrows were noted along the slopes and crest of the Fly Ash Pond Dam. APS work crews subsequently removed part of the vegetation in the identified areas with the remainder scheduled for removal in the upcoming year. Although both the vegetation and the animal burrows were not of sufficient size to cause concern for the stability or erosion of the embankment, failure to promptly identify and correct these issues could lead to eventual deterioration of the embankment slope. It is recommended, therefore, to continue inspection and maintenance activities of the impoundment to identify and correct minor issues in order to prevent progressive deterioration of the embankment.

4.9 Structural Stability Assessment Results

AECOM did not identify any structural stability deficiencies that would affect the structural condition of the Fly Ash Pond CCR Impoundment based on the documents provided and reviewed as part of this assessment. AECOM assesses that the design, construction, operation and maintenance of the Fly Ash Pond are consistent with recognized and generally accepted good engineering practice for the maximum volume of CCR and CCR wastewater which can be impounded therein.

5 Safety Factor Assessment

This section summarizes the safety factor assessment for the Fly Ash Pond. This assessment is intended to satisfy the requirement of Rule 40 CFR *§* 257.73(e).

5.1 Methodology and Design Criteria

Slope stability analyses were performed to document minimum factors of safety for loading conditions identified by 40 CFR *§* 257.73(e) using the software program SLOPE/W (GEO-SLOPE International, 2012). The analyses were performed using Spencer's Method; a limit equilibrium method of slices that satisfies both force and moment equilibrium and incorporates the effects of interslice forces. The analyses incorporate strength and density properties and pore pressure distributions described in Sections 5.4 and 5.5. The slope stability models are presented in Appendix B.

5.2 Critical Cross Section

Safety factors were calculated for three cross sections of the Fly Ash Pond Dam selected to represent different embankment geometries, heights, and stratigraphic conditions to provide confidence that the critical cross section was identified. The critical cross section is the cross section that is anticipated to be most susceptible to structural failure for a given loading condition. The critical cross section thus represents a "most-severe" case. Section locations were selected based on variation in the embankment height, presence of cutoff trench/cutoff wall, and stratigraphic conditions. Subsurface soil profiles were developed using as-built drawings and historical borings reported by Ebasco (1975) and Harza (1987). The locations of the cross sections along the Fly Ash Pond Dam are shown in Figure 5.1. The three cross sections analyzed are:

Fly Ash Pond Cross Section 1: This cross-section corresponds approximately to Section B as shown in Figure 5-1 and on the as-built section (Ebasco, 1977). This section represents the highest dam section where bedrock is shallow and, thus, includes an extension of the embankment clay core forming a cutoff trench that is keyed into bedrock. The embankment is approximately 80 ft high and the upstream and downstream slopes are at 3H:1V. The zoned embankment at this section consists of a sandy lean clay core with an outer clayey sand shell and the foundation consists of about 20 ft of alluvial clays, silts, and sands overlying bedrock consisting of mudstones, siltstones, and sandstones. The clay core extends to form a cutoff trench that is keyed into the top of bedrock.

Approximately 60 ft of hydraulically-placed fly ash is impounded behind the embankment at the Cross Section 1 location, based on comparison between pre-construction topographic survey data (Ebasco, 1975) and topographic survey data collected in 2014 (APS, 2016).

Fly Ash Pond Cross Section 2: This cross-section corresponds approximately to Section D as shown on Figure 5-1 and the as-built section (Ebasco, 1977). This section represents the section at the greatest depth to bedrock. The cross-section is located approximately 50 ft west of a long-standing downstream seep, the Geronimo Seep, which lies near Geronimo Knob. The section includes a cutoff slurry wall beneath the embankment clay core. The embankment is approximately 80 ft high and the upstream and downstream slopes are at 3H:1V. The zoned embankment at this section consists of a sandy lean clay core with an outer clayey sand shell and the foundation consists of approximately 52 ft of alluvial overburden (clays, silts, and sands) overlying interbedded layers of mudstone, siltstone, and sandstone bedrock.

Approximately 60 ft of hydraulically-placed fly ash is impounded behind the embankment at the Cross Section 2 location, based on comparison between pre-construction topographic survey data (Ebasco 1975) and topographic survey data collected in 2014 (APS, 2016). Calculated factors of safety for Section 2 were lower than those calculated for Sections 1 and 3. Section 2 is, therefore, designated the critical cross section.

Fly Ash Pond Cross Section 3: This cross section corresponds approximately to Section E as shown on Figure 5-1 and the as-built section (Ebasco, 1977). At this cross section location, the Fly Ash Pond intersects Geronimo Knob along its downstream slope. This section includes an extension of the embankment clay core forming a cutoff trench that is keyed into bedrock. The embankment is approximately 68 ft high and the upstream and downstream slopes are at 3H:1V. The zoned embankment at this section consists of a sandy lean clay core with an outer clayey sand shell and the foundation consists of approximately four to nine ft of alluvial overburden (clays, silts, and sands) overlying interbedded layers of mudstone, siltstone, and sandstone bedrock.

Approximately 50 ft of hydraulically-placed fly ash is impounded behind the embankment at the Cross Section 3 location, based on comparison between pre-construction topographic survey data (Ebasco, 1975) and topographic survey data collected in 2014 (APS, 2016).

5.3 Subsurface Stratigraphy

Idealized models of subsurface stratigraphic conditions for each cross section were developed based on design drawings (Ebasco, 1977) and previous geotechnical site investigations (Ebasco, 1975, Harza, 1987, and Dames & Moore, 1999). The following stratigraphic units were used to develop SLOPE/W models for each cross section:

Embankment Core: The zoned embankment includes a central impervious clay core with 1H:1V side slopes and a clay cap at the embankment crest. Fine-grained material was obtained from upstream borrow pits along the dam alignment and mechanically compacted in lifts to construct the clay core. The clay core soils consist predominately of Sandy Lean Clay (CL) with isolated zones of Sandy Fat Clay (CH) based on the Unified Soil Classification System (USCS).

Embankment Shell (Random Zone): The zoned embankment includes a more pervious zone of random material, or shell that flanks the clay core to support and protect the impervious core. The shell provides stability against rapid drawdown (upstream shell) and drainage (downstream shell). Shell material was obtained from upstream borrow pits along the dam alignment and mechanically compacted in lifts. Shell soils consist predominately of Silty Sand (SM), Clayey Sand (SC), and Sandy Lean Clay (CL) based on the USCS.

Alluvium: Alluvial deposits overlie the bedrock beneath the embankment and are the foundation bearing layer over most of the embankment alignment. The alluvium consists of a Quaternary Age, heterogeneous mixture of unconsolidated clays, silts, and sands deposited by flows in an unnamed tributary to the Little Colorado River prior to the construction of the Fly Ash Pond.

Bedrock: Bedrock beneath the embankment consists of mudstones, siltstones, and sandstones of the Triassic-age Chinle and Moenkopi Formations.

Slurry Cutoff Wall: A slurry cutoff wall was constructed using soil-bentonite slurry where the depth to bedrock is greater than 20 ft and extended into either the bedrock or dense clay soils.

Fly Ash: Fly ash waste product from the power generating process is pumped from the plant to the Fly Ash Pond and allowed to settle hydraulically.

5.4 Material Properties

Material properties for soil, rock and embankment construction materials were developed based on an analysis and interpretation of historical geologic and geotechnical data presented in:

- Ebasco Services Inc., “Arizona Public Services Cholla Generating Station Ash Disposal Sites Seepage and Foundation Studies: Volume I of II Engineering Report” (Ebasco, 1975),
- Harza Engineering Company, “Safety Inspection Report on Fly Ash Dam, Bottom Ash Dam, and Cooling Dike” (Harza, 1987), and
- Dames & Moore, ” Interim Report, Geotechnical Investigation for Evaluation of Dam Embankment Crack, Fly Ash Pond Dam, Cholla Power Plant, Joseph City, Arizona” (Dames & Moore, 1999).

The material properties developed by the dam designers and subsequent investigators were assessed for reliability and applicability to this safety factor assessment. The design report (Ebasco, 1975) indicated that soil strength parameters were obtained from laboratory testing. Specific details of the soil strength property derivations used for the original design stability analyses were not provided in the design report. The Harza investigation (1987) included more detailed documentation of the laboratory testing, soil strength derivations, and stability analyses performed in 1987. The parameters developed by Harza were used in subsequent stability analyses performed by Dames & Moore (1991). AECOM assessed the historical soil strength data and parameters used by previous investigators and found the Harza (1987) data to be the most reliable and applicable to this safety factor assessment.

The material properties selected for use in the slope stability analyses of the Fly Ash Pond Dam are presented in Table 5-1. The drained strength values presented in Table 5-1 were taken from Harza (1987). The undrained strength value presented in Table 5-1 for the Embankment Core was derived by AECOM based on interpretation of the Harza Triaxial Compression Test data. Undrained strength properties were not needed for other material types for the safety factor calculations. Moist unit weight values used in this safety factor assessment were taken from Dames & Moore (1991); saturated unit weights were interpreted by AECOM based on the moist unit weights and material types reported by previous investigators. The Fly Ash unit weight was selected by AECOM to be 90 pounds per cubic foot (pcf) based on engineering experience with similar materials.

Table 5-1. Selected Material Parameters – Fly Ash Pond Safety Factor Assessment

Material	Saturated Unit Weight, γ_{sat} (pcf)	Moist Unit Weight, γ_m (pcf)	Effective Strengths		Total Strengths	
			Cohesion, c' (psf)	Friction Angle, ϕ' (degrees)	Undrained Strength, S_u (psf)	Undrained Strength Ratio
Embankment Core	125	120	0	28	-	0.38
Embankment Shell	130	125	0	33	-	-
Alluvium	120	120	0	26	-	-
Bedrock	150	150	1,000	65	-	-
Slurry Cutoff Wall	106	106	0	28	10	-
Fly Ash	90	90	0	0	-	-

5.5 Embankment Pore Pressure Distribution

Water levels have been historically monitored weekly to quarterly and are now monitored on an interval not exceeding 30 days in piezometers installed along or near the Fly Ash Pond and reported annually in an inspection report (AECOM & APS, 2016). These data were considered to be the most reliable indicators of pore pressure distribution within the Fly Ash Pond Dam embankment. The pore pressure distributions were estimated for each section using water level measurements obtained from:

- Cross Section 1: Piezometers F-93, F104, and F-105;
- Cross Section 2: Piezometers F-90, F-91, F-92, F-109, F-110, F-132, and F-134;
- Cross Section 3: Piezometers F-112, F-127, F-128, F-129, and F-130.

Piezometer locations are shown on Figure 1-2. Piezometer data were used, along with pond water level under steady-state, maximum permitted storage pool conditions (ADWR, 1986), and pond water levels under maximum surcharge pool conditions (Ebasco, 1975) to estimate pore pressure distributions within the embankment sections.

The pore water levels measured in the piezometers near Cross Section 2 reflect the influence of the Geronimo Seep collection system. The collection system consists of an underground French drain system and wellpoints and has been in continuous operation since the early 1990s. The seep collection system presumably lowers the phreatic water level at the downstream toe of the dam in the vicinity of the wellpoints. Since the radial influence of the collection system is not documented, a conservative assumption of a non-operational Geronimo Seep seepage collection system was used in the stability analysis of

Cross Section 2. This assumption corresponds to the condition of raising the water level downstream of the dam to near the ground surface.

5.6 Embankment Loading Conditions

Per 40 CFR § 257.73(e)(1)(i) through (iv), the following loading conditions were analyzed for each developed stability cross section:

- Long-term, maximum storage pool
- Maximum surcharge pool
- Seismic loading, and
- Liquefaction

These loading conditions are described in the following sub-sections.

Long-Term, Maximum Storage Pool: The maximum storage pool loading is the maximum water level that will be maintained for a sufficient length of time for steady-state seepage or hydrostatic conditions to develop within the embankment. This loading condition is evaluated to document whether the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading.

The long-term, maximum storage pool loading condition was evaluated using the permitted water level of the pond, as stated in the ADWR operating license for the dam. Since the dam has no outlet structure and relies on pumping rate from plant, seepage, and evaporation to control water levels, the maximum storage pool was set at the maximum ADWR-permitted water levels. For the Fly Ash Pond, the safety factor was calculated for the long-term maximum storage pool at EL 5,114 ft (ADWR, 1985).

Maximum Surcharge Pool: The maximum surcharge pool loading is the temporary rise in pool elevation above the maximum storage pool elevation to which the CCR surface impoundment could be subject under inflow design flood state. This loading condition is evaluated to document whether the downstream slope of the CCR surface impoundment embankment can withstand the short-term impact of a raised pool level.

The maximum surcharge pool considers a temporary pool elevation that is higher than the maximum storage pool that persists for a length of time sufficient for steady-state seepage or hydrostatic conditions to fully develop within the embankment. The maximum surcharge pool loading condition was evaluated using the expected water level raise during the design PMF of 2.0 ft (Ebasco, 1976). For the Fly Ash Pond, the safety factor was calculated for the maximum surcharge pool at EL 5,116 ft.

Seismic Loading: Seismic loading is evaluated to document whether the embankment is capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of contents. The seismic loading condition is assessed for a seismic loading event with a two percent probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years. A pseudo-static analysis was used to represent the seismic loading condition.

The seismic response of soil embankments is incorporated into the analysis method by adding a horizontal force to simulate the seismic force acting on the embankment during an earthquake. The horizontal force is applied in the pseudo-static analyses through the addition of a seismic coefficient into the limit equilibrium calculations. The seismic coefficient was selected using the following procedure:

1. Determine the peak horizontal ground acceleration (PGA) generated in bedrock at the site by an earthquake having the 2% probability of exceedance in 50 years;

2. Select a Site Class, per International Building Code definitions, which incorporates the effects of seismic wave propagation through the top 100 ft of the soil profile above bedrock, and calculate the adjusted for Site Class effects, PGA_M;

3. Calculate the maximum transverse acceleration at the crest of the embankment, PGA_{crest}, using the PGA_M from step two; and

4. Adjust the PGA_{crest} using the method developed by Makdisi and Seed (1977) to account for the variation of induced average acceleration with embankment depth to calculate the seismic coefficient.

Each of these steps is discussed in more detail in the calculation presented in Appendix B. The maximum average acceleration for the potential sliding mass was incorporated into the pseudo-static safety factor analyses as the horizontal seismic coefficient equal to 0.13, corresponding to the calculated, adjusted PGA_{crest} value.

The water level in the Fly Ash Pond for the seismic loading analysis was set to EL 5,114 ft to match the long-term, maximum storage pool. The Clay Core and Cutoff Wall materials were assigned total strengths because it is anticipated that they would behave in an undrained manner due to the relatively rapid loading induced during the seismic event and the relatively low hydraulic conductivity of these materials. All, other materials used effective strength parameters.

Liquefaction: The liquefaction factor of safety is evaluated for CCR embankments and foundation soils that are believed to be susceptible to liquefaction based on representative soil sampling and construction documentation or anecdotal evidence from personnel with knowledge of the CCR unit's construction., The liquefaction factor of safety is calculated to document whether the CCR unit would remain stable if the soils in the embankment and/or foundation experienced liquefaction.

Post-construction geotechnical exploration of the Fly Ash Pond Dam (Harza, 1987 and Dames & Moore, 1999) indicated the Clay Core (embankment) and Alluvium Overburden (foundation) materials have plasticity indexes and fine contents as shown in Table 5-2. Data are not presented in Table 5-2 for the Embankment Shell material because of limited available geotechnical data because the Embankment Shell material was sourced from the Alluvium Overburden and is anticipated to have similar properties. Generally, the behavior of soils that have fines contents greater than 35 percent are dominated by the plasticity of the fines (Idriss and Boulanger, 2008). Fines with Plasticity Indices (PI) less the seven tend to behave more sand-like and are susceptible to soil liquefaction, while those with PI greater than seven tend to behave more clay-like and are not susceptible to liquefaction. The lowest measured value of PI for both the Clay Core and Alluvium Overburden is 12, indicating these soils would tend to behave in a clay-like manner during a seismic event and not be susceptible to soil liquefaction. Therefore, a liquefaction factor of safety analysis was not assessed as being necessary and was not performed for this impoundment.

Table 5-2. Range of Plasticity Index and Fines Content Values for Site Materials

Material	Plasticity Index, %		Fines Contents, %	
	Minimum Value	Maximum Value	Minimum Value	Maximum Value
Clay Core	12	39	48	88
Alluvium Overburden	12	17	30	54

5.7 Safety Factor Assessment Results

Table 5-3 summarizes the results of the safety factor analysis for the Fly Ash Pond Dam, for a more detailed discussion of the results see the safety factor calculation presented in Appendix B.

Table 5-3. Summary of Calculated Safety Factors

Loading Condition	Required Safety Factor[1]	Calculated Safety Factor		
		Section 1	Section 2	Section 3
Long-term, maximum storage pool	1.50	1.63	1.53	1.73
Maximum surcharge pool	1.40	1.61	1.52	1.70
Seismic	1.00	1.08	1.02	1.15

Notes: [1] From 40 CFR § 257.73(e)(1)(i) through (iii) (EPA, 2015)

The calculated factors of safety for the three critical cross sections along the Fly Ash Pond Dam exceeded the required minimum values for the long-term, maximum storage pool; the maximum surcharge pool; and the seismic (pseudo-static) loading conditions.

6 Conclusions

Based on the findings and results of the structural integrity assessment, AECOM provides the following conclusions regarding the structural integrity of the Fly Ash Pond at the Cholla Power Plant.

- The Fly Ash Pond is classified as a High Hazard Potential CCR surface impoundment.
- The embankment is founded on stable foundations and abutments. Seepage is limited by a clay core that extends to the bedrock in shallow locations or a cutoff slurry wall where the depth to bedrock is greater than 20 ft. Downstream seeps exist and are captured and monitored by drainage systems typically consisting of French drains connected to sumps.
- The embankment has adequate slope protection consisting of riprap on both the upstream and downstream slopes.
- Based on the available quality control test results, the Fly Ash Pond Dam embankment was mechanically compacted to a density sufficient to withstand the range of loading conditions anticipated at the site.
- The Fly Ash Pond impoundment is capable of adequately managing the flow during and following the peak discharge from the PMF event without a spillway or other water release structures because the pond has been designed, constructed, operated, and maintained with sufficient storage volume above the maximum storage pool water level to store the PMF inflow and maintain at least four ft of freeboard.
- Factors of safety greater than the minimum values required by the CCR Rule were calculated for three cross sections along the Fly Ash Pond Dam for loading conditions associated with the maximum storage pool water level, maximum surcharge pool water level, and design level seismic event. The liquefaction factor of safety of the impoundment was not analyzed due to the low potential for soil liquefaction of the embankment and foundation soils as determined from index test results.
- Based on review of available records concerning the Fly Ash Pond and the results of the stability analyses, no deficiencies were noted that would affect the structural condition of the dam.

7 Limitations

This report is for the sole use of APS on this project only, and is not to be used for other projects. In the event that conclusions based upon the data obtained in this report are made by others, such conclusions are the responsibility of others. The Initial Structural Stability Assessment presented in this report was based on available information identified in Reference Section of the report that AECOM has relied on but not independently verified. Therefore, the Certification of Professional Opinion is limited to the information available to AECOM at the time the Assessment was performed in accordance with current practice and the standard of care. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period. Professional judgments presented herein are primarily based on information from previous reports that were assumed to be accurate, knowledge of the site, and partly on our general experience with dam safety evaluations performed on other dams. No warranty or guarantee, either written or implied, is applicable to this work.

The use of the words “certification” and/or “certify” in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

8 References

Arizona Department of Water Resources (ADWR), 1986, License of Approval, Cholla Fly Ash Pond Dam and Reservoir, State File No. 09.28, October 21.

AECOM and Arizona Public Services Company (APS), 2016, “Cholla Power Plant Fly Ash Pond, Bottom Ash Pond, Sedimentation Pond and Bottom Ash Monofill: Annual CCR Impoundment and Landfill Report 2015”, January.

APS, 2016, “Cholla Power Plant Bottom and Fly Ash Ponds & Cooling Reservoir Basic Data Report. “Cooper Aerial Surveys Co., 2014, “Cholla Ash 2014: June 13, 2009 Topographic Mapping,” Prepared for Arizona Public Service Company, Drawing No. 1, Sheet No. 1.

Arizona Water Commission, 1976, “Summary of Review of Plans and Specifications of Proposed Bottom Ash Dam (9-27) and Fly Ash Dam (9-28) by J.D. Walters and W.C. Jenkins.” Division of Dam Safety, March 31.

Dames & Moore, 1999, “Interim Report, Geotechnical Investigation for Evaluation of Dam Embankment Crack, Fly Ash Pond Dam, Cholla Power Plant, Joseph City, Arizona,” Prepared for Arizona Public Service Company, D&M Job No. 02353-143-022, May 9.

Ebasco Services Inc. (Ebasco), 1975, “Arizona Public Services Cholla Generating Station Ash Disposal Sites Seepage and Foundation Studies: Volume I of II Engineering Report,” Prepared for Arizona Public Service Company, August.

Ebasco, 1976, “Arizona Public Services Cholla Steam Electric Station, Flood Routing Studies for Bottom Ash and Fly Ash Ponds,” May.

Ebasco, 1977, “Ash Disposal System: Fly Ash Pond Dike – Sections & Details,” Prepared for Arizona Public Service Company, APS Drawing No. G-44558 Revision No. 10 (As Built), November 9.

Ebasco, 1977, “Arizona Public Services Cholla Steam Electric Station Units 2, 3, & 4 Ash Pond Construction, November 1977 – Final Report,” December 5.

GEOSLOPE International, 2012, GeoStudio 2012, Version 8.15.4.11512, August 2015 Release.

Harza Engineering Company (Harza), 1987, “Cholla S.G.S., Safety Inspection Report on Fly Ash Dam, Bottom Ash Dam, and Cooling Dike,” Prepared for Arizona Public Service Company, February 27.

Idriss, I.M. and Boulanger, R.W., 2008, “Soil Liquefaction During Earthquakes,” Earthquake Engineering Research Institute, Monograph No MNO-12.

Makdisi, F.I. and Seed, H.B., 1977, “A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments,” Report No. UCB/EERC-77/19, University of California, Berkeley, August.

Temchin, M., 1977, “Arizona Public Service Company Cholla Steam Electric Station Units 2, 3, & 4 Ash Pond Construction November 1977 – Final Report,” Memorandum to G.W. Strengham of Arizona Public Service, Ebasco Services Inc., December 5.

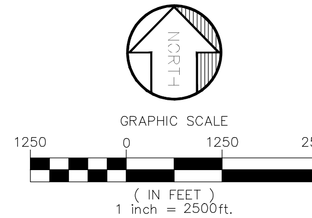
United States Environmental Protection Agency (EPA), 2015, 40 CFR Parts 257 and 261 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, Federal Register Vol. 80, No. 74, April 17.

United States Geological Survey (USGS), 2013, 7.5-Minute Series Joseph City, AZ Quadrangle Map

URS Corporation (URS), 2001, "Transverse Crack Evaluation and Monitoring for Fly Ash Pond Dam Arizona Public Services Cholla Power Plant Joseph City, Arizona," Prepared for Arizona Public Service Company, URS Job No. 02353-160-058, October 12.

Figures

Last saved by: ALEISA_KRUG(2016-06-16) Last Plotted: 2016-06-16
Filename: P:\ARIZONA PUBLIC SERVICE\60445840_APS_CHOLLA_STRUCTURAL_INTEGRITY\CADD FILES\FIGURES\FIGURE 1-1_SITE VICINITY MAP.DWG



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SITE VICINITY MAP

AECOM

FIGURE 1-1

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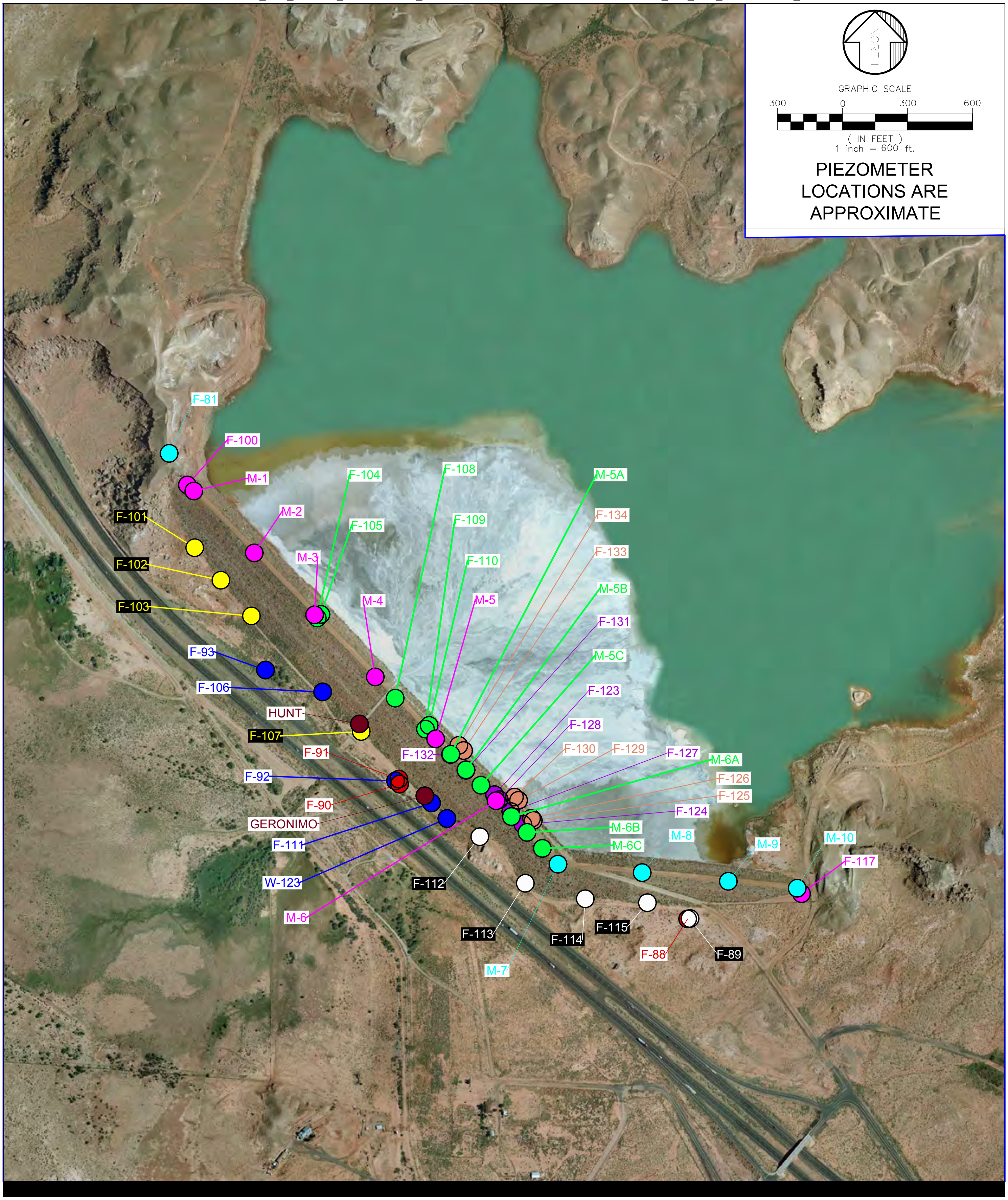
Filename: P:\ARIZONA PUBLIC SERVICE\60445840_APS_CHOLLA_STRUCTURAL_INTEGRITY\CADD FILES\FIGURES\FIGURE 1-2_FLY_ASH_INSTRUMENT_LOCATIONS.DWG



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FLY ASH POND
MONITORED INSTRUMENTATION
AND SEEPAGE LOCATION MAP

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FIGURE 1-2

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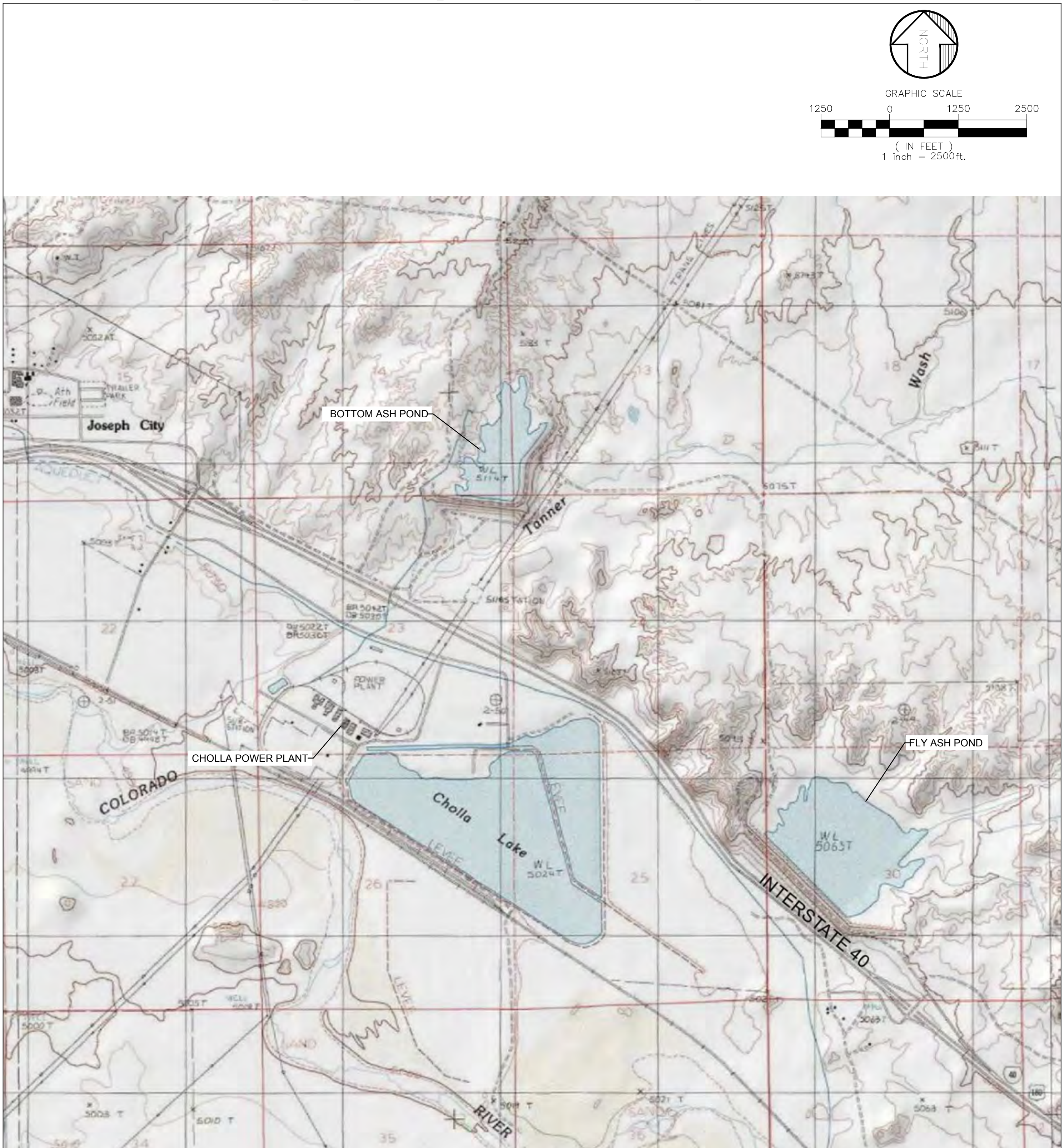
Filename: P:\ARIZONA PUBLIC SERVICE\60445840_APS_CHOLLA_STRUCTURAL_INTEGRITY\CADD FILES\FIGURES\FIGURE 4-1_SITE TOPO MAP.DWG



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SITE TOPOGRAPHIC MAP

FIGURE 3-1

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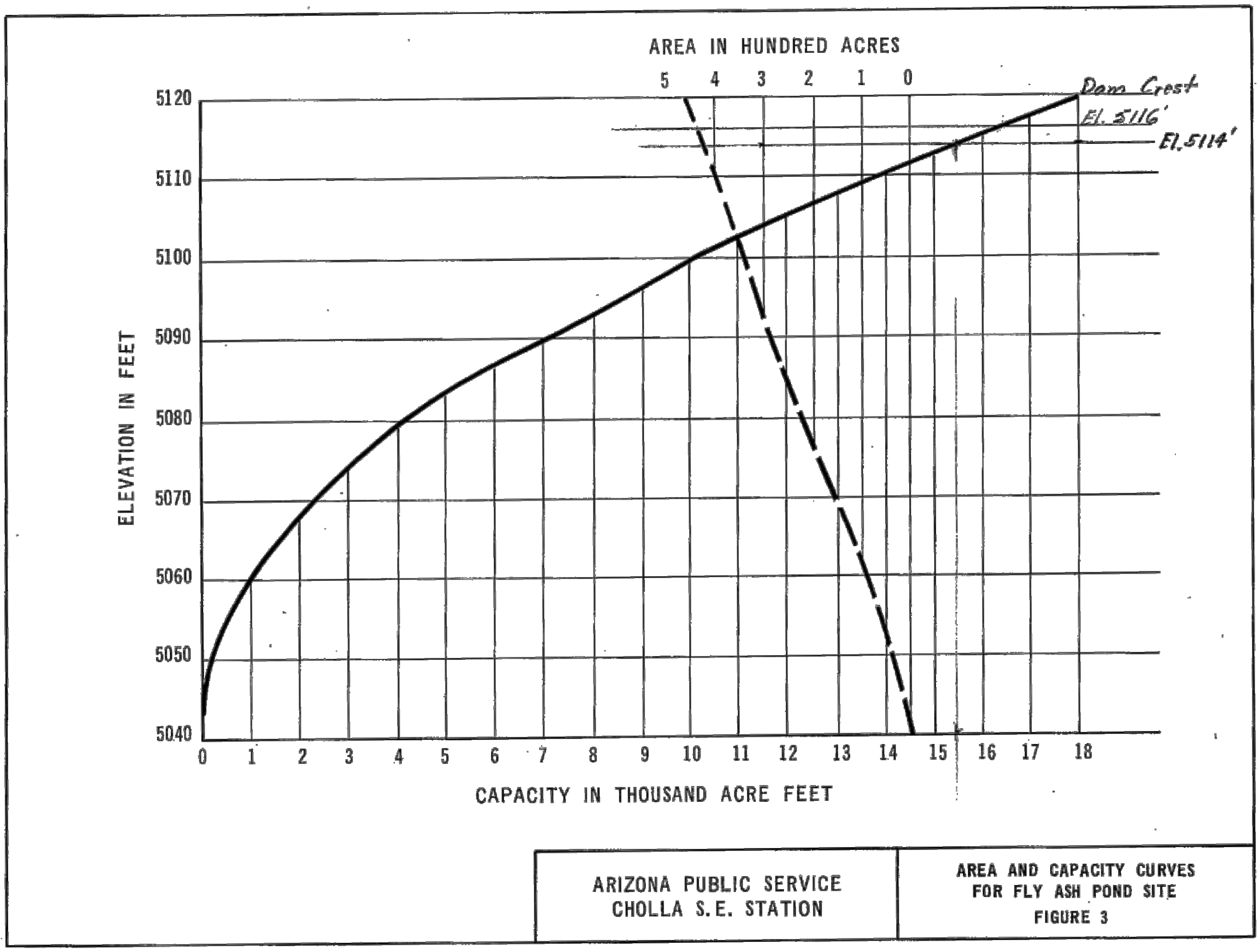
Filename: P:\ARIZONA PUBLIC SERVICE\60445840_APS_CHOLLA_STRUCTURAL_INTEGRITY\CADD FILES\FIGURES\FIGURE 4-2_AREA CAPACITY CURVE_JSK.DWG



SOURCE:

SEEPAGE AND FOUNDATION STUDIES: VOLUME I OF II ENGINEERING REPORT (EBASCO,1975)

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Filename: P:\ARIZONA PUBLIC SERVICE\60445840_APS_CHOLLA_STRUCTURAL_INTEGRITY\CADD FILES\FIGURES\FIGURE 5-1_CROSS SECTION LOCATIONS SFA - FAP.DWG
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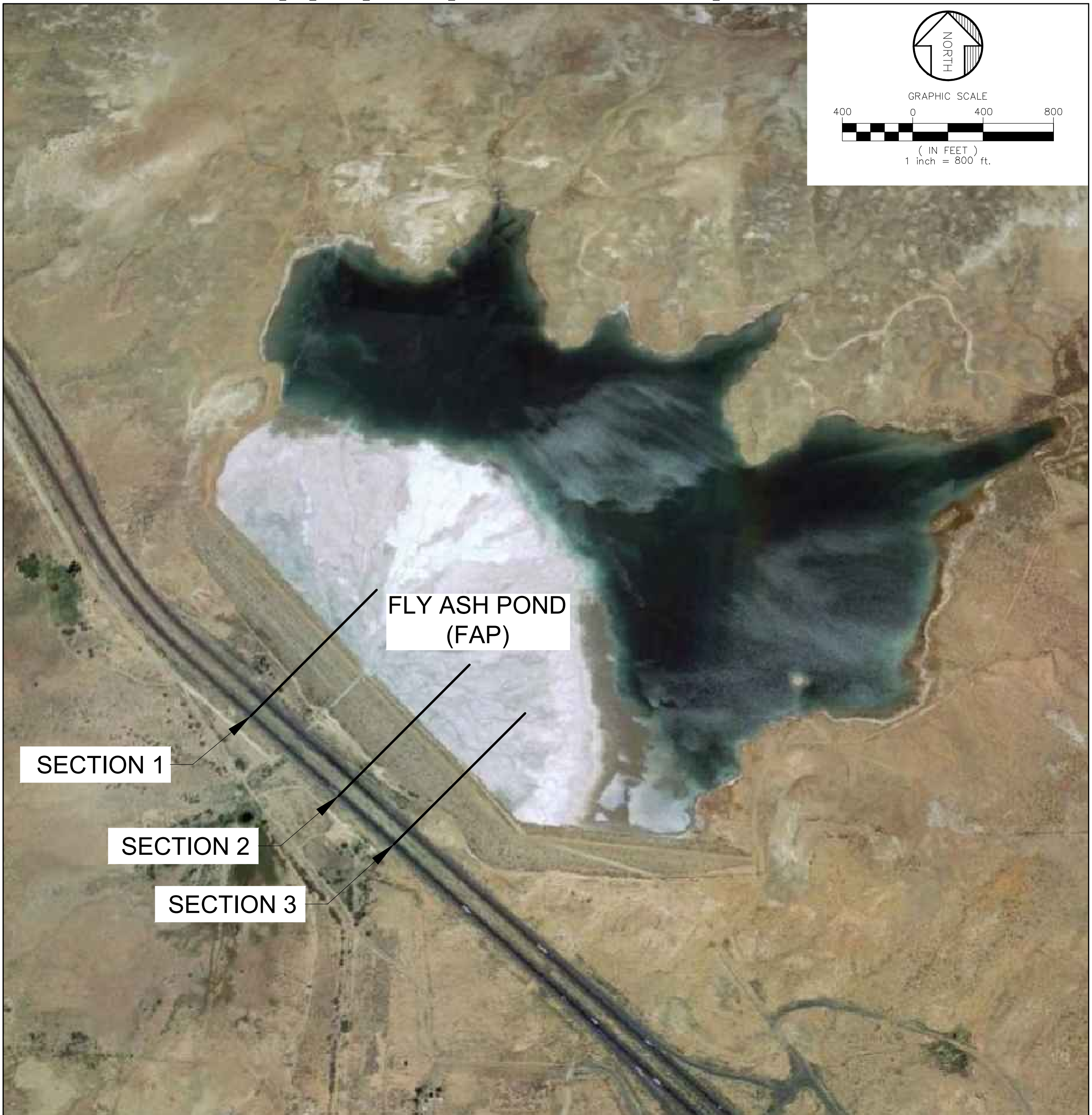

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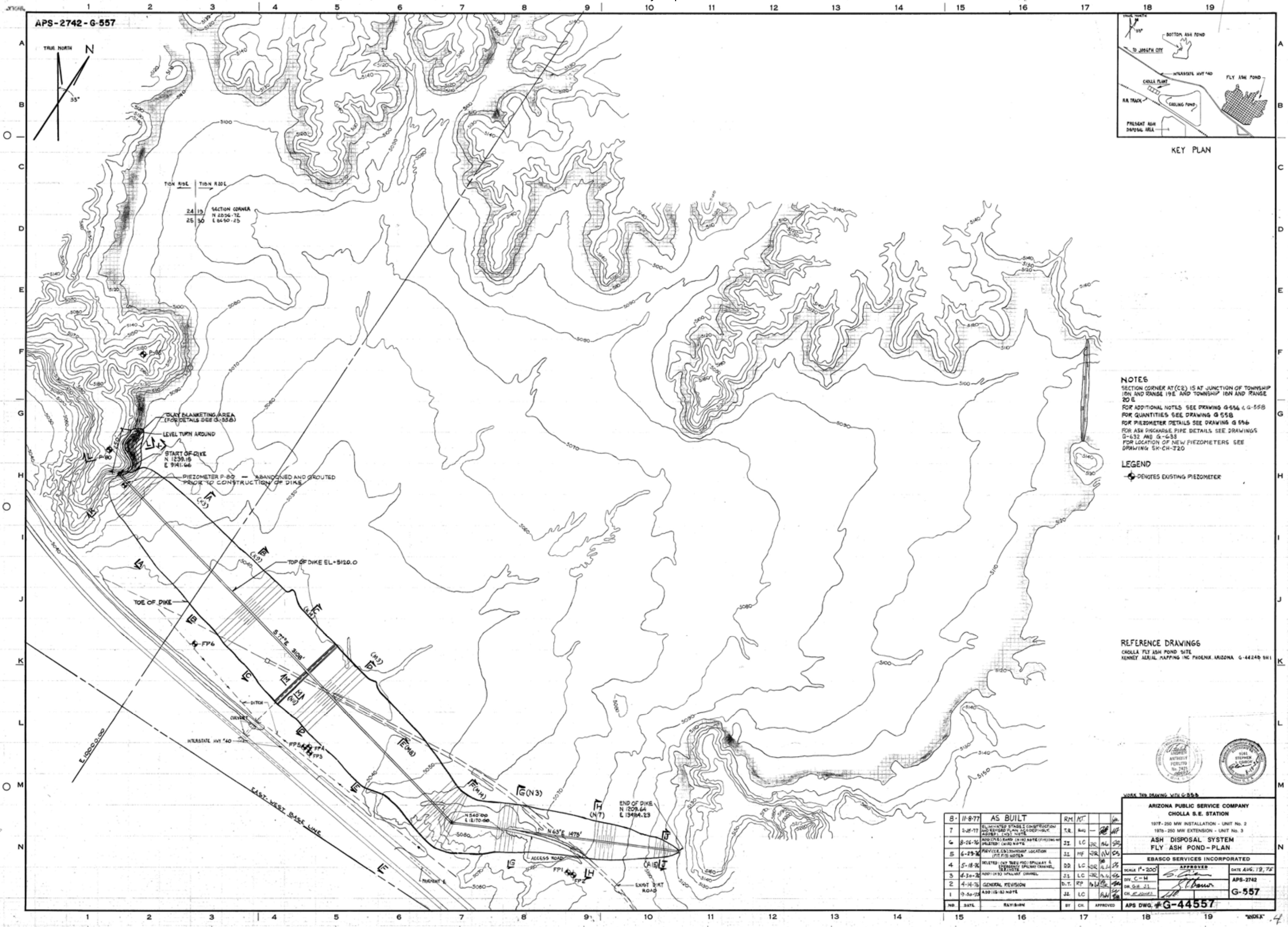
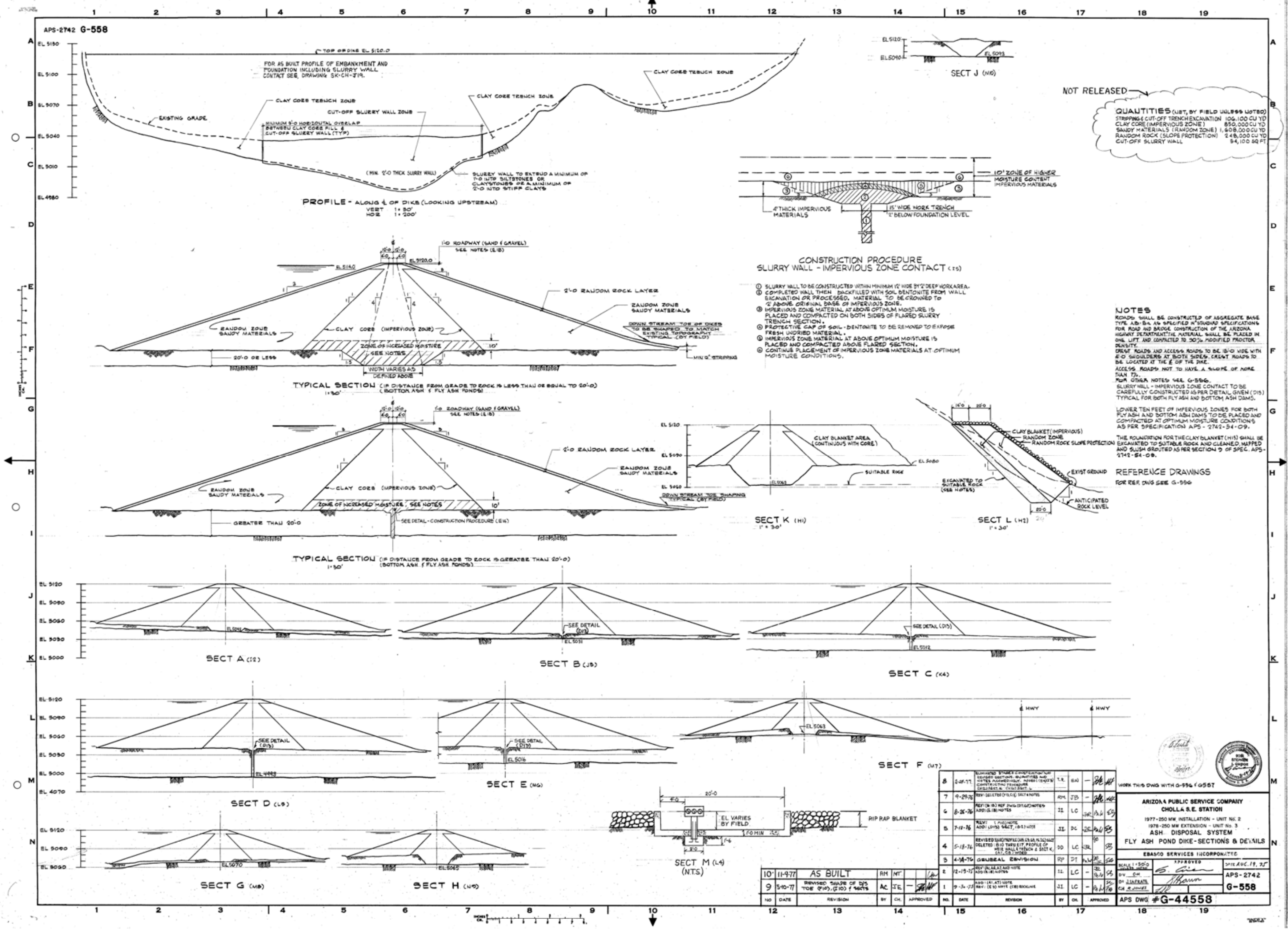
CROSS SECTION LOCATIONS
SAFETY FACTOR ASSESSMENT

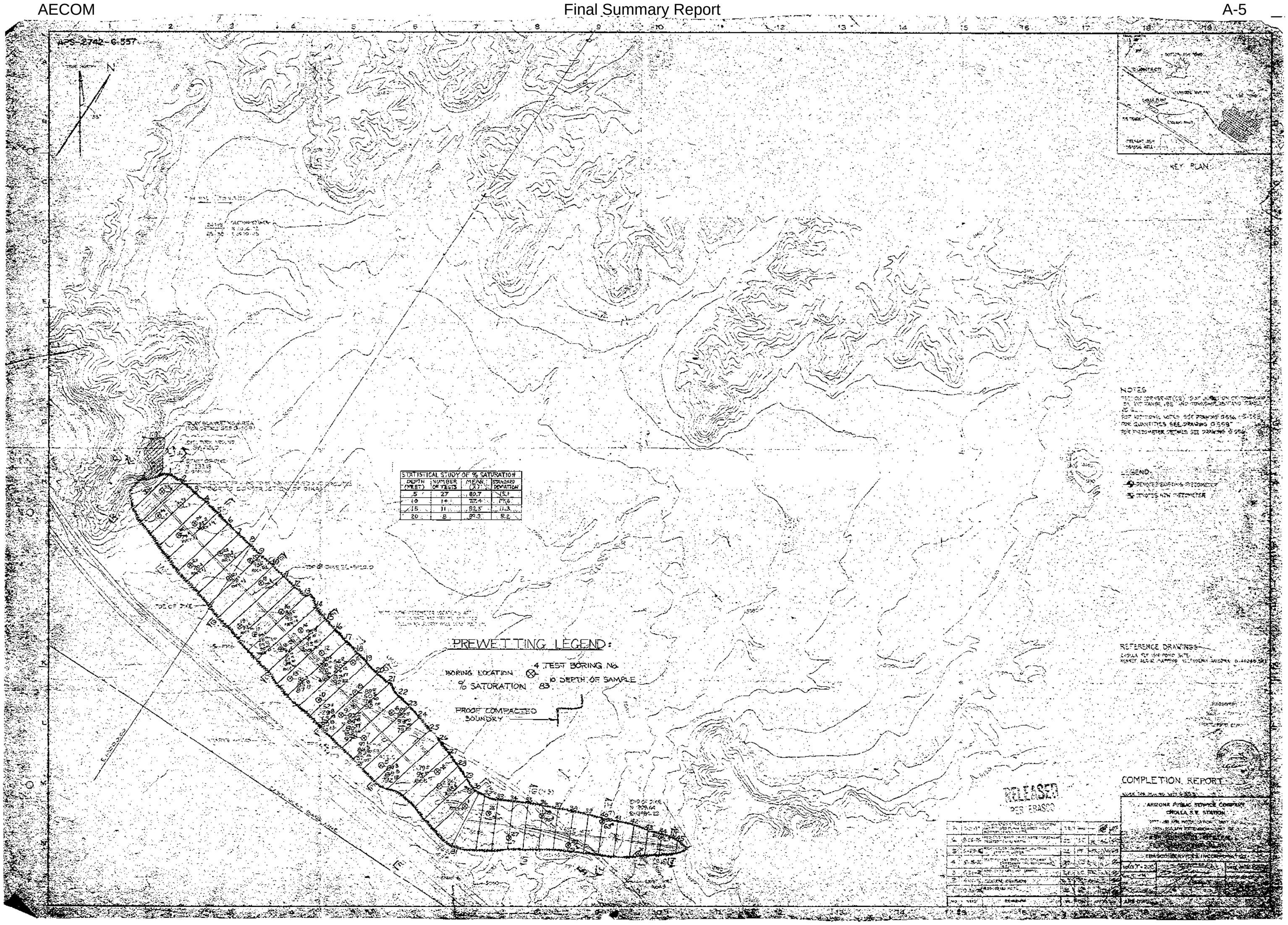
AECOM

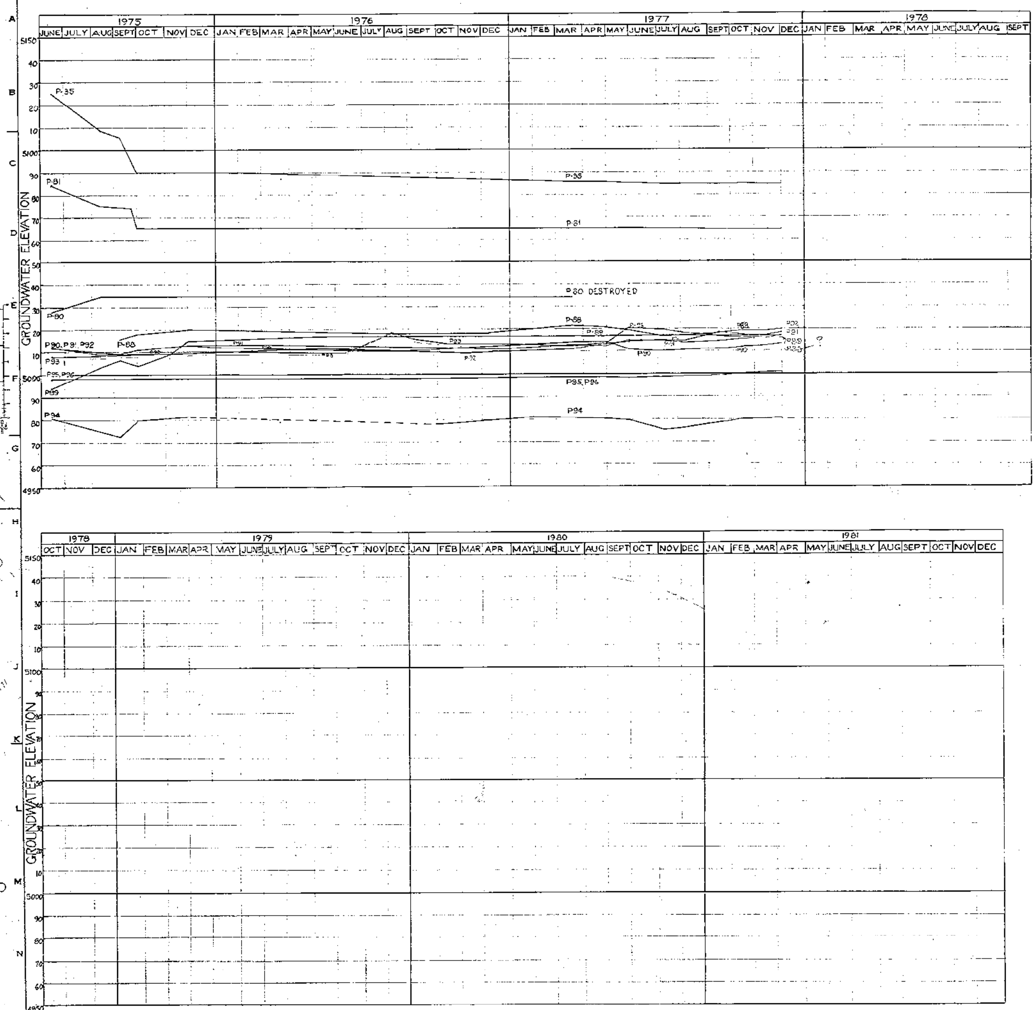
FIGURE 5-1

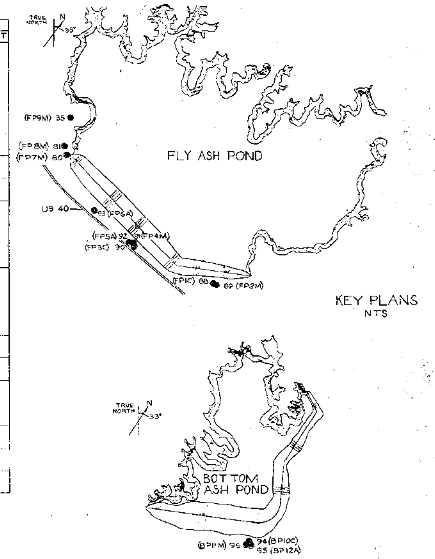
Appendix A. Historic Drawings


APS-2742-G-557
TRUE NORTH
N
KEY PLAN
BOTTOM ASH POND
TO JOSEPH CITY
INTERSTATE HWY 40
CHOLLA PLANT
FLY ASH POND
R.R. TRACK
COOLING POND
PRESENT ASH DISPOSAL AREA
T19N R19E | T18N R20E
SECTION CORNER
CLAY BLANKETING AREA (FOR DETAILS SEE G-558)
LEVEL TURN AROUND
START OF DIKE
PIEZOMETER P-80 — ABANDONED AND GROUTED PRIOR TO CONSTRUCTION OF DIKE
TOP OF DIKE EL=5120.0
TOE OF DIKE
DITCH
CULVERT
INTERSTATE HWY 40
EAST-WEST BASE LINE
END OF DIKE
ACCESS ROAD
EXIST DIRT ROAD
NOTES
SECTION CORNER AT (C2) IS AT JUNCTION OF TOWNSHIP 18N AND RANGE 19E AND TOWNSHIP 18N AND RANGE 20E
FOR ADDITIONAL NOTES SEE DRAWING G-556 & G-558
FOR QUANTITIES SEE DRAWING G 558
FOR PIEZOMETER DETAILS SEE DRAWING G 556
FOR ASH DISCHARGE PIPE DETAILS SEE DRAWINGS G-632 AND G-633
FOR LOCATION OF NEW PIEZOMETERS SEE DRAWING SK-CH-J20
LEGEND
DENOTES EXISTING PIEZOMETER
REFERENCE DRAWINGS
CHOLLA FLY ASH POND SITE
KENNEY AERIAL MAPPING INC PHOENIX, ARIZONA G-44246 SH1
WORK THIS DRAWING WITH G-558
8 11-8-77 AS BUILT
2 4-14-76 GENERAL REVISION
NO. DATE REVISION BY CH. APPROVED
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1977 - 250 MW INSTALLATION - UNIT No. 2
1978 - 250 MW EXTENSION - UNIT No. 3
ASH DISPOSAL SYSTEM
FLY ASH POND - PLAN
EBASCO SERVICES INCORPORATED
SCALE 1" = 200'
APPROVED
DATE AUG. 19, 75
APS-2742
G-557
APS DWG. # G-44557
"INDEX"


APS-2742 G-558
TOP OF DIKE EL 5120.0
FOR AS BUILT PROFILE OF EMBANKMENT AND FOUNDATION INCLUDING SLURRY WALL CONTACT SEE DRAWING SK-CH-319.
CLAY CORE TRENCH ZONE
CUT-OFF SLURRY WALL ZONE
EXISTING GRADE
MINIMUM 5'-0 HORIZONTAL OVERLAP BETWEEN CLAY CORE FILL & CUT-OFF SLURRY WALL (TYP)
(MIN. 2'-0 THICK SLURRY WALL)
SLURRY WALL TO EXTEND A MINIMUM OF 1'-0 INTO SILTSTONES OR CLAYSTONES OR A MINIMUM OF 2'-0 INTO STIFF CLAYS
PROFILE - ALONG ℄ OF DIKE (LOOKING UPSTREAM)
VERT 1" = 30'
HOR 1" = 200'
SECT J
NOT RELEASED
QUANTITIES (NET, BY FIELD UNLESS NOTED)
STRIPPING & CUT-OFF TRENCH EXCAVATION 106,100 CU YD
CLAY CORE (IMPERVIOUS ZONE) 850,000 CU YD
SANDY MATERIALS (RANDOM ZONE) 1,608,000 CU YD
RANDOM ROCK (SLOPE PROTECTION) 248,000 CU YD
CUT-OFF SLURRY WALL 94,100 SQ FT
10' ZONE OF HIGHER MOISTURE CONTENT IMPERVIOUS MATERIALS
4' THICK IMPERVIOUS MATERIALS
15' WIDE WORK TRENCH
2' BELOW FOUNDATION LEVEL
CONSTRUCTION PROCEDURE
SLURRY WALL - IMPERVIOUS ZONE CONTACT (I5)
① SLURRY WALL TO BE CONSTRUCTED WITHIN MINIMUM 12' WIDE BY 2' DEEP WORK AREA.
② COMPLETED WALL THEN BACKFILLED WITH SOIL BENTONITE FROM WALL EXCAVATION OR PROCESSED. MATERIAL TO BE CROWNED TO 2' ABOVE ORIGINAL BASE OF IMPERVIOUS ZONE.
③ IMPERVIOUS ZONE MATERIAL AT ABOVE OPTIMUM MOISTURE IS PLACED AND COMPACTED ON BOTH SIDES OF FLARED SLURRY TRENCH SECTION.
④ PROTECTIVE CAP OF SOIL-BENTONITE TO BE REMOVED TO EXPOSE FRESH UNDRIED MATERIAL.
⑤ IMPERVIOUS ZONE MATERIAL AT ABOVE OPTIMUM MOISTURE IS PLACED AND COMPACTED ABOVE FLARED SECTION.
⑥ CONTINUE PLACEMENT OF IMPERVIOUS ZONE MATERIALS AT OPTIMUM MOISTURE CONDITIONS.
1'-0 ROADWAY (SAND & GRAVEL) SEE NOTES (E18)
2'-0 RANDOM ROCK LAYER
RANDOM ZONE SANDY MATERIALS
CLAY CORE (IMPERVIOUS ZONE)
ZONE OF INCREASED MOISTURE SEE NOTES
DOWN STREAM TOE OF DIKES TO BE SHAPED TO MATCH EXISTING TOPOGRAPHY TYPICAL (BY FIELD)
MIN 2' STRIPPING
20'-0 OR LESS
WIDTH VARIES AS DEFINED ABOVE
TYPICAL SECTION (IF DISTANCE FROM GRADE TO ROCK IS LESS THAN OR EQUAL TO 20'-0) (BOTTOM ASH & FLY ASH PONDS)
NOTES
ROADS SHALL BE CONSTRUCTED OF AGGREGATE BASE TYPE AB-B4 AS SPECIFIED IN "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION OF THE ARIZONA HIGHWAY DEPARTMENT" THE MATERIAL SHALL BE PLACED IN ONE LIFT AND COMPACTED TO 90% MODIFIED PROCTOR DENSITY.
CREST ROADS AND ACCESS ROADS TO BE 15'-0 WIDE WITH 4'-0 SHOULDERS AT BOTH SIDES. CREST ROADS TO BE LOCATED AT THE ℄ OF THE DIKE.
ACCESS ROADS NOT TO HAVE A SLOPE OF MORE THAN 7%.
FOR OTHER NOTES SEE G-556.
SLURRY WALL - IMPERVIOUS ZONE CONTACT TO BE CAREFULLY CONSTRUCTED AS PER DETAIL GIVEN (D15) TYPICAL FOR BOTH FLY ASH AND BOTTOM ASH DAMS.
LOWER TEN FEET OF IMPERVIOUS ZONES FOR BOTH FLY ASH AND BOTTOM ASH DAMS TO BE PLACED AND COMPACTED AT OPTIMUM MOISTURE CONDITIONS AS PER SPECIFICATION APS-2742-54-09.
THE FOUNDATION FOR THE CLAY BLANKET (H15) SHALL BE EXCAVATED TO SUITABLE ROCK AND CLEANED, MAPPED AND SLUSH GROUTED AS PER SECTION 9 OF SPEC. APS-2742-54-09.
REFERENCE DRAWINGS
FOR REF. DWG SEE G-556
CLAY BLANKET AREA (CONTINUOUS WITH CORE)
SUITABLE ROCK
SECT K (H1)
CLAY BLANKET (IMPERVIOUS)
RANDOM ZONE
RANDOM ROCK SLOPE PROTECTION
EXIST GROUND
EXCAVATED TO SUITABLE ROCK (SEE NOTES)
ANTICIPATED ROCK LEVEL
SECT L (H2)
ZONE OF INCREASED MOISTURE, SEE NOTES
SEE DETAIL - CONSTRUCTION PROCEDURE (E14)
GREATER THAN 20'-0
DOWN STREAM TOE SHAPING TYPICAL (BY FIELD)
TYPICAL SECTION (IF DISTANCE FROM GRADE TO ROCK IS GREATER THAN 20'-0) (BOTTOM ASH & FLY ASH PONDS)
SECT A (I2)
SECT B (J8)
SECT C (K4)
SECT D (L5)
SECT E (M6)
SECT F (M7)
SECT G (M8)
SECT H (N9)
RIP RAP BLANKET
EL VARIES BY FIELD
SECT M (L4) (N.T.S.)
10 11-9-77 AS BUILT
9 5-10-77 REVISED SHAPE OF D/S TOE (F10), (J10) & SECTS
8 2-28-77
7 9-29-76
6 8-26-76
5 7-12-76
4 5-18-76
3 4-14-76 GENERAL REVISION
2 12-19-75
1 9-30-75
NO. DATE REVISION BY CH. APPROVED
WORK THIS DWG WITH G-556 & G567
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1977-250 MW INSTALLATION - UNIT No. 2
1978-250 MW EXTENSION - UNIT No. 3
ASH DISPOSAL SYSTEM
FLY ASH POND DIKE - SECTIONS & DETAILS
EBASCO SERVICES INCORPORATED
APPROVED
DATE AUG. 19, 75
APS-2742
G-558
APS DWG #G-44558


APS-2742-G-557
STATISTICAL STUDY OF % SATURATION
DEPTH (FEET) | NUMBER OF TESTS | MEAN (X̄) | STANDARD DEVIATION
5 | 27 | 80.7 | 5.1
10 | 14 | 77.4
15 | 11 | 82.5
20 | 8 | 8.2
PREWETTING LEGEND:
BORING LOCATION
4 TEST BORING No.
% SATURATION 83
10 DEPTH OF SAMPLE
PROOF COMPACTED BOUNDRY
NOTES
LEGEND:
REFERENCE DRAWINGS
KEY PLAN
COMPLETION REPORT
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
RELEASED
PER EBASCO





PIEZOMETER LEGEND:

F - FLY ASH
B - BOTTOM ASH
P - PIEZOMETER
C - COCONINO
M - MOENKOPI
A - ALLUVIUM

INSTALLATION DATA 6-75

PIEZOMETER NUMBER	DRILLED DEPTH	DEPTH TO SCREEN	TOP OF RISER PIPE ELEVATION	RISER HEIGHT
35 (FP9M)	132	32	5191.3	3.2
80 (FP7M)	58	43	5083.0	1.7
81 (FP8M)	112	32	5164.0	1.5
88 (FP1C)	191	175	5086.5	2.0
89 (FP2M)	92	52	5085.9	1.8
90 (FP3C)	146	133	5036.7	3.0
91 (FP4M)	77	57	5035.1	1.5
92 (FP5A)	56	41	5034.9	1.5
93 (FP6A)	26	16	5034.2	2.0
94 (BP10C)	292	277	5050.7	3.0
95 (BP12A)	102	87	5049.3	2.4
96 (BP11M)	154	114	5049.9	3.1

NOTES:

COMPLETION REPORT

ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1976-250 MW INSTALLATION - UNIT No. 2
1977-250 MW EXTENSION-UNIT No 3

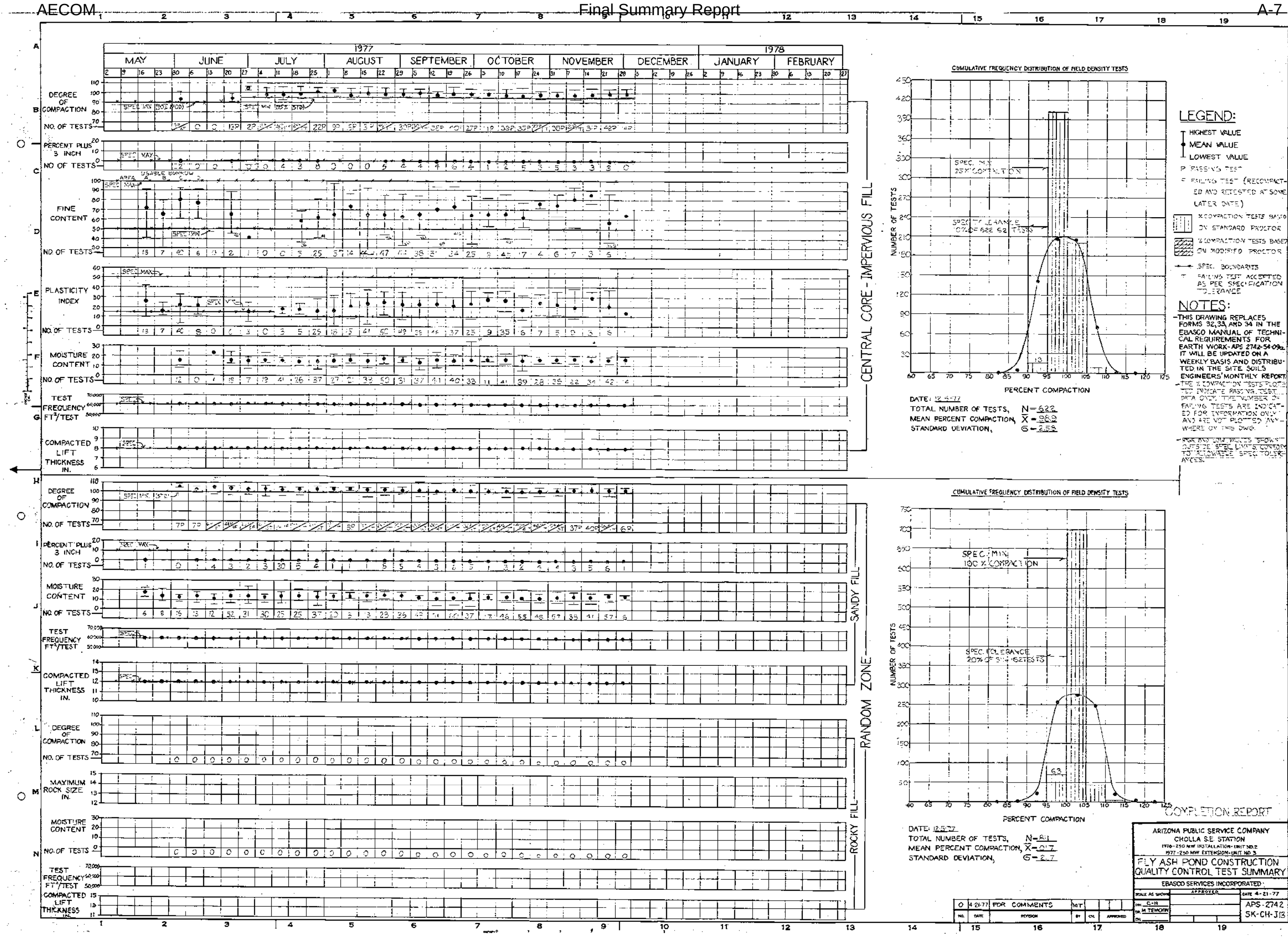
ASH POND PIEZOMETERS
GROUNDWATER ELEVATIONS

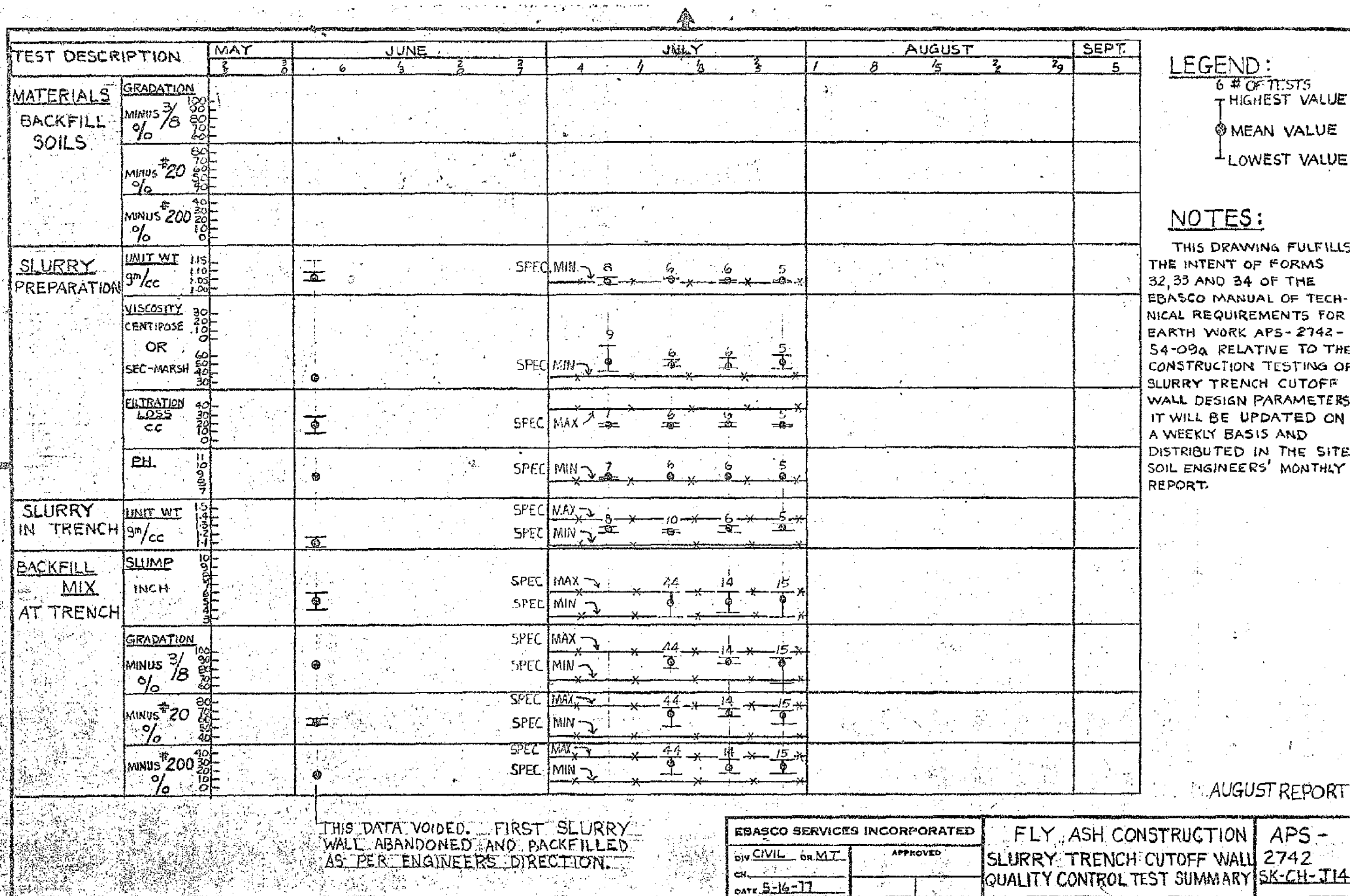
EBASCO SERVICES INCORPORATED

SCALE: AS SHOWN | APPROVED | DATE: 3-28-77
DR. C-H
CK. M. TEMKIN

APS-2742
SK-CH-J11

NO.	DATE	REVISION	BY	CH.	APPROVED
0	3-29-77	FOR COMMENTS	MT		


1977
1978
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
DEGREE OF COMPACTION
NO. OF TESTS
PERCENT PLUS 3 INCH
FINE CONTENT
PLASTICITY INDEX
MOISTURE CONTENT
TEST FREQUENCY FT³/TEST
COMPACTED LIFT THICKNESS IN.
MAXIMUM ROCK SIZE IN.
CENTRAL CORE - IMPERVIOUS FILL
RANDOM ZONE - SANDY FILL
ROCKY FILL
CUMULATIVE FREQUENCY DISTRIBUTION OF FIELD DENSITY TESTS
NUMBER OF TESTS
PERCENT COMPACTION
DATE: 12-5-77
TOTAL NUMBER OF TESTS, N=
MEAN PERCENT COMPACTION, X̄=
STANDARD DEVIATION, σ=
LEGEND:
HIGHEST VALUE
MEAN VALUE
LOWEST VALUE
P PASSING TEST
F FAILING TEST (RECOMPACTED AND RETESTED AT SOME LATER DATE)
% COMPACTION TESTS BASED ON STANDARD PROCTOR
% COMPACTION TESTS BASED ON MODIFIED PROCTOR
SPEC. BOUNDARIES
FAILING TEST ACCEPTED AS PER SPECIFICATION TOLERANCE
NOTES:
-THIS DRAWING REPLACES FORMS 32, 33, AND 34 IN THE EBASCO MANUAL OF TECHNICAL REQUIREMENTS FOR EARTH WORK-APS 2742-54-092. IT WILL BE UPDATED ON A WEEKLY BASIS AND DISTRIBUTED IN THE SITE SOILS ENGINEERS' MONTHLY REPORT.
-THE % COMPACTION TESTS PLOTTED INDICATE PASSING TEST DATA ONLY. THE NUMBER OF FAILING TESTS ARE INDICATED FOR INFORMATION ONLY AND ARE NOT PLOTTED ANYWHERE ON THIS DWG.
-HIGH AND LOW VALUES SHOWN OUTSIDE SPEC LIMITS CONFORM TO ALLOWABLE SPEC TOLERANCES.
COMPLETION REPORT
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1976-250 MW INSTALLATION-UNIT NO. 2
1977-250 MW EXTENSION-UNIT NO. 3
FLY ASH POND CONSTRUCTION
QUALITY CONTROL TEST SUMMARY
EBASCO SERVICES INCORPORATED
SCALE AS SHOWN
APPROVED
DATE 4-21-77
APS-2742
SK-CH-J13
0 4-21-77 FOR COMMENTS MT
NO. DATE REVISION BY CK. APPROVED


TEST DESCRIPTION
MAY
JUNE
JULY
AUGUST
SEPT.
MATERIALS BACKFILL SOILS
GRADATION
MINUS 3/8 %
MINUS #20 %
MINUS #200 %
SLURRY PREPARATION
UNIT WT gm/cc
VISCOSITY CENTIPOSE OR SEC-MARSH
FILTRATION LOSS cc
PH.
SLURRY IN TRENCH
UNIT WT gm/cc
BACKFILL MIX AT TRENCH
SLUMP INCH
GRADATION MINUS 3/8 %
MINUS #20 %
MINUS #200 %
SPEC MIN
SPEC MAX
LEGEND:
6 # OF TESTS
HIGHEST VALUE
MEAN VALUE
LOWEST VALUE
NOTES:
THIS DRAWING FULFILLS THE INTENT OF FORMS 32, 33 AND 34 OF THE EBASCO MANUAL OF TECHNICAL REQUIREMENTS FOR EARTH WORK APS-2742-54-09a RELATIVE TO THE CONSTRUCTION TESTING OF SLURRY TRENCH CUTOFF WALL DESIGN PARAMETERS. IT WILL BE UPDATED ON A WEEKLY BASIS AND DISTRIBUTED IN THE SITE SOIL ENGINEERS' MONTHLY REPORT.
AUGUST REPORT
THIS DATA VOIDED. FIRST SLURRY WALL ABANDONED AND BACKFILLED AS PER ENGINEERS DIRECTION.
EBASCO SERVICES INCORPORATED
DIV CIVIL
DR M.T.
APPROVED
DATE 5-16-77
FLY ASH CONSTRUCTION
SLURRY TRENCH CUTOFF WALL
QUALITY CONTROL TEST SUMMARY
APS-2742
SK-CH-J14

LEGEND:

- PROPERTY LINE
- ASH PIPE LINE
- WATER RETURN LINE

CREST OF DIKES EL 5120'-0
IMPOUNDING LEVEL EL 5116'-0
CONTOUR INTERVALS 10'

REVISED NOV 25, 1975
REVISED SEP 10, 1975

ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1976-250 MW INSTALLATION - UNIT No. 2
1977-250 MW EXTENSION - UNIT No. 3

ASH PONDS BORROW AREA MATERIAL PLAN

EBASCO SERVICES INCORPORATED

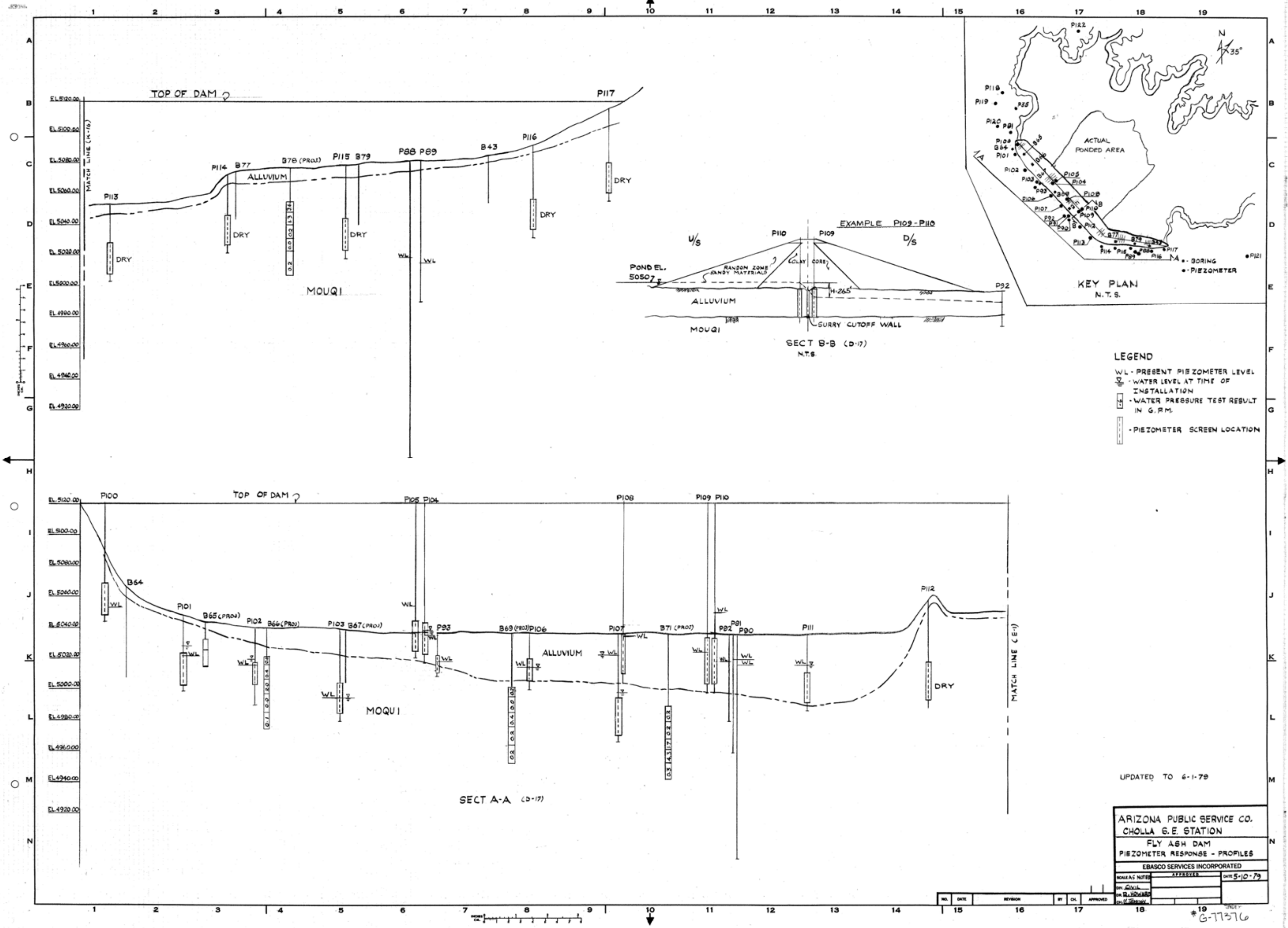
SCALE 1"=400'-0	APPROVED	DATE
DIV. C-H		APS-2742
DR. D. KOVACHEV		SK-CH-160
CH.		

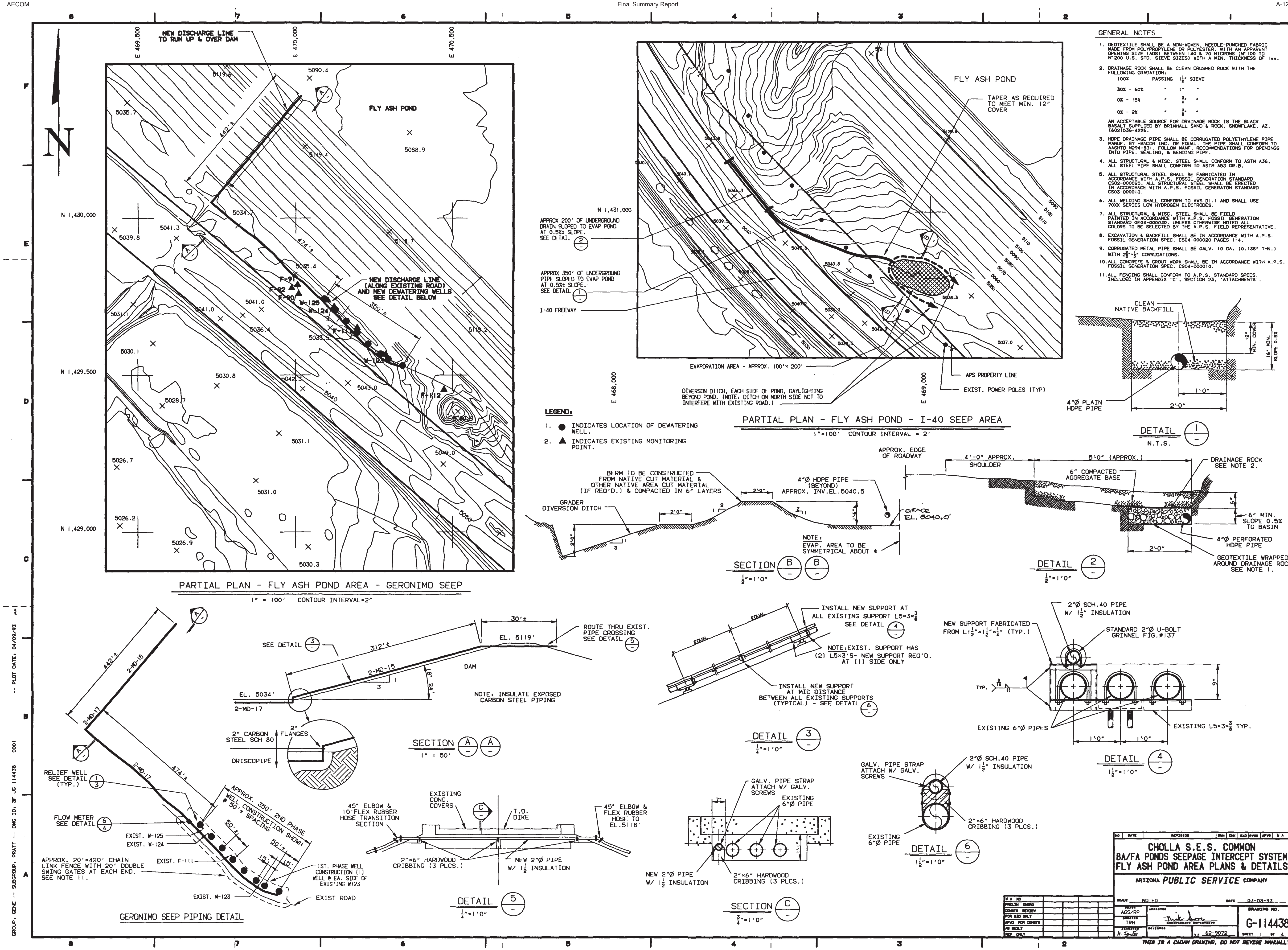
NO.	DATE	REVISION	BY	CH.	APPROVED

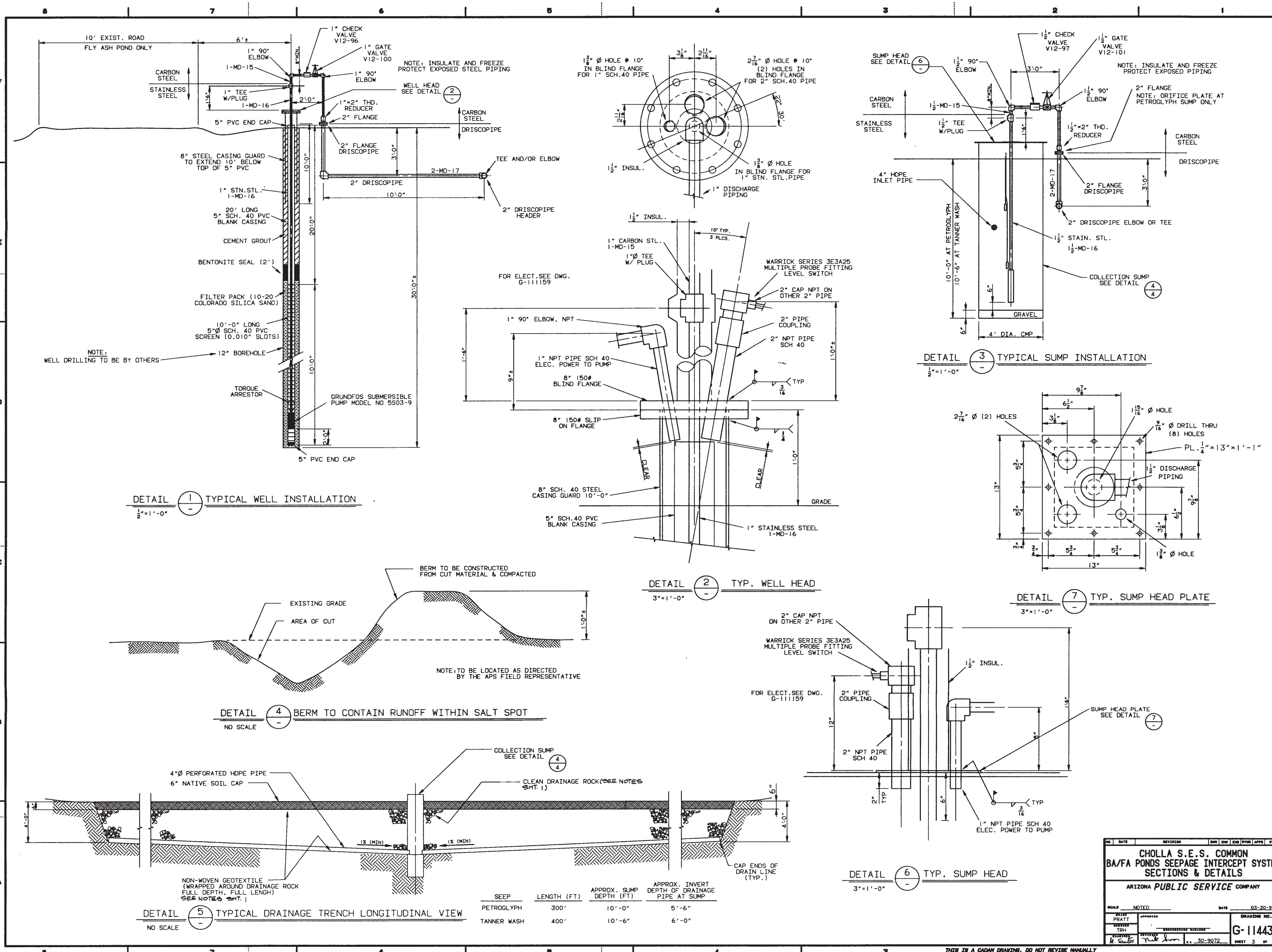
APS DWG. G44254 P2

09.27
09.28

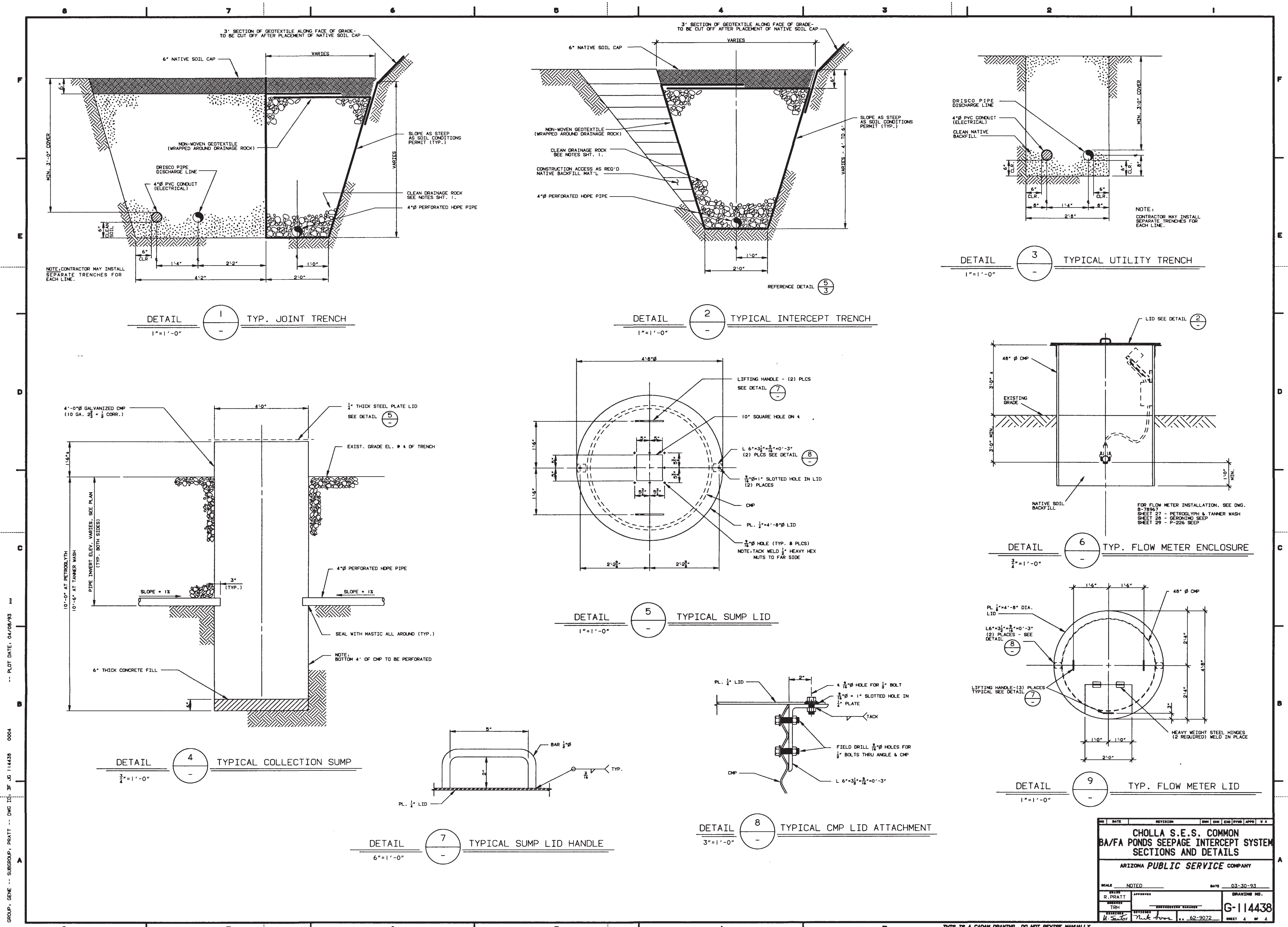
"INDEX"


TOP OF DAM
EL.5120.00
EL.5100.00
EL.5080.00
EL.5060.00
EL.5040.00
EL.5020.00
EL.5000.00
EL.4980.00
EL.4960.00
EL.4940.00
EL.4920.00
MATCH LINE (K-16)
P113
P114 B77
B78 (PROJ)
P115 B79
P88 P89
B43
P116
P117
ALLUVIUM
MOUQI
DRY
WL
EXAMPLE P109-P110
U/S
D/S
P110 P109
POND EL. 5050
RANDOM ZONE SANDY MATERIALS
CLAY CORE
H-265'
P92
SURRY CUTOFF WALL
SECT B-B (D-17)
N.T.S.
KEY PLAN
N.T.S.
ACTUAL PONDED AREA
• - BORING
• - PIEZOMETER
LEGEND
WL - PRESENT PIEZOMETER LEVEL
- WATER LEVEL AT TIME OF INSTALLATION
- WATER PRESSURE TEST RESULT IN G.P.M.
- PIEZOMETER SCREEN LOCATION
P100
B64
P101
B65 (PROJ)
P102
B66 (PROJ)
P103 B67 (PROJ)
P105 P104
P93
B69 (PROJ) P106
P107
B71 (PROJ)
P108
P109 P110
P92 P91 P90
P111
P112
MOQUI
MATCH LINE (E-1)
SECT A-A (D-17)
UPDATED TO 6-1-79
ARIZONA PUBLIC SERVICE CO.
CHOLLA S.E. STATION
FLY ASH DAM
PIEZOMETER RESPONSE - PROFILES
EBASCO SERVICES INCORPORATED
5-10-79
#G-77376


GENERAL NOTES
1. GEOTEXTILE SHALL BE A NON-WOVEN, NEEDLE-PUNCHED FABRIC MADE FROM POLYPROPYLENE OR POLYESTER, WITH AN APPARENT OPENING SIZE (AOS) BETWEEN 140 & 70 MICRONS (N°100 TO N°200 U.S. STD. SIEVE SIZES) WITH A MIN. THICKNESS OF 1mm.
2. DRAINAGE ROCK SHALL BE CLEAN CRUSHED ROCK WITH THE FOLLOWING GRADATION:
AN ACCEPTABLE SOURCE FOR DRAINAGE ROCK IS THE BLACK BASALT SUPPLIED BY BRIMHALL SAND & ROCK, SNOWFLAKE, AZ. (602)536-4226.
3. HDPE DRAINAGE PIPE SHALL BE CORRUGATED POLYETHYLENE PIPE MANUF. BY HANCOR INC. OR EQUAL. THE PIPE SHALL CONFORM TO AASHTO M294-83I. FOLLOW MANF. RECOMMENDATIONS FOR OPENINGS INTO PIPE, SEALING, & BENDING PIPE.
4. ALL STRUCTURAL & MISC. STEEL SHALL CONFORM TO ASTM A36. ALL STEEL PIPE SHALL CONFORM TO ASTM A53 GR.B.
5. ALL STRUCTURAL STEEL SHALL BE FABRICATED IN ACCORDANCE WITH A.P.S. FOSSIL GENERATION STANDARD CS02-000020. ALL STRUCTURAL STEEL SHALL BE ERECTED IN ACCORDANCE WITH A.P.S. FOSSIL GENERATION STANDARD CS03-000010.
6. ALL WELDING SHALL CONFORM TO AWS D1.1 AND SHALL USE 70XX SERIES LOW HYDROGEN ELECTRODES.
7. ALL STRUCTURAL & MISC. STEEL SHALL BE FIELD PAINTED IN ACCORDANCE WITH A.P.S. FOSSIL GENERATION STANDARD GE04-000030. UNLESS OTHERWISE NOTED ALL COLORS TO BE SELECTED BY THE A.P.S. FIELD REPRESENTATIVE.
8. EXCAVATION & BACKFILL SHALL BE IN ACCORDANCE WITH A.P.S. FOSSIL GENERATION SPEC. CS04-000020 PAGES 1-4.
9. CORRUGATED METAL PIPE SHALL BE GALV. 10 GA. (0.138" THK.) WITH 2⅔"×½" CORRUGATIONS.
10. ALL CONCRETE & GROUT WORK SHALL BE IN ACCORDANCE WITH A.P.S. FOSSIL GENERATION SPEC. CS04-000010.
11. ALL FENCING SHALL CONFORM TO A.P.S. STANDARD SPECS. INCLUDED IN APPENDIX 'C', SECTION 23, 'ATTACHMENTS'.
PARTIAL PLAN - FLY ASH POND AREA - GERONIMO SEEP
1" = 100' CONTOUR INTERVAL=2"
NEW DISCHARGE LINE TO RUN UP & OVER DAM
FLY ASH POND
NEW DISCHARGE LINE (ALONG EXISTING ROAD) AND NEW DEWATERING WELLS SEE DETAIL BELOW
N 1,430,000
N 1,429,500
N 1,429,000
E 469,500
E 470,000
E 470,500
PARTIAL PLAN - FLY ASH POND - I-40 SEEP AREA
1"=100' CONTOUR INTERVAL = 2'
TAPER AS REQUIRED TO MEET MIN. 12" COVER
APPROX 200' OF UNDERGROUND DRAIN SLOPED TO EVAP POND AT 0.5%± SLOPE. SEE DETAIL 2
APPROX 350' OF UNDERGROUND PIPE SLOPED TO EVAP POND AT 0.5%± SLOPE. SEE DETAIL 1
I-40 FREEWAY
EVAPORATION AREA - APPROX. 100'× 200'
DIVERSON DITCH, EACH SIDE OF POND. DAYLIGHTING BEYOND POND. (NOTE: DITCH ON NORTH SIDE NOT TO INTERFERE WITH EXISTING ROAD.)
APS PROPERTY LINE
EXIST. POWER POLES (TYP)
N 1,431,000
E 468,000
E 469,000
LEGEND:
1. INDICATES LOCATION OF DEWATERING WELL.
2. INDICATES EXISTING MONITORING POINT.
CLEAN NATIVE BACKFILL
4"Ø PLAIN HDPE PIPE
DETAIL 1
N.T.S.
BERM TO BE CONSTRUCTED FROM NATIVE CUT MATERIAL & OTHER NATIVE AREA CUT MATERIAL (IF REQ'D.) & COMPACTED IN 6" LAYERS
GRADER DIVERSION DITCH
4"Ø HDPE PIPE (BEYOND) APPROX. INV.EL.5040.5
GRADE EL. 5040.0'
NOTE: EVAP. AREA TO BE SYMMETRICAL ABOUT ℄
SECTION B B
½"=1'0"
APPROX. EDGE OF ROADWAY
4'-0" APPROX. SHOULDER
5'0" (APPROX.)
6" COMPACTED AGGREGATE BASE
DRAINAGE ROCK SEE NOTE 2.
6" MIN. SLOPE 0.5% TO BASIN
4"Ø PERFORATED HDPE PIPE
GEOTEXTILE WRAPPED AROUND DRAINAGE ROCK SEE NOTE 1.
DETAIL 2
½"=1'0"
SEE DETAIL 3
ROUTE THRU EXIST. PIPE CROSSING SEE DETAIL 5
EL. 5119'
EL. 5034'
2-MD-17
2-MD-15
DAM
NOTE: INSULATE EXPOSED CARBON STEEL PIPING
2" CARBON STEEL SCH 80
2" FLANGES
DRISCOPIPE
SECTION A A
1" = 50'
INSTALL NEW SUPPORT AT ALL EXISTING SUPPORT L5×3×⅜ SEE DETAIL 4
NOTE: EXIST. SUPPORT HAS (2) L5×3'S- NEW SUPPORT REQ'D. AT (1) SIDE ONLY
INSTALL NEW SUPPORT AT MID DISTANCE BETWEEN ALL EXISTING SUPPORTS (TYPICAL) - SEE DETAIL 6
DETAIL 3
¼"=1'0"
2"Ø SCH.40 PIPE W/ 1½" INSULATION
NEW SUPPORT FABRICATED FROM L1½"×1½"×¼" (TYP.)
STANDARD 2"Ø U-BOLT GRINNEL FIG.#137
EXISTING 6"Ø PIPES
EXISTING L5×3×⅜ TYP.
DETAIL 4
1½"=1'0"
RELIEF WELL SEE DETAIL 1/3 (TYP.)
FLOW METER SEE DETAIL 6/4
APPROX. 350' 2ND PHASE WELL CONSTRUCTION SHOWN @ 50'± SPACING
EXIST. W-125
EXIST. W-124
EXIST. F-111
EXIST. W-123
APPROX. 20'×420' CHAIN LINK FENCE WITH 20' DOUBLE SWING GATES AT EACH END. SEE NOTE 11.
1ST. PHASE WELL CONSTRUCTION (1) WELL @ EA. SIDE OF EXISTING W123
EXIST ROAD
GERONIMO SEEP PIPING DETAIL
45° ELBOW & 10'FLEX RUBBER HOSE TRANSITION SECTION
EXISTING CONC. COVERS
T.O. DIKE
45° ELBOW & FLEX RUBBER HOSE TO EL.5118'
2"×6" HARDWOOD CRIBBING (3 PLCS.)
NEW 2"Ø PIPE W/ 1½ INSULATION
DETAIL 5
¼"=1'0"
GALV. PIPE STRAP ATTACH W/ GALV. SCREWS
EXISTING 6"Ø PIPE
NEW 2"Ø PIPE W/ 1½ INSULATION
2"×6" HARDWOOD CRIBBING (3 PLCS.)
SECTION C
¾"=1'0"
2"Ø SCH.40 PIPE W/ 1½" INSULATION
2"×6" HARDWOOD CRIBBING (3 PLCS.)
EXISTING 6"Ø PIPE
DETAIL 6
1½"=1'0"
CHOLLA S.E.S. COMMON
BA/FA PONDS SEEPAGE INTERCEPT SYSTEM
FLY ASH POND AREA PLANS & DETAILS
ARIZONA PUBLIC SERVICE COMPANY
SCALE NOTED
DATE 03-03-93
G-114438
THIS IS A CADAM DRAWING, DO NOT REVISE MANUALLY



SEEP	LENGTH (FT)	APPROX. SUMP DEPTH (FT)	APPROX. INVERT DEPTH OF DRAINAGE PIPE AT SUMP
PETROGLYPH	300'	10'-0"	5'-6"
TANNER WASH	400'	10'-6"	6'-0"



3' SECTION OF GEOTEXTILE ALONG FACE OF GRADE-TO BE CUT OFF AFTER PLACEMENT OF NATIVE SOIL CAP
6" NATIVE SOIL CAP
VARIES
NON-WOVEN GEOTEXTILE (WRAPPED AROUND DRAINAGE ROCK)
SLOPE AS STEEP AS SOIL CONDITIONS PERMIT (TYP.)
DRISCO PIPE DISCHARGE LINE
4"Ø PVC CONDUIT (ELECTRICAL)
CLEAN DRAINAGE ROCK SEE NOTES SHT. 1.
4"Ø PERFORATED HDPE PIPE
MIN. 3'-0" COVER
NOTE: CONTRACTOR MAY INSTALL SEPARATE TRENCHES FOR EACH LINE.
DETAIL 1 TYP. JOINT TRENCH 1"=1'-0"
CONSTRUCTION ACCESS AS REQ'D NATIVE BACKFILL MAT'L
VARIES - 4' TO 6'
REFERENCE DETAIL 5/3
DETAIL 2 TYPICAL INTERCEPT TRENCH 1"=1'-0"
CLEAN NATIVE BACKFILL
DETAIL 3 TYPICAL UTILITY TRENCH 1"=1'-0"
4'-0"Ø GALVANIZED CMP (10 GA. 2⅔ x ½ CORR.)
¼" THICK STEEL PLATE LID SEE DETAIL 5
EXIST. GRADE EL. @ ℄ OF TRENCH
10'-0" AT PETROGLYPH
10'-6" AT TANNER WASH
PIPE INVERT ELEV. VARIES, SEE PLAN (TYP. BOTH SIDES)
SLOPE = 1%
SEAL WITH MASTIC ALL AROUND (TYP.)
NOTE: BOTTOM 4' OF CMP TO BE PERFORATED
6" THICK CONCRETE FILL
DETAIL 4 TYPICAL COLLECTION SUMP ¾"=1'-0"
LIFTING HANDLE - (2) PLCS SEE DETAIL 7
10" SQUARE HOLE ON ℄
L 6"x3½"x5/16"x0'-3" (2) PLCS SEE DETAIL 8
5/16"Ø x 1" SLOTTED HOLE IN LID (2) PLACES
CMP
PL. ¼"x4'-8"Ø LID
5/16"Ø HOLE (TYP. 8 PLCS)
NOTE: TACK WELD ¼" HEAVY HEX NUTS TO FAR SIDE
DETAIL 5 TYPICAL SUMP LID 1"=1'-0"
48" Ø CMP
LID SEE DETAIL 2
EXISTING GRADE
NATIVE SOIL BACKFILL
FOR FLOW METER INSTALLATION, SEE DWG. B-78967
SHEET 27 - PETROGLYPH & TANNER WASH
SHEET 28 - GERONIMO SEEP
SHEET 29 - P-226 SEEP
DETAIL 6 TYP. FLOW METER ENCLOSURE ¾"=1'-0"
PL ¼"x4'-8" DIA. LID
L6"x3½"x5/16"x0'-3" (2) PLACES - SEE DETAIL 8
LIFTING HANDLE-(3) PLACES TYPICAL SEE DETAIL 7
HEAVY WEIGHT STEEL HINGES (2 REQUIRED) WELD IN PLACE
DETAIL 9 TYP. FLOW METER LID 1"=1'-0"
BAR ½"Ø
PL. ¼" LID
DETAIL 7 TYPICAL SUMP LID HANDLE 6"=1'-0"
5/16"Ø HOLE FOR ¼" BOLT
5/16"Ø x 1" SLOTTED HOLE IN ¼" PLATE
TACK
FIELD DRILL 5/16"Ø HOLES FOR ¼" BOLTS THRU ANGLE & CMP
L 6"x3½"x5/16"x0'-3"
DETAIL 8 TYPICAL CMP LID ATTACHMENT 3"=1'-0"
CHOLLA S.E.S. COMMON
BA/FA PONDS SEEPAGE INTERCEPT SYSTEM
SECTIONS AND DETAILS
ARIZONA PUBLIC SERVICE COMPANY
SCALE NOTED
DATE 03-30-93
DRAWN R.PRATT
CHECKED TRH
DRAWING NO. G-114438
SHEET 4 OF 4
THIS IS A CADAM DRAWING. DO NOT REVISE MANUALLY
GROUP, GENE -- SUBGROUP, PRATT -- DWG ID: 3F JG 114438 0004 -- PLOT DATE, 04/08/93

EMBANKMENT MONITORING

APS 9

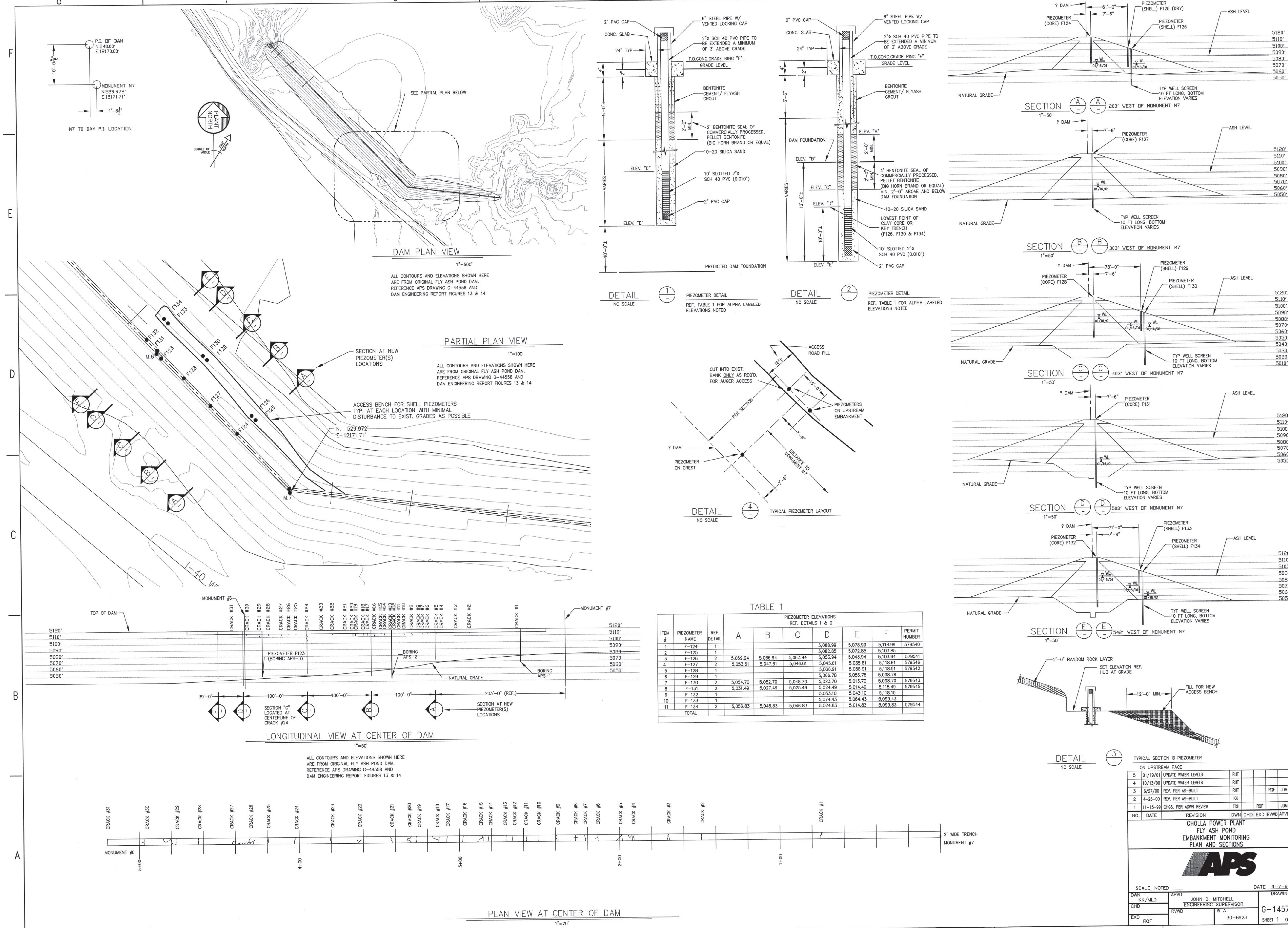


TABLE 1

ITEM #	PIEZOMETER NAME	REF. DETAIL	PIEZOMETER ELEVATIONS REF. DETAILS 1 & 2						
			A	B	C	D	E	F	PERMIT NUMBER
1	F-124	1				5,088.99	5,078.99	5,118.99	579540
2	F-125	1				5,082.85	5,072.85	5,103.85	
3	F-126	2	5,069.94	5,066.94	5,063.94	5,053.94	5,043.94	5,103.94	579541
4	F-127	2	5,053.61	5,047.61	5,046.61	5,045.61	5,035.61	5,118.61	579546
5	F-128	1				5,066.91	5,056.91	5,118.91	579542
6	F-129	1				5,066.78	5,056.78	5,098.78	
7	F-130	2	5,054.70	5,052.70	5,048.70	5,023.70	5,013.70	5,098.70	579543
8	F-131	2	5,031.49	5,027.49	5,025.49	5,024.49	5,014.49	5,118.49	579545
9	F-132	1				5,053.10	5,043.10	5,118.10	
10	F-133	1				5,074.43	5,064.43	5,099.43	
11	F-134	2	5,056.83	5,048.83	5,046.83	5,024.83	5,014.83	5,099.83	579544
	TOTAL								

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
5	01/19/01	UPDATE WATER LEVELS	RHT					30-9238
4	10/13/00	UPDATE WATER LEVELS	RHT					30-9238
3	6/27/00	REV. PER AS-BUILT	RHT			RQF	JDM	30-9238
2	4-26-00	REV. PER AS-BUILT	KK					30-9238
1	11-15-99	CHGS. PER ADWR REVIEW	TRH		RQF		JDM	30-6923

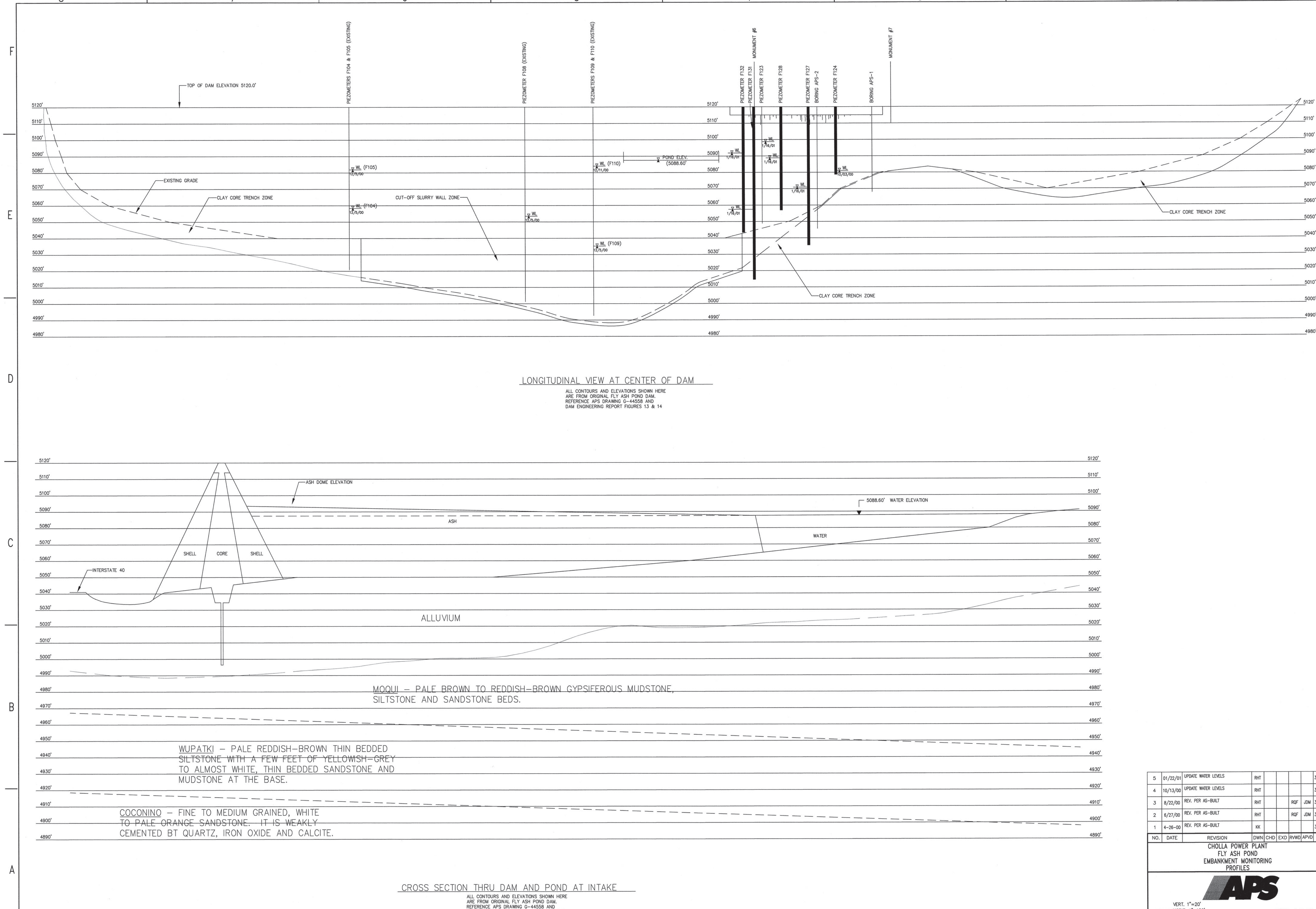
CHOLLA POWER PLANT
FLY ASH POND
EMBANKMENT MONITORING
PLAN AND SECTIONS

APS

SCALE NOTED
DATE 9-7-99

DWN KK/MLD
CHD
EXD RQF
APVD JOHN D. MITCHELL, ENGINEERING SUPERVISOR
RVWD
W A 30-6923
DRAWING NO. G-145746
SHEET 1 OF 2

AAAAAMDU.DWG



NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
5	01/22/01	UPDATE WATER LEVELS	RHT					30-9238
4	10/13/00	UPDATE WATER LEVELS	RHT					30-9238
3	8/22/00	REV. PER AS-BUILT	RHT			RQF	JDM	30-9238
2	6/27/00	REV. PER AS-BUILT	RHT			RQF	JDM	30-9238
1	4-26-00	REV. PER AS-BUILT	KK					30-9238

CHOLLA POWER PLANT
FLY ASH POND
EMBANKMENT MONITORING
PROFILES

APS

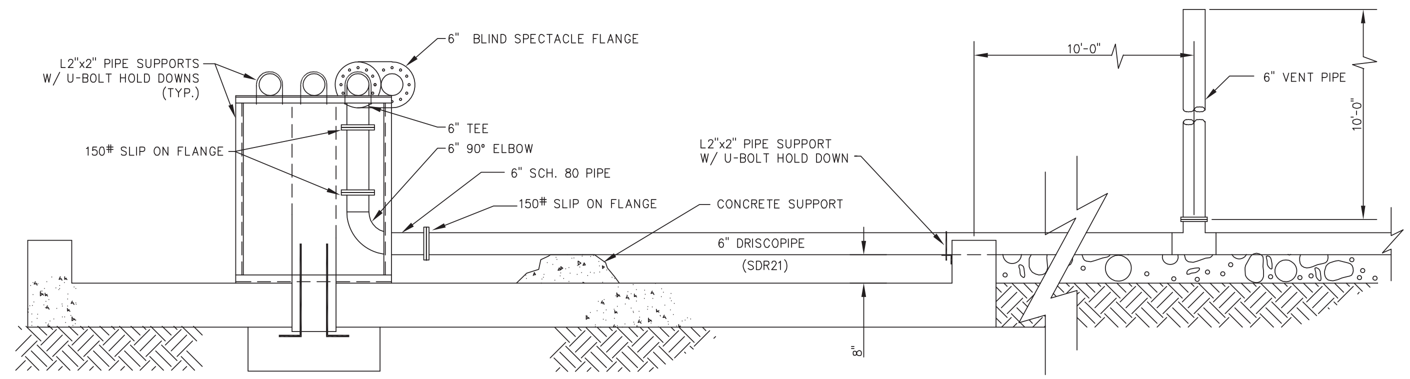
SCALE VERT. 1"=20' HORIZ. 1"=120'
DATE 9-7-99

DWN KK/MLD
CHD
EXD RQF
APVD JOHN D. MITCHELL, ENGINEERING SUPERVISOR
RVWD
W A 30-6923
DRAWING NO. G-145746
SHEET 2 OF 2

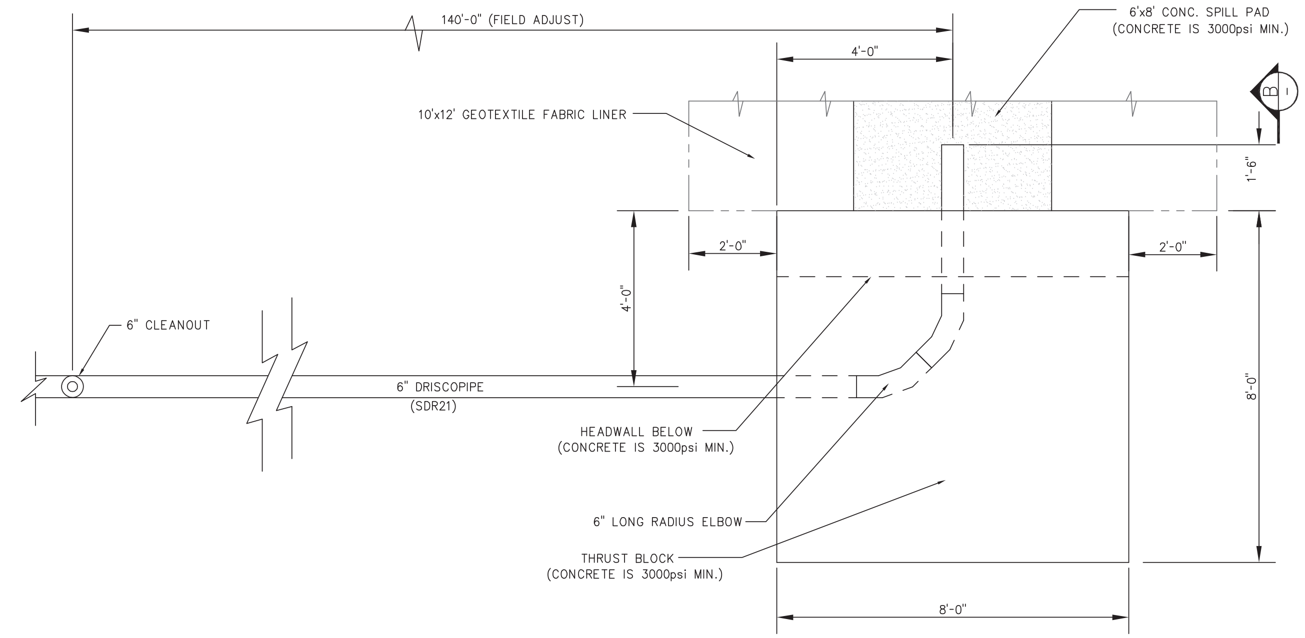
AAAAAMDV.DWG

DISCHARGE PIPE DR I

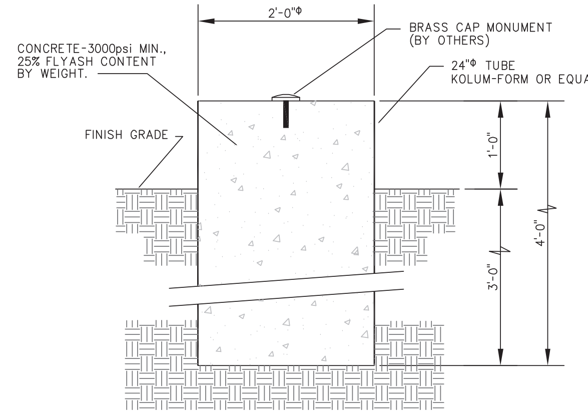
APS Rev. 2004



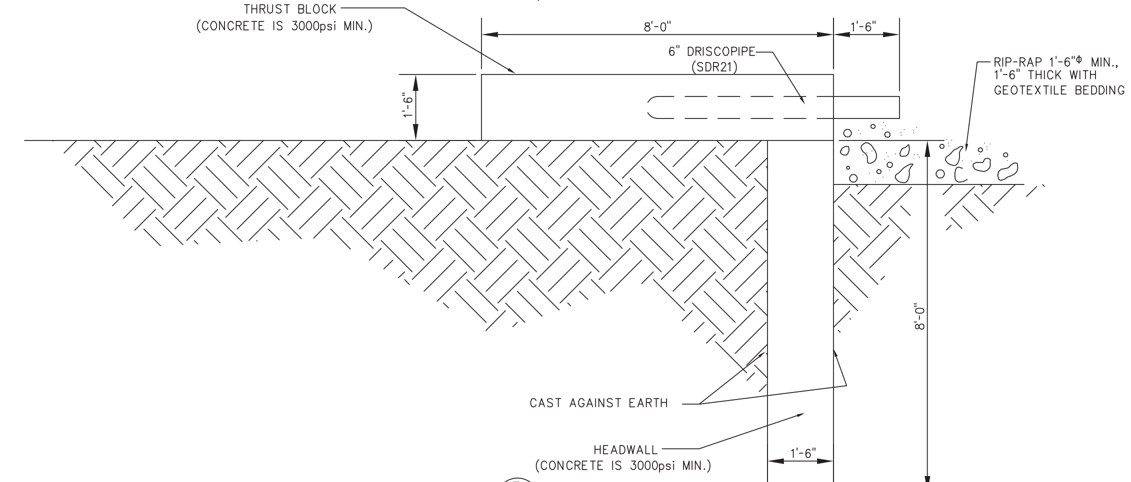
SECTION (A) NEW DISCHARGE CONNECTION
1/2"=1'-0"



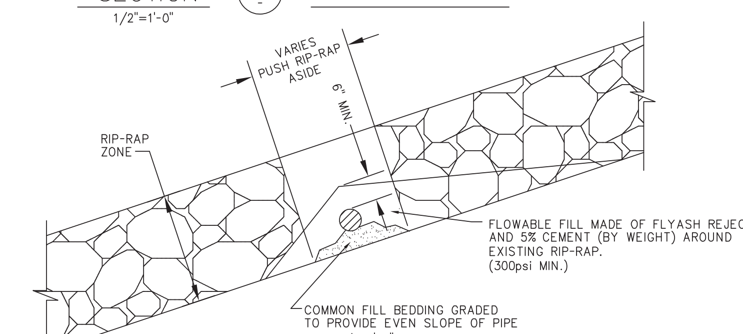
PLAN VIEW
(DISCHARGE POINT)
1/2"=1'-0"



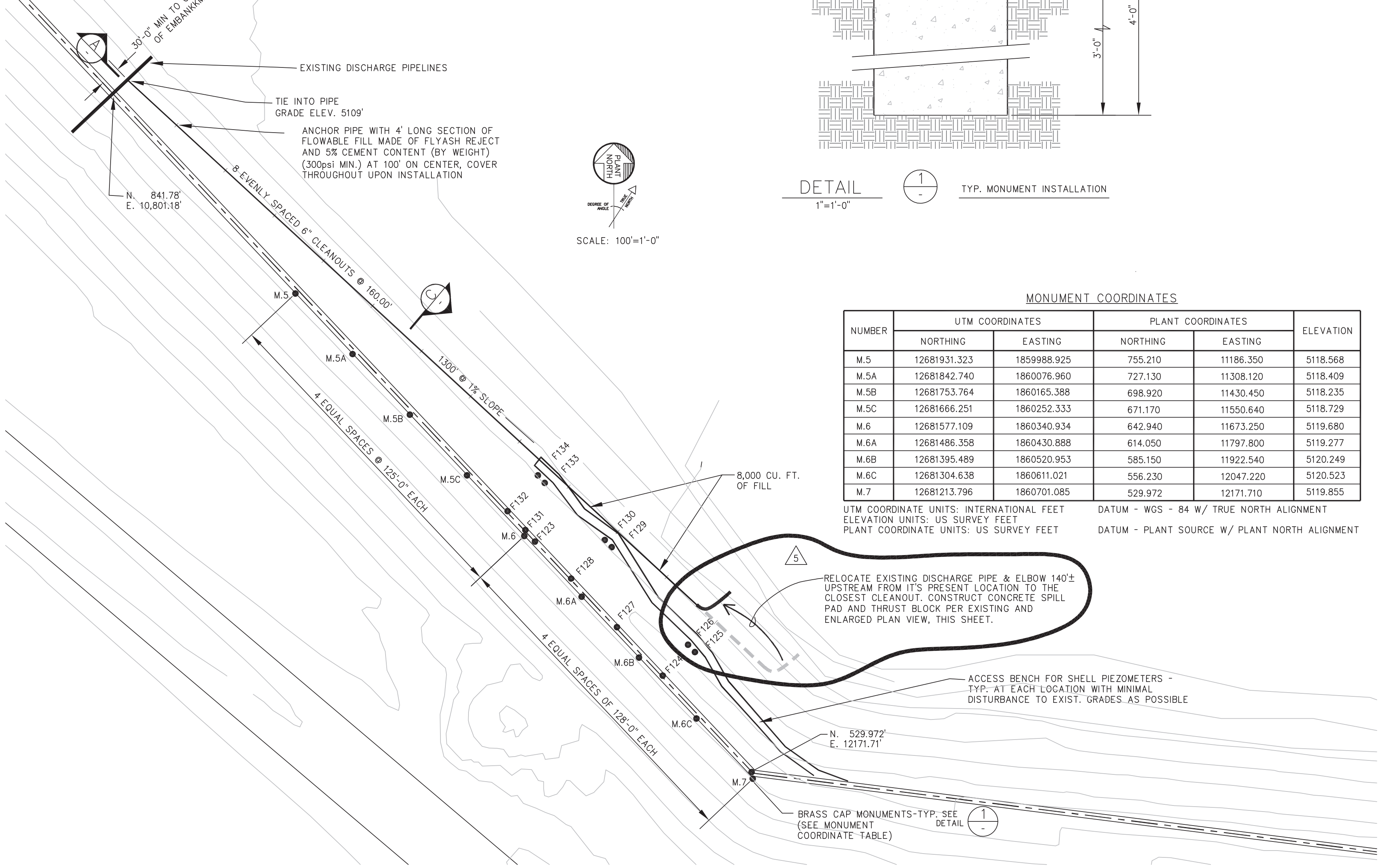
DETAIL (1) TYP. MONUMENT INSTALLATION
1"=1'-0"



SECTION (B) HEADWALL AND BASE
1/2"=1'-0"



SECTION (C) COVER AND BEDDING SECTION
1/2"=1'-0"



MONUMENT COORDINATES

NUMBER	UTM COORDINATES		PLANT COORDINATES		ELEVATION
	NORTHING	EASTING	NORTHING	EASTING	
M.5	12681931.323	1859988.925	755.210	11186.350	5118.568
M.5A	12681842.740	1860076.960	727.130	11308.120	5118.409
M.5B	12681753.764	1860165.388	698.920	11430.450	5118.235
M.5C	12681666.251	1860252.333	671.170	11550.640	5118.729
M.6	12681577.109	1860340.934	642.940	11673.250	5119.680
M.6A	12681486.358	1860430.888	614.050	11797.800	5119.277
M.6B	12681395.489	1860520.953	585.150	11922.540	5120.249
M.6C	12681304.638	1860611.021	556.230	12047.220	5120.523
M.7	12681213.796	1860701.085	529.972	12171.710	5119.855

UTM COORDINATE UNITS: INTERNATIONAL FEET
ELEVATION UNITS: US SURVEY FEET
PLANT COORDINATE UNITS: US SURVEY FEET

DATUM - WGS - 84 W/ TRUE NORTH ALIGNMENT
DATUM - PLANT SOURCE W/ PLANT NORTH ALIGNMENT

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
5	12-14-04	Relocate discharge pipe	PRATT	PSS			DRR	1500-001
4	11-12-02	NEW DISCHARGE PIPE INSTALLED	DCM		RQF		JDM	30-6876
3	2-26-02	CORRECTION TO AS-BUILTS	PRATT		RQF		JDM	30-9238
2	6-21-01	REVISE PER AS-BUILTS	PRATT		RQF		JDM	30-9238
1	02-28-01	REVISED COVER AND BEDDING DETAIL	BTF		RQF		JDM	30-6923

CHOLLA POWER PLANT
FLY ASH POND
DISCHARGE CONNECTION
PLAN AND DETAILS

APS

SCALE AS NOTED DATE 01-19-01

DWN RHT
CHD
EXD RQF
APVD JOHN D. MITCHELL ENGINEERING SUPERVISOR
RVWD
W A 30-6923
DRAWING NO. E-146981
SHEET 1 OF 1

REFERENCE DRAWINGS
G-145746
G-114438

AAAAOVR.DWG

DRAWING: L:\A_CAD_USERS\BOBJP\CC-C-39-WWD-146981-1.dwg

Appendix B.
Safety Factor Calculation

URS Quality - *It's Good Business*

QMS Form 3-4 (MM)

Date: September 2014

IE QMS	Check and Review Record

Project Name	CHPP SIA	**Client Name**	APS
Project Location	Cholla Power Plant	**PM Name**	Frances Ackerman, R.G., P.E.
Project Number / Office Code	60445840	**PIC Name**	Alexander Gourlay, P.E.

Type

☒ Detail Check	☐ Coordination Review	☐ Constructability Review	☐ Bidability Review
☐ Independent Technical Review (ITR)	☐ Calculation Check *(can also use QMS Form 3-3)*	☐ Other:	*For Subconsultant, Client, or Third-Party Information Review, use Form 3-11.*

Identifying Information

(This section is to be completed by the Project Manager or the PM's Designee.)

Individual Assigned:	Tafwachi Chamunda, P.E.	Comments Required by:	3/23/16
Work Product Originator:	Jed Stoken, P.E.	Title of Work Product:	Safety Factor Calculation Package

Review Scope

☒ Technical edit for elements such as grammar, punctuation and formatting.	☐ Completion of review of client and third-party information.	☒ Basis and validity of conclusion / recommendation.
☒ Detail Check of calculations and graphics.	☒ Soundness of approach/design.	☒ Organization, clarity and completeness.
☐ Completion of Detail Check	☒ Conformance with standards	☐ Application of Statements of Limitations.
☐ Other:		

[signature] 8/12/16

Project Manager (or Designee) Signature **Date**

Comments

Select:

☐ Checker / Reviewer has no comments.

or

☒ Comments have been provided on:

☒ Marked directly on work product (electronically or on hard copy).

☐ Comment and Disposition Record (QMS Form 3-5).

☐ Other:

[signature] 3/23/16

Checker / Reviewer Signature **Date**

Verification

(Note: Reviews and Checks are often iterative, requiring multiple rounds to verify accuracy and completeness of the work product. This section is to be completed by the Checker/Reviewer after verification of comment incorporation to include subsequent or new comments.)

Select:

☒ Checker / Reviewer has verified that comments have been adequately addressed. There are no outstanding issues.

or

☐ Checker / Reviewer has verified that comments have been adequately addressed. Any unresolved issues have been submitted to the Project Manager or Designee for final resolution.

and

☒ Checker / Reviewer confirms that the work product Check / Review is complete.

[signature] 4/13/16

Checker / Reviewer Signature **Date**

URS Quality - It's Good Business	QMS Form 3-4 (MM)
	Date: September 2014
IE QMS	Check and Review Record

Approval	*(This section is to be completed by the Project Manager or PM's designee.)* ☐ Project Manager or Designee confirms that the Check / Review process has been followed. [signature] — 8/12/16 **Project Manager (or Designee) Signature** — **Date**
DISTRIBUTION	Project Central File – Quality File Folder Other – Specify:

<table>
<tr><td colspan="5">DESIGN CALCULATION</td></tr>
<tr><td>Calculation Title:
Fly Ash Pond
Safety Factor Assessment</td><td>Project Title:
APS Cholla Structural
Integrity Assessment</td><td>Project No:
60445840</td><td>Date:
4/13/16</td><td>Page No:
Page 1 of 15</td></tr>
</table>

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Figures

Tables

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 2 of 15

1 INTRODUCTION

The purpose of this calculation is to perform limit equilibrium slope stability analyses to assess the stability of the existing Coal Combustion Residual (CCR) surface impoundment dam Fly Ash Pond (FAP) Dam, ADWR Dam #09.28, at Arizona Public Service (APS)'s Cholla Power Plant near Joseph City, AZ.

2 ANALYSIS CRITERIA

The analyses were performed to meet the regulations set forth in the United States Environmental Protection Agency (EPA) 40 CFR Part 257.73(e) Structural Integrity Criteria for Existing CCR Surface Impoundments (EPA 2015). The code requires safety factor assessments for units containing CCRs. The safety factors for various embankment loading and tailwater conditions must meet the values outlined. For the FAP Dam, the following safety factors must be met:

- Long-term, maximum storage pool FS = 1.50;
- Maximum surcharge pool FS = 1.40;
- Seismic loading FS = 1.00; and
- Liquefaction loading FS = 1.20 (only for sites with liquefiable soils).

3 ANALYSIS INPUTS

The following inputs were used in the analysis:

- Surface profiles were developed from 2009 elevation contour drawings of the FAP Dam and surrounding terrain (Cooper Aerial Surveys Co. 2014).
- Subsurface stratigraphies were developed from as-built cross section drawings of the FAP Dam (Ebasco 1977).
- Material properties used in the model were developed in a separate calculation (AECOM 2016).
- Pore pressure distribution within the dam was developed from interpretation of water level readings for piezometers installed at the dam and surrounding area. Water level measurements are presented in the annual dam basic data report (APS 2016).

<table>
<tr><td colspan="5">DESIGN CALCULATION</td></tr>
<tr><td>Calculation Title:
Fly Ash Pond
Safety Factor Assessment</td><td>Project Title:
APS Cholla Structural
Integrity Assessment</td><td>Project No:
60445840</td><td>Date:
4/13/16</td><td>Page No:
Page 3 of 15</td></tr>
</table>

- The maximum storage pool water level of the CCR Pond was based on the maximum permissible water level stated in the permitting license for the FAP (ADWR 1986).
- The surcharge pool water level of the CCR Pond was developed based on estimated water levels for the design probable maximum flood (PMF) of the FAP (Ebasco 1975).
- The seismic loading for the FAP was developed from the deaggregated seismic hazard at the site based on the 2008 United States Geological Survey (USGS) National Earthquake Hazards Reduction Program (NEHRP) Provisions (USGS 2008).

The slope stability analyses were performed using the software program SLOPE/W, commercially available through GEO-SLOPE International, Ltd. (GEO-SLOPE International 2012).

4 ASSUMPTIONS

The following assumptions were used in the analysis:

- The surface profile for the site was developed based on the most recent topographic survey available, from June of 2009. It is assumed that the surface topography shown in this survey is sufficiently representative of the current topography so as not to produce significant differences in the estimated safety factors. This seems reasonable since there have been no significant alterations to the FAP Dam or the immediate surrounding area since the survey was conducted, except for additional accumulation of fly ash within the impoundment.
- The water level measured in the piezometers near Cross Section 2, reflect the influence of the Geronimo Seep collection system. The collection system consists of an underground french drain system and wellpoints and has been in continuous operation since the early 1990s. The seep collection system presumably lowers the phreatic water level at the downstream toe of the dam in the vicinity of the wellpoints. Since it is difficult to assess the radial influence of the collection system, it is assumed the Geronimo Seep seepage collection system is non-operational for the stability analysis of Cross Section 2. This has the effect of raising the water level downstream of the dam to near the ground surface.

5 STABILITY ANALYSIS

Slope stability analyses were performed to document minimum factors of safety for loading conditions identified by 40 CFR Section 257.73(e) using the software program SLOPE/W (GEO-SLOPE International, Ltd. 2012). The analyses were performed using Spencer's Method, a limit

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 4 of 15

equilibrium method of slices that satisfies both force and moment equilibrium in addition to incorporating the effects of interslice forces.

5.1 Critical Stability Cross Sections

Factors of safety were calculated for critical cross-sections of the FAP Dam. The critical cross section is the cross section that is anticipated to be most susceptible to structural failure for a given loading condition. The critical cross section thus represents a "most-severe" case. Section locations were selected based on variation in the embankment height and stratigraphic conditions to represent the most-severe case.

The safety factor assessments were performed for three cross-sections along the FAP Dam:

FAP Dam Cross Sections

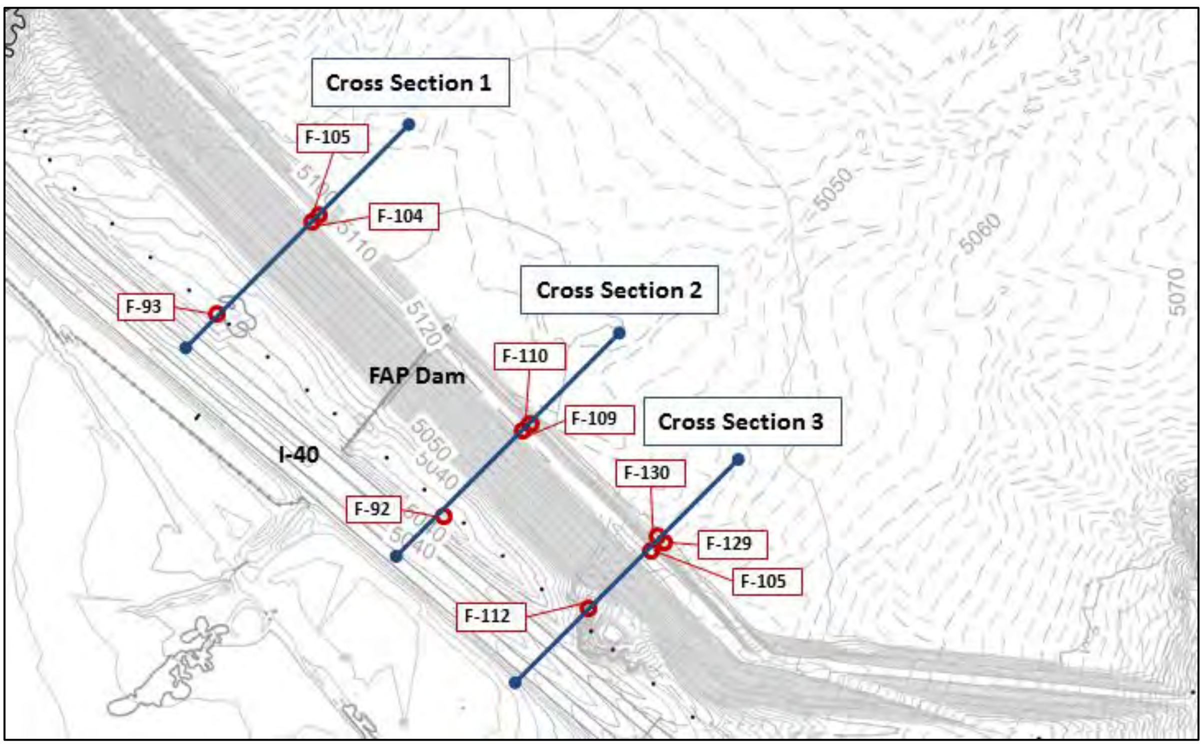

Figure 1. Slope Stability Cross Section and Piezometer Locations Along the FAP Dam

FAP Cross Section 1:

Cross Section 1 at the FAP was located along the western portion of the dam near piezometers F-93, F-104, and F-105. At this location, the dam is approximately 80 feet (ft) in height from EL 5,040 ft at the downstream toe to 5,120 ft at the crest; with upstream and downstream slope angles are about 3H:1V. The dam at this cross section consists of a sandy

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 5 of 15

lean clay core with an outer clayey sand shell. The dam lies on a foundation of alluvial overburden consisting of clays, silts, and sands; overlying bedrock consisting of mudstones, siltstones, and sandstones. The depth to bedrock is about 20 ft below the ground surface (bgs). A cutoff trench filled with compacted clay extends from the clay core down to the bedrock and is used to control seepage beneath the dam, in lieu of a cutoff wall which is used for greater depths to bedrock. The upstream slope of the dam is confined by approximately 60 ft of hydraulically-placed fly ash based on comparison between initial topographic surveys of the area (Ebasco 1975) and 2009 surveys (Cooper Aerial Surveys 2014).

FAP Cross Section 2:

Cross Section 2 at the FAP was located near the center of the dam near piezometers F-92, F-109, and F-110. At this location, the dam is approximately 80 ft in height from EL 5,040 ft at the downstream toe to 5,120 ft at the crest; with upstream and downstream slope angles of about 3H:1V. Similar to Cross Section 1 described above, the dam consists of a sandy lean clay core with an outer clayey sand shell. At this location the depth to bedrock beneath the alluvial soils (same as those described for Section 1) is greatest along the dam at approximately 52 ft bgs. A cement-bentonite cutoff wall extends from the clay core of the dam to approximately 2 ft into the bedrock and is used to control seepage beneath the dam The upstream slope of the dam is confined by approximately 60 ft of hydraulically-placed fly ash based on comparison between initial topographic surveys of the area (Ebasco 1975) and 2009 surveys (Cooper Aerial Surveys 2014).

FAP Cross Section 3:

Cross Section 3 at the FAP was located along the eastern portion of the dam near piezometers F-112, F-127, F-129, and F-130. At this location, the dam intersects a rock outcropping commonly referred to as Geronimo Knob along its downstream slope. Consequently, the upstream and downstream slope heights are considerably different at approximately 68 ft versus 51 ft, respectively, although both slope angles are about 3H:1V. Similar to other cross sections described above, the dam consists of a sandy lean clay core with an outer clayey sand shell. The depth to bedrock beneath the alluvial soils (same as those described for Section 1) is shallow at this section, approximately 4 to 9 ft bgs. A cutoff trench filled with compacted clay extending to the bedrock is used to control seepage. The upstream slope of the dam is confined by approximately 50 ft of hydraulically-placed fly ash based on comparison between initial topographic surveys of the area (Ebasco 1975) and 2009 surveys (Cooper Aerial Surveys 2014).

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 6 of 15

5.2 Material Properties

A material properties calculation package was prepared to present the methods and information supporting the parameter selection for the materials at the FAP Dam (AECOM 2016). The material properties identified in the calculation and used in the slope stability analyses are presented in Table 1 below.

Table 1. Material Properties for the FAP Dam Safety Factor Analyses

Material	Sat. Unit Weight, γ_{sat} (pcf)	Moist Unit Weight, γ_m (pcf)	Drained Strengths		Undrained Strengths	
			Cohesion, c' (psf)	Friction Angle, ϕ' (degrees)	Undrained Strength, S_u (psf)	Undrained Strength Ratio
Clay Core	125	120	0	28	-	0.38
Shell	130	125	0	33	-	-
Alluvium	120	120	0	26	-	-
Bedrock	150	150	1,000	65	-	-
Cutoff Wall	106	106	0	28	10	-
Fly Ash	90	90	0	0	-	-

5.3 Embankment Pore Pressure Distribution

Based on guidance from the EPA Regulations (EPA 2015), pore-water pressures are estimated from the most reliable of the following: *"1) Field measurements of pore pressures in existing slopes; 2) past experience and judgment of the Engineer; 3) hydrostatic pressures calculated for the no-flow condition; or 4) steady-state seepage analysis using flow nets or finite element analyses."* For the FAP analysis, the pore pressure distribution was assigned using water level readings obtained from piezometers located near the stability cross sections (APS 2014). This distribution was adjusted based on engineering judgement to correspond with pond water level under steady-state, maximum storage pool conditions (ADWR 1986), and pond water levels under maximum surcharge pool conditions (Ebasco 1975). The piezometers used to estimate the pore water pressure within the dam cross sections are shown in Figures 1.

The FAP (upstream) water level under maximum storage pool condition was based on the permitted water level of the pond as stated in the ADWR operating license for the dam. Since the dam has no outlet work structure and rely on pumping rate from plant, seepage, and evaporation to control water levels, the maximum storage pool was set at the maximum permitted water levels. For the FAP this is EL 5,114.0 ft (ADWR 1986). The surcharge pool level is based on the expected water level raise during the design PMF and is EL 5,116.0 ft for the FAP (Ebasco 1975).

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 7 of 15

5.4 Embankment Loading Conditions

Per 40 CFR Section 257.73(e), the following loading conditions were considered for each selected stability cross section:

- Long-term, maximum storage pool;
- Maximum surcharge pool;
- Seismic loading; and
- Liquefaction.

These loading conditions are described below.

Long-Term, Maximum Storage Pool

The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. This loading condition is evaluated to document whether the CCR surface impoundments can withstand the maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The maximum storage pool considers a pool elevation in the CCR unit that is equivalent to the maximum permitted water levels using shear strengths expressed as effective stress with pore water pressures that correspond to the long-term condition.

For this analysis, the long-term, maximum storage pool in the FAP was set at EL 5,114.0 ft. Since the piezometric conditions within the dam are at steady-state flow, drained material strengths were used in the analysis.

Maximum Surcharge Pool

The maximum surcharge pool loading is the temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment is normally subject under the inflow design flood state. This loading condition is evaluated to document whether the CCR surface impoundments can withstand a short-term impact of a raised pool level on the stability of the downstream slope. The maximum surcharge pool considers a temporary pool elevation that is higher than the maximum storage pool assuming that it persists for a length of time sufficient for steady-state seepage or hydrostatic conditions to fully develop within the embankment.

For this analysis, the maximum surcharge pool in the FAP was set at EL 5,116.0 ft. Since the piezometric conditions within the dam are at steady-state flow for this loading condition, drained material strengths were used in the analysis.

Seismic Loading

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 8 of 15

Seismic loading was evaluated to document whether the CCR surface impoundments are capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. The seismic loading is assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years. A pseudo-static analysis was used to represent the seismic loading.

The peak horizontal bedrock acceleration for a site classification of B “Rock” based on the USGS 2008 NEHRP seismic hazard map with a 2% probability of exceedance in 50 years is 0.0807g as presented in Attachment A (USGS 2008). Based on previous site explorations, a sit classification of D “Stiff Soil” was assigned to the site as illustrated in Table 1615.1.1 from the IBC (2003) shown in Figure 2.

TABLE 1615.1.1
SITE CLASS DEFINITIONS

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100 feet, AS PER SECTION 1615.1.5		
		Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \bar{v}_s \leq 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_s \leq 2{,}500$	$\bar{N} > 50$	$\bar{s}_u \geq 2{,}000$
D	Stiff soil profile	$600 \leq \bar{v}_s \leq 1{,}200$	$15 \leq \bar{N} \leq 50$	$1{,}000 \leq \bar{s}_u \leq 2{,}000$
E	Soft soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	$\bar{s}_u < 1{,}000$
E	—	Any profile with more than 10 feet of soil having the following characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \geq 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H >$ 10 feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H >$25 feet with plasticity index $PI >$75) 4. Very thick soft/medium stiff clays ($H >$120 feet)		

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kPa. N/A = Not applicable

Figure 2. Table 161.1.1 Site Class Definitions (IBC 2003)

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Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 9 of 15

The PGA at the ground surface for Site Class D, or PGA_M, was determined by amplifying the PGA for rock (Site Class B) using the following equation presented in NEHRP, 2009:

$$PGA_M = F_{PGA}(PGA)$$

$$PGA_M = 1.6(0.0807g)$$

$$PGA_M = 0.129g$$

Where:

PGA_M = Maximum considered earthquake geometric mean peak ground acceleration adjusted for Site Class effects

PGA = Mapped maximum considered earthquake geometric mean peak ground acceleration

F_{PGA} = Site coefficient from Table 11.8-1 (Figure 3)

Table 11.8-1 Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.1	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA ≥ 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of PGA.

Figure 3. Table 11.8-1 Site Coefficient F_{PGA} (NEHRP 2009)

The PGA at the ground surface for Site Class D (PGA_M) was then used to estimate the peak transverse acceleration at the crest of the embankment, PGA_{crest} = 0.307g, as shown on Figure 4 and based on variations in recorded peak crest accelerations versus those recorded at the base of earth and rock fill dams by Idriss (2015) and on recorded values for Loma Prieta, and other earthquakes, by Holzer (USGS, 1998).

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Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 10 of 15

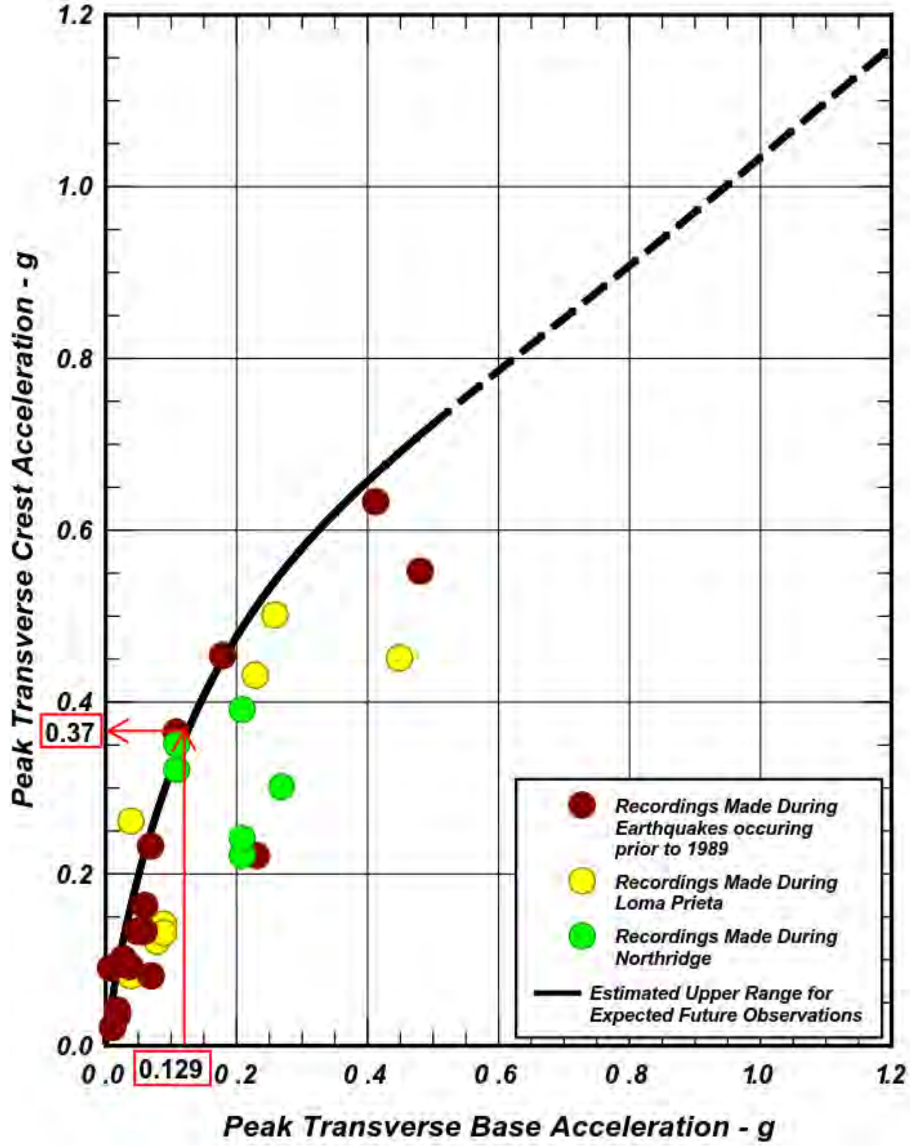

Figure 4. Variations of Peak Transverse Crest Acceleration vs. Peak Transverse Base Acceleration Based on Holzer (1998)

Makdisi and Seed (1977) notes that the "maximum acceleration ratio" varies with the depth of the sliding mass relative to the embankment height. Figure 5 (shown below) presents the relationship between maximum acceleration ratio (k_{max}/u_{max}) and depth of sliding mass (y/h). For deep-seated failure surfaces that involve the entire vertical profile of the dam slope and extend from the crest to the toe or below the toe of the embankment into the foundation soils, the acceleration at the crest can be as low as approximately 34 percent of the maximum value:

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Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 11 of 15

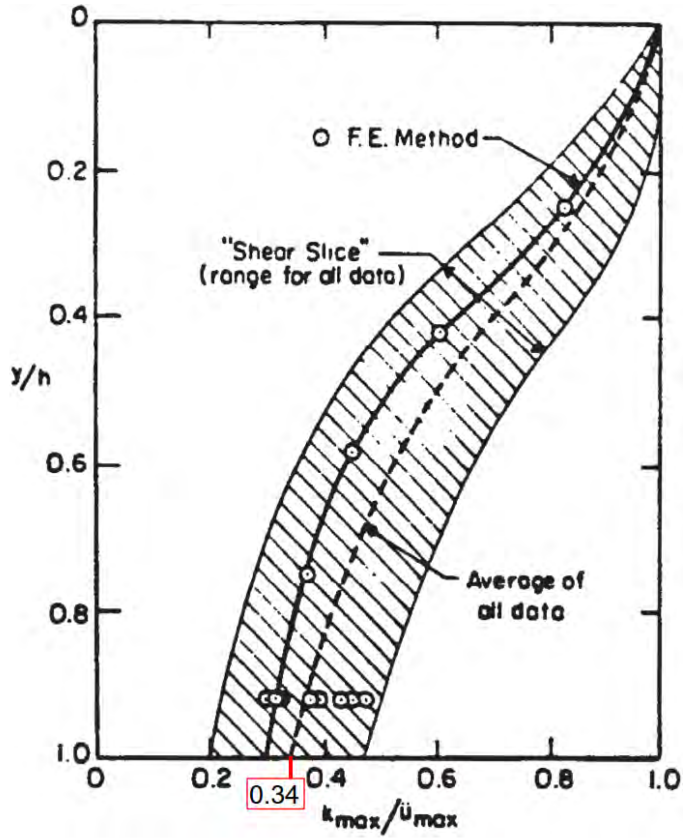

Figure 5. Variation of "Maximum Acceleration Ratio" with Depth of Sliding Mass after Makdisi and Seed (1977)

Therefore:

$$\frac{k_{max}}{u_{max}} = 0.34$$

Where: k_{max} = the maximum average acceleration for the potential sliding mass
u_{max} = the maximum crest acceleration

$$k_{max} = 0.34(u_{max})$$

$$k_{max} = 0.34(0.37g)$$

$$k_{max} = 0.13g$$

The pseudo-static analyses incorporated a horizontal seismic coefficient of 0.13g.

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 12 of 15

The water level in the FAP for the seismic loading analysis was set to EL 5,114.0 ft, to match the long-term, maximum storage pool. The Clay Core and Cutoff Wall materials were assigned undrained strength. Due to the relatively rapid loading induced during the seismic event and these materials' relatively low hydraulic conductivity, it is anticipated that the Clay Core and Cutoff Wall materials would behave in an undrained manner. All, other materials used drained strength parameters.

Liquefaction

The liquefaction factor of safety is evaluated for CCR units that show, through representative soil sampling and construction documentation that soils of the embankment and/or foundation are susceptible to liquefaction. The liquefaction factor of safety is calculated to document whether the CCR unit would remain stable if the soils in the embankment and/or foundation experienced liquefaction.

Post-construction geotechnical exploration of the FAP and Bottom Ash Pond Dams (Harza 1987 and D&M 1999) indicated the Clay Core (embankment) and Alluvium Overburden (foundation) materials have plasticity indexes and fine contents as shown in Table 2 below. Generally, the behavior of soils that have fines contents greater than 35 percent are dominated by the plasticity of their fines (Idriss and Boulanger 2008). Fines with Plasticity Index (PI) less the 7 tend to behave more sand-like and are susceptible to soil liquefaction, while those with PI greater than 7 tend to behave more clay-like and are not susceptible to liquefaction. The lowest measured value of PI for both the Clay Core and Alluvium Overburden is 12, indicating these soils would tend to behave in a clay-like manner during a seismic event and not be susceptible to soil liquefaction. Consequently, a liquefaction factor of safety analysis was not performed for the FAP.

Table 2. Range of Plasticity Index and Fines Content Values for Site Materials

	Plasticity Index		Fines Contents, %	
Material	**Minimum Value**	**Maximum Value**	**Minimum Value**	**Maximum Value**
Clay Core	12	39	48	88
Alluvium Overburden	12	17	30	54

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Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 13 of 15

6 ANALYSIS RESULTS AND CONCLUSIONS

The results of the slope stability analysis are presented in Attachment B. Tables 3 below summarize the results of the safety factor analysis.

Table 3. Safety Factor Results for the FAP Dam

Loading Condition	Required Safety Factor	Calculated Minimum Safety Factor		
		Cross Section 1	Cross Section 2	Cross Section 3
Long-term, maximum storage pool	1.50	1.63	1.53	1.73
Maximum surcharge pool	1.40	1.61	1.52	1.70
Seismic (Pseudo-Static)	1.00	1.08	1.02	1.15

The results of the safety factor analyses show that the FAP Dam exceed the minimum required factors of safety for the long-term, maximum storage pool; the maximum surcharge pool; and the seismic (pseudo-static) loading conditions.

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 14 of 15

7 REFERENCES

The following references were used in performing this calculation:

AECOM, 2016, "Material Properties Calculation Package," Prepared for Arizona Public Service Company, March 7.

Arizona Department of Water Resources (ADWR), 1986, *License of Approval*, Cholla Bottom Ash Pond Dam and Reservoir, State File No. 09.28, October 21.

Arizona Public Services Company (APS), 2016, "Cholla Power Plant Fly Ash Pond, Bottom Ash Pond, Sedimentation Pond and Bottom Ash Monofill Annual CCR Impoundment and Landfill Inspection Report 2015."

Cooper Aerial Surveys Co., 2014, "Cholla Ash 2014: June 13, 2009 Topographic Mapping," Prepared for Arizona Public Service Company, Drawing No. 1, Sheet No. 1.

Dames and Moore (D&M), 1999, "Interim Report, Geotechnical Investigation for Evaluation of Dam Embankment Crack, FAP Dam, Cholla Power Plant, Joseph City, Arizona," Prepared for Arizona Public Service Company, D&M Job No. 02353-143-022, May 9.

Ebasco Services Inc. (Ebasco), 1975, "Arizona Public Services Cholla Generating Station Ash Disposal Sites Seepage and Foundation Studies: Volume I of II Engineering Report," Prepared for Arizona Public Service Company, August.

Ebasco Services Inc. (Ebasco), 1977, "Ash Disposal System: Fly Ash Pond Dike – Sections & Details," Prepared for Arizona Public Service Company, APS Drawing No. G-44558, Revision No. 10 (As Built), November 9.

GEOSLOPE International, 2012, GeoStudio 2012, Version 8.15.4.11512, August 2015 Release.

Harza Engineering Company (Harza), 1987, "Cholla S.G.S., Safety Inspection Report on Fly Ash Dam, Bottom Ash Dam, and Cooling Dike," Prepared for Arizona Public Service Company, February 27.

Holzer, Thomas L., 1998, "The Loma Prieta Earthquake of October 17, 1989, Earth Structures and Engineering Characterization of Ground Motion," USGS Professional Paper 1552-D, U.S. Government Printing Office.

Idriss, I.M. and Boulanger, R.W., 2008, "Soil Liquefaction During Earthquakes," Earthquake Engineering Research Institute, Monograph No MNO-12.

International Code Council (ICC), Inc., 2003, "2003 International Building Code [IBC]," May.

DESIGN CALCULATION				
Calculation Title: Fly Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 15 of 15

National Earthquake Hazard Reduction Program (NEHRP), 2009, "Recommended Seismic Provisions for New and Other Structures," Document No. FEMA P-750, 2009 Ed.

Makdisi, F.I. and Seed, H.B., 1977, "A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments," Report No. UCB/EERC-77/19, University of California, Berkeley, August.

United States Environmental Protection Agency (EPA), 2015, 40 CFR § 257 and 261 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, Federal Register Vol. 80, No. 74, April 17.

United States Geological Survey (USGS), 2008. *2008 Interactive Deaggregations*. http://geohazards.usgs.gov/deaggint/2008/. Accessed March 11, 2016.

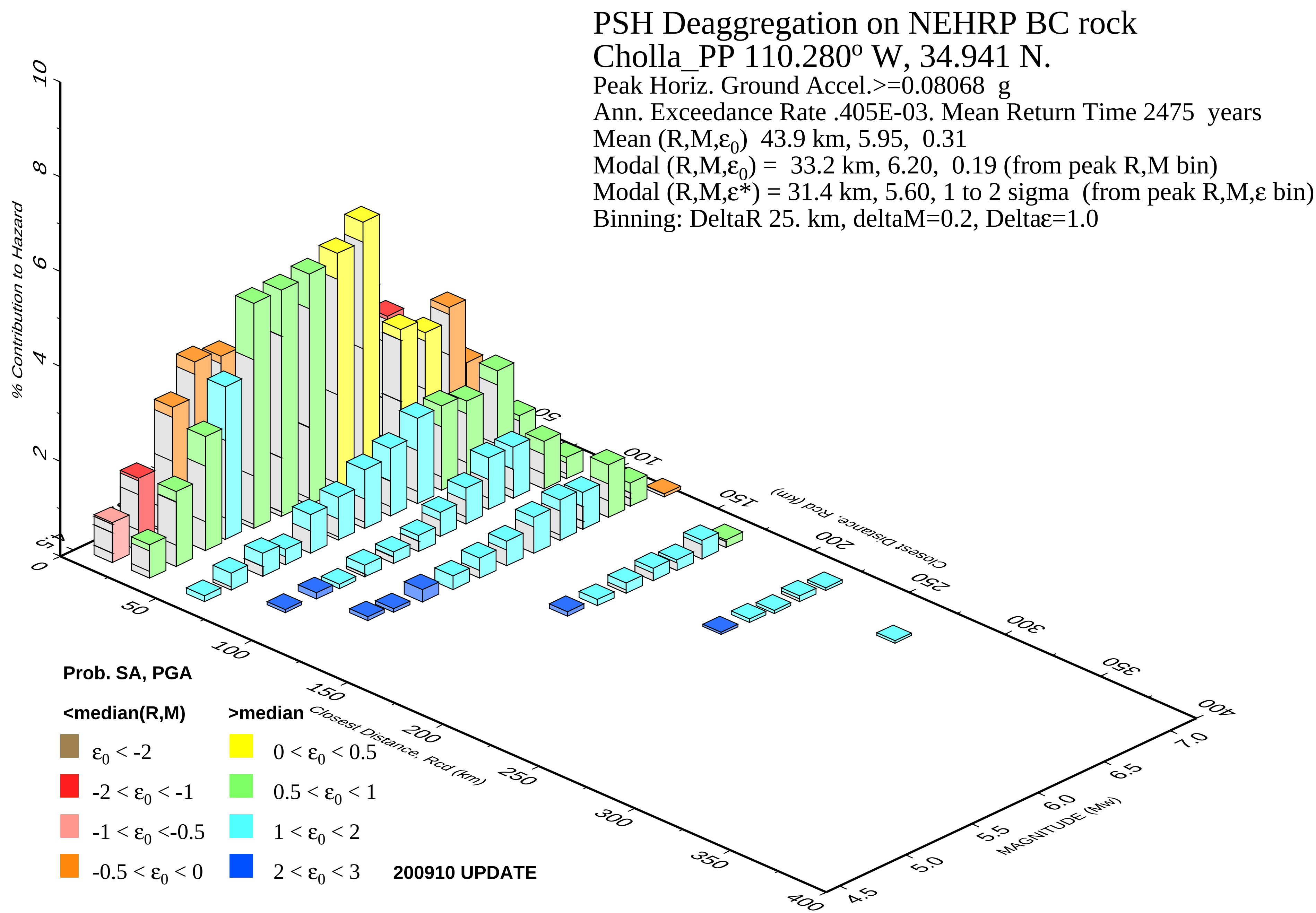
8 ATTACHMENTS

ATTACHMENT A USGS 2008 Seismic PSH Deaggregation

ATTACHMENT B Slope/W Output Figures

ATTACHMENT A

USGS 2008 Seismic PSH Deaggregation



GMT 2016 Mar 11 23:50:39 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

ATTACHMENT B

Slope/W Output Figures

Slope Stability Analysis
Cross Section 1
Fly Ash Pond

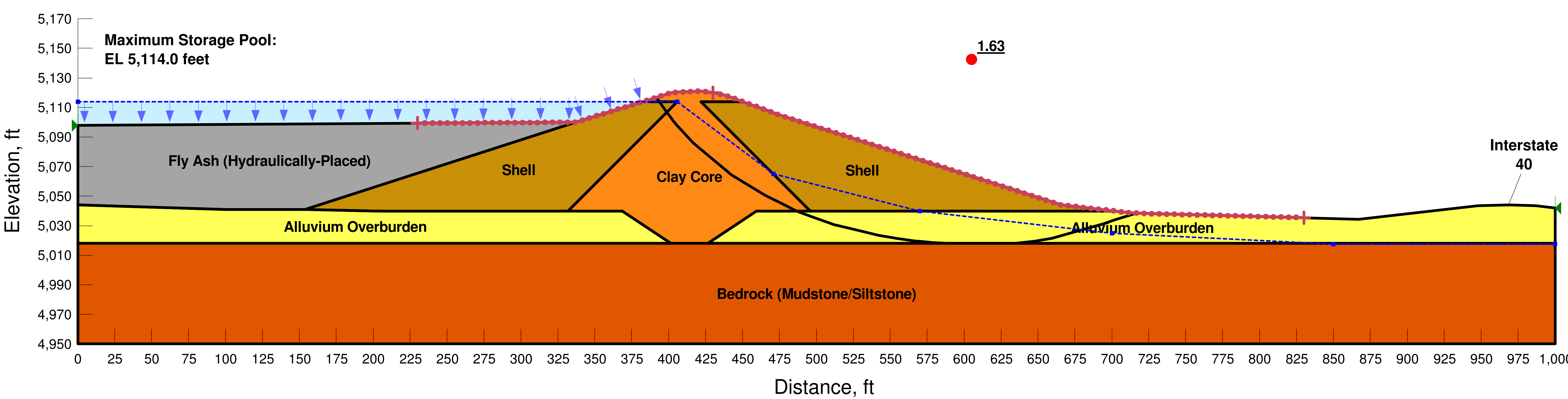
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B1) Static Maximum Storage Pool
File Name: APS Cholla FAP Section 1 - Static.gsz
Date: 4/13/2016
Method: Spencer

Factor of Safety: 1.63

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °



Slope Stability Analysis
Cross Section 1
Fly Ash Pond

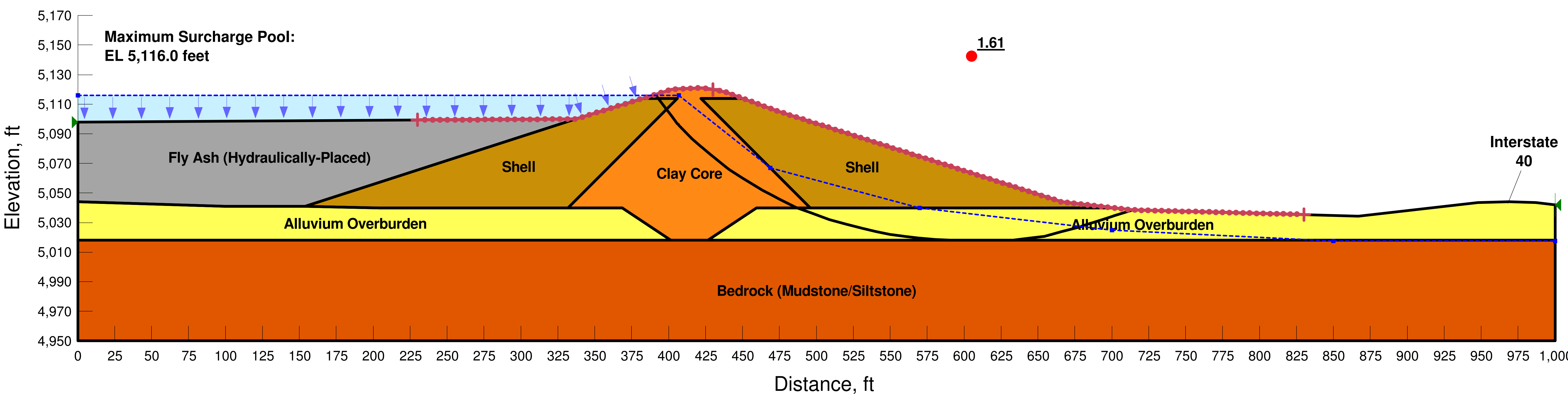
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B2) Static Maximum Surcharge Pool
File Name: APS Cholla FAP Section 1 - Static.gsz
Date: 4/13/2016
Method: Spencer

Factor of Safety: 1.61

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °



Slope Stability Analysis
Cross Section 1
Fly Ash Pond

Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

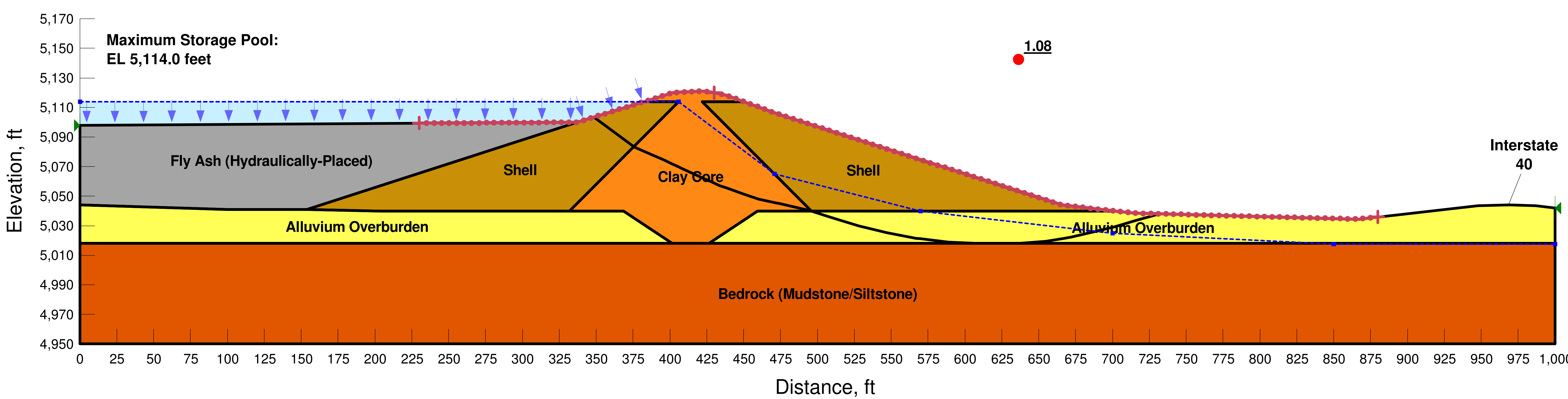
Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B3) Seismic Maximum Storage Pool
File Name: APS Cholla FAP Section 1 - Seismic.gsz
Date: 4/13/2016
Method: Spencer

Factor of Safety: 1.08

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:	Undrained Strength Ratio:
Clay Core	125 pcf	120 pcf	--	--	0.38
Shell	130 pcf	125 pcf	0 psf	33 °	--
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °	--
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °	--
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °	--

Horz Seismic Coef.: 0.13



Slope Stability Analysis
Cross Section 2
Fly Ash Pond

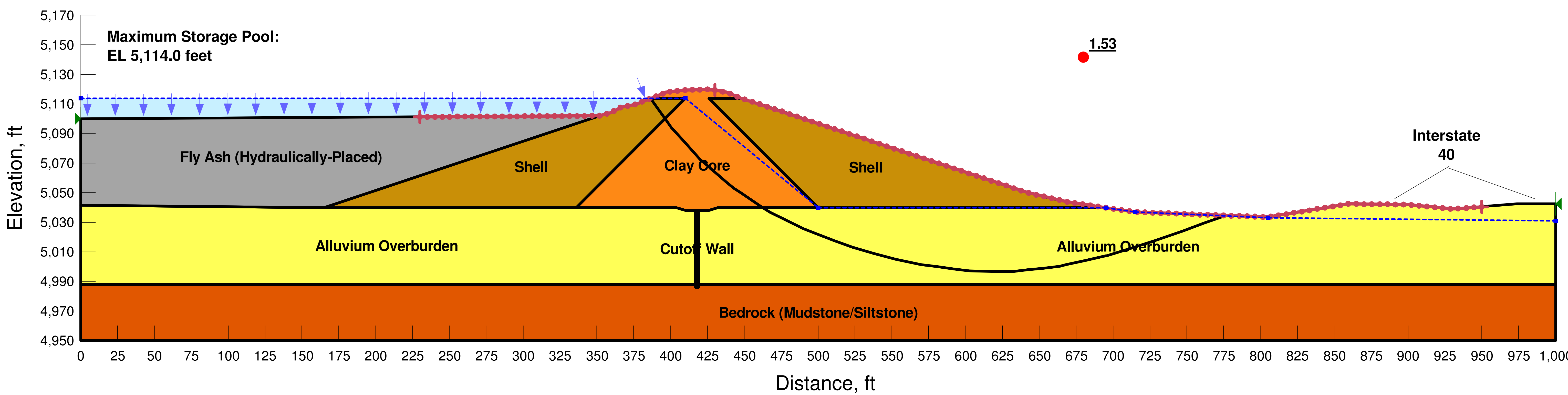
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B4) Static Maximum Storage Pool
File Name: APS Cholla FAP Section 2 - Static.gsz
Date: 6/20/2016
Method: Spencer

Factor of Safety: 1.53

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Cutoff Wall	106 pcf	106 pcf	0 psf	28 °
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °



Slope Stability Analysis
Cross Section 2
Fly Ash Pond

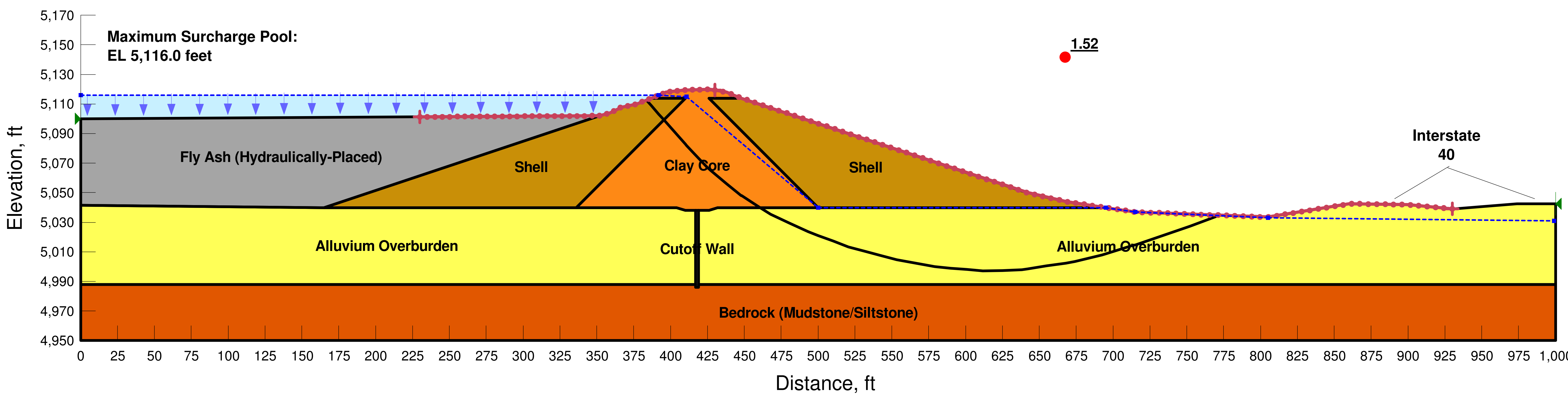
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B5) Static Maximum Surcharge Pool
File Name: APS Cholla FAP Section 2 - Static.gsz
Date: 6/20/2016
Method: Spencer

Factor of Safety: 1.52

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Cutoff Wall	106 pcf	106 pcf	0 psf	28 °
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °



Slope Stability Analysis
Cross Section 2
Fly Ash Pond

Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

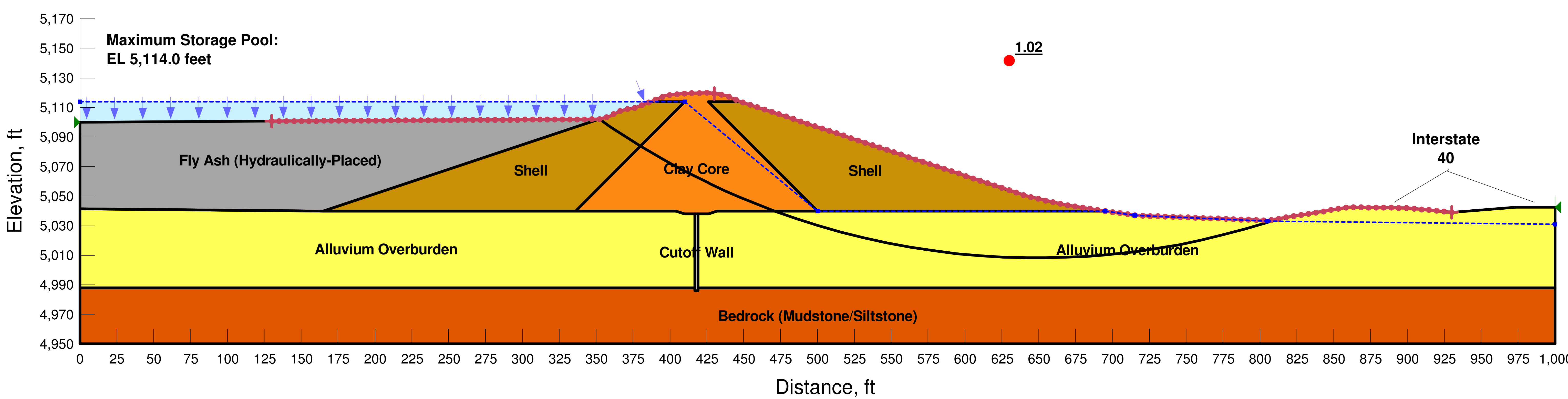
Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B6) Seismic Maximum Storage Pool
File Name: APS Cholla FAP Section 2 - Seismic.gsz
Date: 6/20/2016
Method: Spencer

Factor of Safety: 1.02

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:	Undrained Strength Ratio:
Clay Core	125 pcf	120 pcf	--	--	0.38
Shell	130 pcf	125 pcf	0 psf	33 °	--
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °	--
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °	--
Cutoff Wall	106 pcf	106 pcf	10 psf	0 °	--
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °	--

Horz Seismic Coef.: 0.13



Slope Stability Analysis
Cross Section 3
Fly Ash Pond

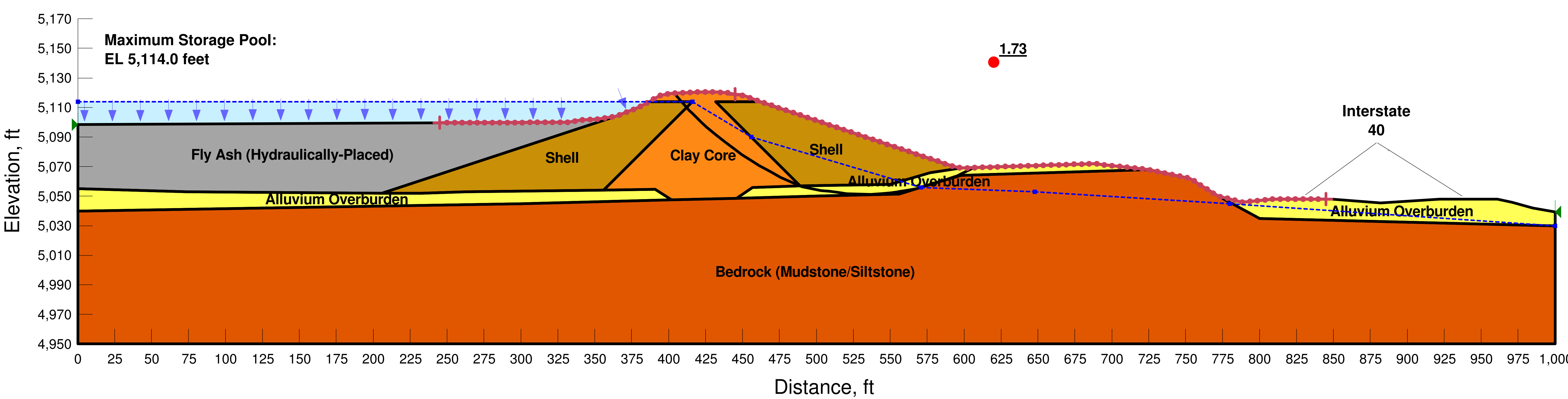
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B7) Static Maximum Storage Pool
File Name: APS Cholla FAP Section 3 - StaticA.gsz
Date: 4/13/2016
Method: Spencer

Factor of Safety: 1.73

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °



Slope Stability Analysis
Cross Section 3
Fly Ash Pond

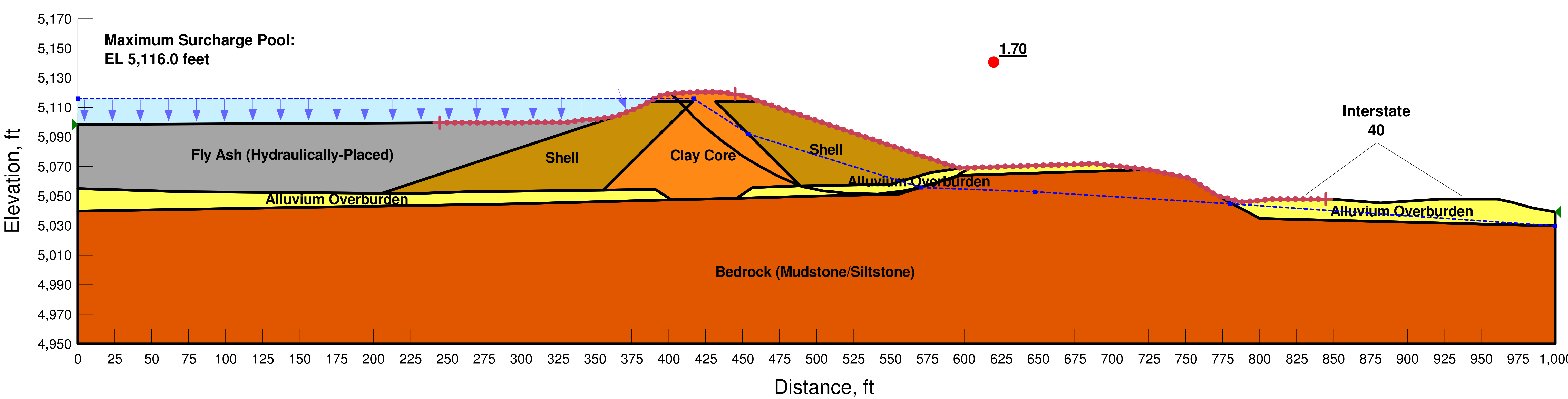
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B8) Static Maximum Surcharge Pool
File Name: APS Cholla FAP Section 3 - StaticA.gsz
Date: 4/13/2016
Method: Spencer

Factor of Safety: 1.70

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °



Slope Stability Analysis
Cross Section 3
Fly Ash Pond

Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

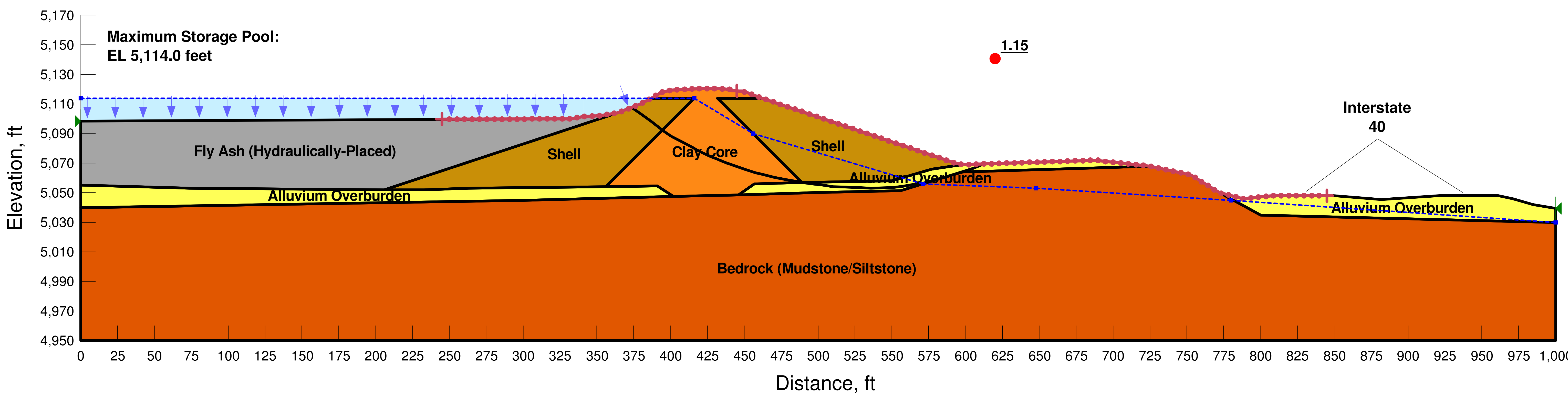
Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B9) Seismic Maximum Storage Pool
File Name: APS Cholla FAP Section 3 - Seismic.gsz
Date: 4/13/2016
Method: Spencer

Factor of Safety: 1.15

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:	Undrained Strength Ratio:
Clay Core	125 pcf	120 pcf	--	--	0.38
Shell	130 pcf	125 pcf	0 psf	33 °	--
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °	--
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °	--
Fly Ash (Hydraulically-Placed)	90 pcf	90 pcf	0 psf	0 °	--

Horz Seismic Coef.: 0.13



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August 26, 2016

Final Summary Report
Structural Integrity Assessment

Bottom Ash Pond
Cholla Power Plant
Joseph City, Arizona

Prepared for:
Arizona Public Service

AECOM Job No. 60445840
August 2016

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List of Acronyms

ADWR	Arizona Department of Water Resources
APS	Arizona Public Service
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EAP	Emergency Action Plan
EL	Elevation
EPA	United States Environmental Protection Agency
ft	feet
HDPE	High Denisty Polyethylene
HPC	Hazard Potential Classification
I-40	Interstate 40
pcf	pounds per cubic foot
psf	pounds per square foot
PI	Plasticity Index
PMF	Probable Maximum Flood
RCRA	Resource Conservation and Recovery Act
USCS	Unified Soil Classification System
USGS	United States Geological Survey

Certification Statement

Certification Statement for:

- **40 CFR § 257.73(a)(2)(ii) – Initial Hazard Potential Classification for an Existing CCR Surface Impoundment**
- **40 CFR § 257.73(d)(3) – Initial Structural Stability Assessment for an Existing CCR Surface Impoundment**
- **40 CFR § 257.73(e)(2) – Initial Safety Factor Assessment for an Existing CCR Surface Impoundment**

CCR Unit: Arizona Public Service Company; Cholla Power Plant; Bottom Ash Pond

I, Alexander Gourlay, being a Registered Professional Engineer in good standing in the State of New Mexico, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the initial hazard potential classification, initial structural stability assessment, and initial safety factor assessment as included in the Structural Integrity Assessment Report dated August 17, 2016 was conducted in accordance with the requirements of 40 CFR § 257.73.

Alexander W. Gourlay, P.E.
____

Printed Name

August 26, 2016
____

Date

1 Introduction

Arizona Public Service Company (APS) contracted URS Corporation, a wholly owned subsidiary of AECOM, to assist in the initial structural integrity assessment of the existing coal combustion residual (CCR) surface impoundments at the Cholla Power Plant in Joseph City, Arizona. Figure 1-1 shows the location of the CCR Impoundments at the Cholla Power Plant. This Summary Report documents the AECOM structural integrity assessment for the Bottom Ash Pond, Arizona Department of Water Resources (ADWR) Dam No. 09.27. Assessments of other CCR Impoundments at the Cholla Power Plant are presented in separate reports.

1.1 Report Purpose and Description

The purpose of this report is to document the initial structural integrity assessment for the Bottom Ash Pond located at the Cholla Power Plant. The Bottom Ash Pond is an existing CCR surface impoundment owned and operated by APS that is regulated by the Arizona Department of Water Resources (ADWR). In 2015, the United States Environmental Protection Agency (EPA) finalized Federal Rule (Rule) 40 Code of Federal Regulations (CFR) § 257.73 (EPA, 2015) regulating CCRs under subtitle D of the Resource Conservation and Recovery Act (RCRA). As part of this Rule, owners and operators of existing CCR surface impoundments must complete initial and periodic structural integrity assessments to document whether the CCR unit poses a reasonable probability of adverse effects on health and the environment.

1.2 EPA Regulatory Requirements

Pursuant to Rule 40 CFR § 257.73 (EPA, 2015), each existing CCR surface impoundment must have initial and periodic structural integrity assessments to evaluate whether the CCR unit poses a reasonable probability of adverse effects on health and the environment. The assessments must address the following elements:

- *Periodic Hazard Potential Classification Assessment (40 CFR § 257.73(a)(2))* - Document the hazard potential classification of each CCR unit as either a high hazard, significant hazard or low hazard potential CCR unit.

- *Emergency Action Plan (EAP) (40 CFR § 257.73(a)(3))* - Prepare and maintain a written EAP for high and significant hazard CCR units. The EAP must be evaluated at least every five years and, if necessary, updated and revised to maintain accurate information of current CCR unit conditions. The evaluation and certification of the EAP is provided in a separate report.

In addition, the following elements must be addressed for CCR units, such as the Bottom Ash Pond, that have a height of five feet (ft) or more and a storage volume of 20 acre-ft or more, or have a height of 20 ft or more:

- *History of Construction (40 CFR § 257.73(c)(1))* - Compile a history of construction of the CCR unit including elements of operation, location, design, monitoring instrumentation, maintenance and repair, and historic structural instabilities.

- *Periodic Structural Stability Assessment (40 CFR § 257.73(d))* - Document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practice for the maximum volume of CCR and CCR wastewater which can be impounded therein.

- *Periodic Safety Factor Assessment (40 CFR § 257.73(e))* - Document whether the calculated factors of safety for each CCR unit achieve minimum safety factors for the critical cross section of the embankment under long-term, maximum storage pool loading conditions, maximum surcharge loading conditions, seismic loading conditions, and post-earthquake loading conditions for dikes constructed of soils susceptible to liquefaction.

Existing CCR surface impoundments, such as the Bottom Ash Pond, are required to have an initial structural integrity assessment within 18 months of publication of the EPA Rule on April 17, 2015 and periodic assessments performed every five years thereafter.

1.3 Report Organization

This Summary Report has been organized into the following sections:

Report Section	Applicable CFR 40 Part 257 Citation
• Section 1 – Introduction	
• Section 2 – Hazard Potential Classification	§ 257.73(a)(2) Periodic hazard classification assessments
• Section 3 – History of Construction	§ 257.73(c)(1) History of construction
• Section 4 – Structural Stability Assessment	§ 257.73(d) Periodic structural stability assessment
• Section 5 – Safety Factor Assessment	§ 257.73(e) Periodic safety factor assessment
• Section 6 – Conclusions	
• Section 7 – Limitations	
• Section 8 – References	
• Figures	
• Appendix A – Historic Drawings	
• Appendix B – Safety Factor Calculation	

1.4 Facility Description

The Cholla Power Plant is an electric generating station located in the town of Joseph City, Navajo County, Arizona. The station consists of four coal-fired units. Units 1, 2 (decommissioned), and 3 are owned by APS and Unit 4 is owned by PacifiCorp. CCR generated at the power plant are disposed of at two major surface impoundments located off-site; the Fly Ash Pond located about one-and-a-half miles east of the plant and the Bottom Ash Pond located about two miles north of the plant. Figure 1-1 shows the location of the Fly Ash Pond and Bottom Ash Pond in relation to the power plant. This assessment evaluates the structural integrity of the Bottom Ash Pond.

The Bottom Ash Pond consists of a reservoir located in the southern portion of the pond, directly upstream of the dam and two coal combustion waste storage cells, the West Cell and the East Cell, located in the northern portion of the pond. The Bottom Ash Pond receives waste water from the Bottom Ash Transfer Sump that contains water and solids from the following sources: bottom ash overflow sump; bottom ash slurry from Units 1 through 4; Area 1, 2, and 3 Area Drainage Sumps; Units 1, 2, 3, and 4 Bottom Ash Hoppers; General Water Sump Liquids and Solids; Sedimentation Pond effluent; Units 1, 2, 3, and 4 Oil Water Separators; boiler cleaning waste; and water siphoned back from the Bottom Ash Pond. In addition, the following are discharged to the Bottom Ash Pond: scrubber sludge, Bottom Ash Pond stormwater, Units 3 and 4 Cooling Tower Basin Solids, seepage and stormwater from the Bottom Ash Monofill retention basins, General Water Sump Solids, Sedimentation Pond solids, WARP Solids, Flue Gas Desulfurization Wastes, and oil/water separator solids. The CCR wastes and other discharges are pumped to one of the two upstream waste storage cells, where the bottom ash is allowed to settle and the water is decanted to the reservoir for reuse at the power plant. At any given time, one of the waste storage cells is receiving bottom ash while the other is drained, excavated, and transported to a monofill north of the pond where the bottom ash is dry stacked. Excess water from the upstream cells are drained to the downstream reservoir via 12-inch pipes that outlet directly to the reservoir. The water is decanted from the reservoir for reuse at the power plant through a siphon system.

The Bottom Ash Pond has a total surface area of about 80 acres and a total storage capacity including solids and water of about 2,300 acre-ft when at its ADWR permitted maximum storage pool water level of EL 5,117.8 ft (ADWR, 1986). The impoundment is surrounded on its west and north sides by natural topography consisting of rock outcrops of mudstones, siltstones, and sandstones. On the south and east side, the impoundment is enclosed by the Bottom Ash Pond Dam, Arizona ADWR Dam No. 09.27, which spans the Tanner Wash. The Bottom Ash Pond has been classified under ADWR regulations as a high hazard impoundment due to probable loss of human life at the nearby U.S. Interstate 40 (I-40), Cholla Power Plant, freight railroad line, and downstream residences, in the event of a dam breach.

The Bottom Ash Pond Dam is an earthen, zoned embankment dam consisting of a central clay core surrounded by an outer sand and gravel shell (random material zone). Construction began on the dam in 1976 and it started receiving CCR materials in 1978. In 1993 the dam crest was raised 3.3 ft when it became apparent that the storage volume of the pond was inadequate and the pond was filling faster than anticipated. In 1999 the impoundment was altered to its current configuration consisting of two upstream waste drainage cells and a downstream reservoir. The two waste cells are alternately dried and dredged to facilitate the removal of bottom ash from the sluice water which drains to the reservoir. By this procedure, the total storage volume in the pond remains relatively constant. The dam is approximately 4,200 ft in length with a maximum toe to crest height of 73 ft and crest width of 12 ft. The top of crest elevation is elevation (EL) 5,123.3 ft after the 1993 crest raise providing 5.5 ft of freeboard above the maximum permitted storage pool water level. Both the upstream and downstream slopes are inclined at a three horizontal to one vertical (3H:1V) angle except for the upper portion of the slopes constructed during the crest raise where the slopes are inclined at a 1.5H:1V vertical angle. Both upstream and downstream slopes are lined with riprap facing to prevent erosion.

To limit seepage beneath the foundation, the central clay core of the Bottom Ash Pond Dam extends to bedrock at relatively shallow depths, less than 20 ft. In the center portion of the dam where the depth to bedrock is greater than 20 ft,, a slurry cutoff wall extends from the clay core to the bedrock or stiff clay. The Bottom Ash Pond Dam has no internal drain system; however, where seepage has been observed downstream of the dam, sumps have been installed to collect surface storm water and groundwater and return it to the pond. These include seepage collection systems for the West Abutment Seep, the Petroglyph Seep, the P-226 Seep, and the Tanner Wash Seep.

The Bottom Ash Pond has no fixed intake or outlet water work structures. Sluiced bottom ash is pumped from the plant to the pond through a discharge line that runs up the right dam abutment, adjacent to the embankment and to a screening plant that scalps off some of the bottom ash solids for commercial use as light weight aggregate by the Salt River Materials Group. The processed slurry is then pumped to one of the two waste cells where the bottom ash settles and the excess water is decanted to the reservoir. Water levels within the pond are controlled by varying the pumping rate from the plant and seepage control system to balance with seepage, evaporation, and siphon system in the reservoir. The siphon system consists of three 12-inch diameter high density polyethylene (HDPE) pipes that float near the surface of the reservoir. The pipes were originally 8-inch in diameter but were replaced with the current 12-inch diameter pipes in the late 2000s. The siphon system pipes extend through the upper portion of the dam at a pipe invert elevation of about EL 5,120.5 ft and continue down the downstream face of the dam to a common valve chamber that combines the flow into a return pipe. The dam was constructed without an overflow spillway channel. To prevent overtopping during the design storm event, defined as the probable maximum flood (PMF), the pond was constructed to fully contain the storm runoff on top of the maximum permitted storage pool water level. This water level, defined as the maximum surcharge pool water level, is estimated at EL 5,119.3 ft based on an expected water level rise of 1.5 ft during the PMF (Dames & Moore, 1991).

Piezometers, settlement monuments, flow measurement devices, and water level gauges are installed at the Bottom Ash Pond to monitor the performance of the dam. Measurements from the monitoring instruments are reviewed by AECOM and documented annually in a data report. Starting on October 19, 2015, the piezometer, survey monuments, V-notch weirs, and sumps are read at intervals not exceeding 30 days per the requirements of 40 CFR § 257.83(a)(1)(iii). The locations of the piezometers, survey monuments, weir, and flow totalizers are shown on Figure 1-2.

Inspections of the Bottom Ash Pond are performed by a qualified person at intervals not exceeding seven days. The inspections examine the Bottom Ash Pond for actual or potential conditions that could disrupt the operation or safety of the impoundment and documents the results of the inspection in the facility’s operating record. In addition, a more detailed annual inspection is performed by a qualified professional engineer. The annual inspection includes a review of available information on the dam including the past year of monitoring data, a field inspection of the dam, abutment, and downstream toe and documentation of findings and recommendations in a dam safety inspection report. The most recent annual inspection of the Bottom Ash Pond was performed on October 16, 2015 (AECOM & APS, 2016).

2 Hazard Potential Classification

This section summarizes the initial Hazard Potential Classification (HPC) for the Bottom Ash Pond. This initial HPC is intended to meet the requirement for periodic hazard potential classification assessment of existing CCR surface impoundments per Rule 40 CFR § 257.73(a)(2).

2.1 Methodology and Design Criteria

Per the Rule, the hazard potential classification provides an indication of the possible adverse incremental consequences that result from the release of water or stored contents due to failure or mis-operation of the CCR surface impoundment. The classification is based solely on the consequences of failure. As such, it is not dependent of the condition of the embankment or the likelihood of failure. Classifications per the Rule are separate from relevant and/or applicable federal, state or local dam safety regulatory standards, which may also include hazard classification definitions, and are not intended to substitute for other regulatory hazard potential classifications.

Rule 40 CFR § 257.53 defines three hazard potential classifications as follows:

High hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation will probably cause loss of human life.

Significant hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

Low hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment's owner's property.

The hazard potential of the Bottom Ash Pond was assessed qualitatively, per the above definitions. The qualitative assessment process is generally performed in a step-wise manner by first determining whether the pond could be classified as low hazard potential, based on immediately obvious factors such as proximity to property lines and/or surface water bodies. After determining that a structure does not meet the criteria for a Low Hazard Potential classification, the structure is assessed to determine whether it meets the criteria for High Hazard Potential. The potential for loss of life differentiates between high and significant hazard potential in the Final CCR Rule, therefore if the Dam does not meet the criteria for high hazard potential, it would be classified as a Significant Hazard Potential structure.

The potential for downstream loss of life is assessed by reviewing land use in areas downstream (to the south) from the Dam, where inundation is likely in the event of a release. A dam break analysis and inundation mapping has been documented for the Bottom Ash Pond (Stantec, 2000). The inundation was reportedly mapped downstream in the Tanner Wash to the Joseph City Wash. Habitable structures reported in the inundation area included I-40, the Burlington Northern & Santa Fe Railroad, and the Cholla Power Plant (Stantec, 2000). The United States Geological Survey (USGS) 7.5-Minute Quadrangle topographic map of Joseph City, Arizona and associated digital orthoimage data (USGS, 2013) were used to review downstream areas for existing permanent and temporary land use. Permanent land uses include permanently inhabited dwellings and worksite areas that would likely contain workers on a daily basis (public utilities, power plants, water and sewage treatment plants, private industrial plants, sand and gravel plants, farm operations, fish hatcheries). Temporary land uses include primary roads, established campgrounds, or other recreational areas.

2.2 Hazard Potential Classification Results

Inspection of the Bottom Ash Pond Dam and its immediate surrounding based on review of the USGS 7.5-Minute Quadrangle topographic map of Joseph City, AZ (USGS, 2013) and the dam break analysis report (Stantec, 2000) identifies that the Bottom Ash Pond is located approximately 2,000 ft upstream of I-40, a major east-west route of the Interstate Highway System. A catastrophic and unexpected failure of the Bottom Ash Pond Dam would likely inundate the travel lanes of I-40 and could result in loss of life. The Bottom Ash Pond is therefore classified as a High Hazard Potential CCR surface impoundment.

3 History of Construction

This section summarizes the history of construction for the Bottom Ash Pond. This information is intended to meet the requirement for compilation of the history of construction for each CCR surface impoundment per Rule 40 CFR § 257.73(c)(1).

3.1 Methodology

AECOM reviewed available documents obtained from APS, the ADWR Document Repository, or in-house resources for information regarding the history of construction for the Bottom Ash Pond. Per the Rule, the compiled history of construction should include, to the extent feasible, the following information:

- Information identifying the CCR Unit, its purpose and the name and address of the owner/operator;
- The location of the CCR unit on the most recent USGS or other topographic map;
- Name and size of the watershed within which the CCR unit is located;
- A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit was constructed;
- A description of the type, size, and physical and engineering properties of each embankment zone;
- Provide detailed engineering drawings;
- A description of the type, purpose and location of existing instruments;
- Area-capacity curves for the CCR unit;
- A description of spillway and diversion design features;
- Construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit; and
- Any record of knowledge of structural instability.

3.2 Bottom Ash Pond Construction Summary

The history of construction dating back to the original construction that began in 1976 is summarized in Table 3-1 below.

Table 3-1. History of Construction for Cholla Bottom Ash Pond

Item	As-Constructed/ Current	Comments	Reference Document
Name and Address of Owner	Arizona Public Service Company (APS): P.O. Box 53999, Phoenix, Arizona 85072	---	---
State ID No.	09.27	---	ADWR License of Approval dated December 11, 1998
Size Classification	Intermediate	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Hazard Classification	High	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Construction Date	Original: 1976 to 1977 Toe Drain System: 1979 Embankment Raise: 1993 Seepage Collection System: 1993 Impoundment Reconfiguration: 1999	---	• Ash Pond Construction Memorandum (Ebasco, 1977) • As-built Drawing No. G-44556 (Ebasco, 1977) • Toe Drain System Drawing No. D-82671 (APS, 1991) • Siphon System & Floating Pipeline As-built APS Drawing No. G566-S02 (APS, 1993)
Location on USGS Quadrangle Map	Joseph City Quadrangle: Section 13, Township 18 North, Range 19 East	See Figure 3-1	Joseph City Quadrangle (USGS, 2013)
Statement of Purpose	Bottom ash containment		Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975).
Name of Watershed	---	---	---
Size of Watershed (ac)	128	---	Flood Routing Report (Ebasco, 1976)
Area Capacity Curve	See Figure 3-2	---	Seepage and Foundation Studies: Volume I of II Engineering Report (Ebasco, 1975)
Embankment Type	Zoned earth fill dam consisting of a clay core and shell	---	As-built Drawing No. G-44556 (Ebasco, 1977)
Embankment Maximum Height (ft)	73	---	• As-built Drawing No. G-556 (Ebasco, 1977) • Siphon System & Floating Pipeline As-built APS Drawing No. G566-S02 (APS, 1993)
Design Total Freeboard (ft)	5.5	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)

Item	As-Constructed/ Current	Comments	Reference Document
Embankment Length (ft)	4,040	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Embankment Crest Elevation (ft)	Original: 5,120 Modified: 5123.3	Embankment raised in 1993	• As-built Drawing No. G-556 (Ebasco, 1977) • Siphon System & Floating Pipeline As-built APS Drawing No. G566-S02 (APS, 1993)
Embankment Crest Width (ft)	Original: 16 Modified: 12	---	• As-built Drawing No. G-44556 (Ebasco, 1977) • Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM, 2016)
Embankment Slopes	Original 3H:1V (downstream & upstream) Raised Upper 3 ft: 1.5H:1V (downstream & upstream)	---	As-built Drawing No. G-44556 (Ebasco, 1977)
Slope Protection	Riprap		Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Maximum Operating Storage Level (ft)	5117.8	Previous maximum storage levels were: 5,116 ft (1981); 5,114 ft (1984, 1986); 5,115 ft (1990, 1992); 5,118.6 ft (1993)	ADWR License of Approval dated December 11, 1998
Storage Capacity (ac-ft)	2,300	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Surface Area (ac)	80	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Clay Core Properties			
Physical Properties	The clay core consists of compacted sandy lean clay and sandy fat clay.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • Safety Inspection Report (Harza, 1987) • Evaluation of Dam Embankment Crack (Dames & Moore, 1999)
Engineering Properties	• Moist Unit Weight = 120 pounds per cubic foot (pcf) • Saturated Unit Weight = 125 pcf • Effective Cohesion = 0 pounds per square foot (psf) • Effective Friction Angle = 28^{o} • Undrained strength ratio = 0.38	---	
Shell (Random Zone) Properties			

Item	As-Constructed/ Current	Comments	Reference Document
Physical Properties	The shell consists of compacted silty or clayey sand and sandy lean clay.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • Safety Inspection Report (Harza, 1987) • Evaluation of Dam Embankment Crack (Dames & Moore, 1999)
Engineering Properties	• Moist Unit Weight = 125 pcf • Saturated Unit Weight = 130 pcf • Effective Cohesion = 0 psf • Effective Friction Angle = 33^{o}	---	
Foundation Conditions			
Physical Properties	The embankment is generally founded on an engineered keyway consisting of the compacted clay core extending to competent bedrock. The exposed bedrock was cleaned and received grout treatment prior to placement of fill material. Where bedrock is deeper than 20 ft, a soil-bentonite cutoff wall extends through the alluvium to bedrock or stiff clay. The alluvium is a Quaternary age wash deposit consisting of unconsolidated clays, silts, and sands. The underlying bedrock consists of mudstone, siltstone, and sandstone associated with the Chinle and Moenkopi Formations.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • Safety Inspection Report (Harza, 1987)
Engineering Properties	Alluvium: • Moist Unit Weight = 120 pcf • Saturated Unit Weight = 120 pcf • Effective Cohesion = 0 psf • Effective Friction Angle = 26^{o} Bedrock: • Moist Unit Weight = 150 pcf • Saturated Unit Weight = 150 pcf • Effective Cohesion = 1,000 psf • Effective Friction Angle = 65^{o}	---	
Engineering Properties (continued)	Cutoff Wall: • Moist Unit Weight = 106 pcf	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975)

Item	As-Constructed/ Current	Comments	Reference Document
	• Saturated Unit Weight = 106 pcf • Effective Cohesion = 0 psf • Effective Friction Angle = 28^o Undrained Strength = 10 psf		• Safety Inspection Report (Harza, 1987)
Abutment Conditions			
Physical Properties	The abutments consist of bedrock comprising mudstone, siltstone, and sandstone associated with the Chinle and Moenkopi Formation. The cut off wall that was part of the engineered foundation of the embankment was extended 350 ft beyond the end of the dam into the right abutment.	---	• Seepage and Foundation Studies: Volume II of II Field and Laboratory Tests (Ebasco, 1975) • Safety Inspection Report (Harza, 1987) • Evaluation of Dam Embankment Crack (Dames & Moore, 1999)
Engineering Properties	• Moist Unit Weight = 150 pcf • Saturated Unit Weight = 150 pcf • Effective Cohesion = 1,000 psf • Effective Friction Angle = 65^o	---	
Spillway	None	The impoundment has sufficient storage volume above the maximum storage pool water level to store the IDF (PMF) and maintain at least four feet of freeboard.	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Construction Specifications	Clay Core: • Fines content ranging from 50% to 100% • No particle sizes greater than 3 inches • Plasticity index ranging from 15 to 50 • Fill lift thickness = 8 inches • Minimum degree of compaction = 95% (standard Proctor) • Test frequency = 60,000 ft^2/test	---	Ash Pond Construction Memorandum (Ebasco, 1977)
Construction Specifications (continued)	Shell (Random Zone): • Maximum rock fraction greater than	---	Ash Pond Construction Memorandum (Ebasco, 1977)

Item	As-Constructed/ Current	Comments	Reference Document
	3 inches = 10% • Fill lift thickness = 12 inches • Minimum degree of compaction = 100% (standard Proctor) • Test frequency = 60,000 ft^2/test Cutoff Wall: • Preparation: ○ Minimum unit weight = 1.02 grams/cubic centimeter (g/cm^3) ○ Minimum viscosity = 30 sec-marsh ○ Maximum filtration loss = 30 cm^3 ○ Minimum pH = 8 • In Trench: ○ Unit weight range between 1.05 and 1.3 g/ cm^3 • Backfill Mix at Trench: ○ Slump ranging between 3 and 6 inches ○ Percent passing 3/8-inch between 60 and 90% ○ Percent passing No. 20 sieve between 30 and 70% Fines content between 15 and 30%		
Detailed Drawings	See Appendix A for drawings	---	• Original As-built (Ebasco, 1977) • Ash Disposal Line Reroute (Ebasco, 1980) • Crest restoration (APS, 1990) • Siphon System & Floating Pipeline (APS, 1993) • Seepage Interception System (APS, 1993)

Existing Instrumentation

Item	As-Constructed/ Current	Comments	Reference Document
Type and Purpose of Instrumentation	• Open standpipe piezometers and wells for monitoring the phreatic levels in the embankment and foundation. • Settlement monuments for monitoring movement of the embankment. • Water level gauge for monitoring water level in reservoir. • V-notch weir and seepage monitoring systems for measuring seepage rates.	---.	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Location of Instrumentation	• Open standpipe piezometers and wells located in and around the embankment. • Movement monuments located along the embankment crest. • Water level gauge located in the reservoir. • V-notch weir and seepage monitoring systems located along the downstream toe.	See Figure 1-2	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)
Provisions for Surveillance, Maintenance and Repair	• Visual inspections of the dam by a qualified person on a frequency not exceeding seven days. • Visual inspections of the dam conducted annually by a professional engineer. • Phreatic level behavior from piezometric measurements and reservoir water level from gauge collected on an interval not exceeding 30 days. • Embankment settlement using movement monuments survey data collected on an interval not exceeding 30 days. • Seepage monitoring at the downstream toe collected on an interval not exceeding 30 days.	---	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)

Item	As-Constructed/ Current	Comments	Reference Document
Record of Structural Instability (See Section 4 for more details)	• Historic seepage at downstream toe • Active seepage at the right abutment. • Seepage areas near the downstream toe are identified as Toe Drain Seep, Petroglyph Seep, Tanner Wash Seep, and P-226 Seep.	See Figure 1-2 for seepage areas. The seepage areas are captured and monitored by a seepage interceptor system near the downstream toe.	Annual CCR Impoundment and Landfill Inspection Report 2015 (AECOM & APS, 2016)

Notes: 1) Site elevations use National Geodetic Vertical Datum (NGVD) 1929

4 Structural Stability Assessment

This section summarizes the structural stability assessment for the Bottom Ash Pond. This information is intended to satisfy the requirement of Rule 40 CFR § 257.73(d).

4.1 Foundation and Abutments

Per the requirements of 40 CFR § 257.73(d)(1)(i), existing CCR impoundments must be assessed for "*Stable foundations and abutments*."

The Bottom Ash Pond Dam is founded on alluvium overburden associated with the Tanner Wash with both abutments resting on bedrock consisting of mudstone, siltstone, and sandstone associated with the Chinle and Moenkopi Formations. Review of the as-built design drawings of the dam (Ebasco,1990) and construction inspection reports prepared by ADWR (formerly Arizona Water Commission) indicate a cut off trench was excavated at the abutments to extend the clay core to bedrock. When the depth to bedrock was greater than 20 ft, a soil-bentonite slurry cut-off wall was installed to the bedrock or to a stiff clay layer found about 60 to 70 ft below the original ground surface. In addition, an approximately 350 ft long slurry wall was installed beyond the right abutment to help control seepage through the Moenkopi bedrock formation. Review of the construction records indicates that where the cutoff trench was excavated to bedrock, loose rock was scaled from the foundation, dental concrete was applied to irregularities to create a relatively level surface, and a thin lift of wet cement tack coat was applied to the bedrock surface before placement of the clay core. For the shell of the dam, which is founded on alluvium overburden soils, the alluvium foundation was proof-compacted using a heavy dynamic compactor and surface stringers of sandy soils that crossed the dam foundation were removed.

Several seepage locations have been observed downstream of the dam since the Bottom Ash Pond went into operation. These seeps are thought to occur due to a combination of normal flow through the embankment, discontinuities in the foundation near the groin of the abutment, and flow through gypsum seams in the Moenkopi Formation. Drain systems have been installed at most of the seepage locations, typically consisting of underground French drains connected to a collection sump. Four sumps and one weir have been installed at the following seeps: the P-226 Seep, the Petroglyph Seep, the Tanner Wash Seep, and the West Abutment Seep. The locations of the seeps are shown in Figure 1-2. Flow from the sumps and weir installed at the seeps are monitored and presented in the annual dam inspection reports. Flow rates ranging from 0 to 25 gallons per minute over the last ten years were measured at the sumps and weirs (AECOM & APS, 2016), indicating very low to moderate flow. The turbidity of the seep water observed at the sumps was also low. Both the low flow rate and the lack of turbidity indicate a low potential of internal erosion of the dam embankment or foundation.

Review of the measured displacements of the survey monuments at the crest of the Bottom Ash Pond Dam, as presented in the 2015 annual dam inspection report (AECOM & APS, 2016), indicates settlements along the crest of the dam of three to eight inches and horizontal movements of three inches or less in the last ten years. Settlement rates appear relatively constant over the last ten years at about one quarter of an inch per year with little horizontal movement upstream or downstream. The relatively small settlement and horizontal movements measured at the Bottom Ash Pond Dam are an indication of stability in the dam foundation and abutments.

4.2 Slope Protection

Per the requirements 40 CFR § 257.73(d)(1)(ii), existing CCR impoundments must be assessed for "*Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown*."

A review on the as-built drawing of the Bottom Ash Pond Dam (Ebasco, 1990), indicates the dam was constructed with a two foot thick layer of random rock fill (riprap) to protect the upstream and downstream slopes against erosion. No specifications for riprap size were shown on the drawings; however, visual observations performed during dam inspection suggest they are cobble to boulder sized. The 2015 annual dam inspection report (AECOM & APS, 2016) reported no significant erosion of the dam slopes indicating the riprap slope protection is performing adequately. Based on the inspection report and experience with similar riprap slope protection designs, the Bottom Ash Pond has adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.

4.3 Dike Compaction

Per the requirements 40 CFR § 257.73(d)(1)(iii), existing CCR impoundments must be assessed for "*Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit*."

Based on review of a memorandum summarizing construction of the Bottom Ash Pond Dam (Temchin, 1977), the dam (or dike) was constructed by placement of soils in mechanically compacted thin lifts of a foot or less. Construction control of the compaction process was maintained using a method procedure where the soil preparation, placement, watering, blading, final watering, rolling, and lift thickness are specified based on the results of fill pad testing conducted prior to start of earthwork (Ebasco, 1977).

In addition to the method controls discussed above, quality control testing consisting of comparison of in-situ measurements of soil density to Standard Proctor maximum dry density, American Society for Testing and Materials D 698, was performed at intervals of once every 60,000 square ft of material placed. Results of quality control testing are summarized in Ebasco Drawing APS-2742-SK-CH-J12 (Temchin, 1977). The drawing indicates 368 tests were conducted on Clay Core materials with 357 of the tests measuring densities greater than 95 percent of the Standard Proctor maximum density and a mean percent compaction of all tests of 98.4 percent of the Standard Proctor maximum density. The drawing indicates 104 tests were conducted on the outer shell materials with 91 of the tests measuring densities greater than 100 percent of the Standard Proctor maximum density and a mean percent compaction of all tests of 101.2 percent of the Standard Proctor maximum density.

Based on the compaction method described in the construction summary memorandum and the quality control test results presented in Drawing APS-2742-SK-CH-J13, the Bottom Ash Pond Dam has been mechanically compacted to a density sufficient to withstand the range of loading condition expected at the Bottom Ash Pond site.

4.4 Slope Vegetation

Per the requirements 40 CFR § 257.73(d)(1)(iv), existing CCR impoundments must be assessed for "*Vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection*." Note that the United States Court of Appeals for the District of Columbia Circuit remanded with vacatur the phrase "*not to exceed a height of six inches above the slope of the dike*" from this subsection of the Rule.

As noted in Section 4.2, the dam was constructed with a two foot thick layer of random rock fill (riprap) slope protection; therefore, the dam is excluded from the vegetated slope requirements since it uses an alternate form of slope protection.

4.5 Impoundment Capacity

Per the requirements 40 CFR § 257.73(d)(1)(v), existing CCR impoundments must be assessed for "*A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this sections. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section*."

The Bottom Ash Pond Dam was constructed without a spillway or other water release structure. To manage flow during the design storm event, the Bottom Ash Pond has been designed, constructed, operated, and maintained with sufficient storage volume over and above the maximum permitted storage pool water level (EL 5,117.8 ft) to store the PMF storm water inflow at EL 5,119.3 ft and maintain four ft of freeboard; therefore, the Bottom Ash Pond impoundment is capable of adequately managing (containing) the flow during and following the peak discharge from the PMF event as required for high hazard potential CCR impoundments.

4.6 Hydraulic Structures

Per the requirements 40 CFR § 257.73(d)(1)(vi), existing CCR impoundments must be assessed for "*Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structures*."

Three 12-inch diameter HDPE pipes associated with the siphoning system which returns water back to the plant are the only hydraulic structures that penetrate the Bottom Ash Pond Dam embankment. Review of the as-built drawings of the siphon system (Ebasco, 1993) indicates the pipes are installed near the crest of the dam with penetration invert elevations of EL 5120.5 ft. The maximum surcharge pool water level, the highest water level anticipated within the pond, is at EL 5,119.3 ft a little over a foot below the pipe penetrations. Since it is not anticipated that the water level will rise to the elevation of the pipe penetration, the pipes are not expected to negatively impact the operation of the dam. Furthermore, since the pipes are buried at a relatively shallow depth beneath the crest, significant distortion or bending of the pipes would be readily apparent and can be easily repaired.

4.7 Downstream Water Body

Per the requirements 40 CFR § 257.73(d)(1)(vii), existing CCR impoundments must be assessed as follows "*For CCR units with downstream slope which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body*."

No structural stability deficiencies are present associated with inundation of the downstream slope of the Bottom Ash Pond Dam by an adjacent body of water since no pool of water, such as a river, stream or lake, is present downstream of the dam which could inundate the downstream slope.

4.8 Other Issues

No deficiencies were identified for the Bottom Ash Pond that could affect the structural stability of the impoundment. However, during the most recent dam inspection (AECOM & APS, 2016), observations of excessive vegetation consisting of small- to medium-sized desert brush and small animal burrows were noted along the slopes and crest of the Bottom Ash Pond Dam. APS work crews subsequently removed vegetation in the identified areas. Although both the vegetation and the animal burrows were not of sufficient size to cause concern for the stability or erosion of the embankment, failure to promptly identify and correct these issues could lead to eventual deterioration of the embankment slope. It is recommended, therefore, to continue inspection and maintenance activities of the impoundment to identify and correct minor issues in order to prevent progressive deterioration of the embankment.

4.9 Structural Stability Assessment Results

AECOM did not identify any structural stability deficiencies that would affect the structural condition of the Bottom Ash Pond CCR Impoundment based on the documents provided and reviewed as part of this assessment. AECOM assesses that the design, construction, operation and maintenance of the Fly Ash Pond are consistent with recognized and generally accepted good engineering practice for the maximum volume of CCR and CCR wastewater which can be impounded therein.

5 Safety Factor Assessment

This section summarizes the safety factor assessment for the Bottom Ash Pond. This assessment is intended to satisfy the requirement of Rule 40 CFR § 257.73(e).

5.1 Methodology and Design Criteria

Slope stability analyses were performed to document minimum factors of safety for loading conditions identified by 40 CFR § 257.73(e) using the software program SLOPE/W (GEO-SLOPE International, 2012). The analyses were performed using Spencer's Method; a limit equilibrium method of slices that satisfies both force and moment equilibrium and incorporates the effects of interslice forces. The analyses incorporate strength and density properties and pore pressure distributions described in Sections 5.4 and 5.5. The slope stability models are presented in Appendix B.

5.2 Critical Cross Section

Safety factors were calculated for two cross sections of the Bottom Ash Pond Dam selected to represent different embankment geometries, heights, and stratigraphic conditions to provide confidence that the critical cross section was identified. The critical cross section is the cross section that is anticipated to be most susceptible to structural failure for a given loading condition. The critical cross section thus represents a "most-severe" case. Section locations were selected based on variation in the embankment height, presence of cutoff trench/cutoff wall, and stratigraphic conditions. Subsurface soil profiles were developed using as-built drawings and historical borings reported by Ebasco (1975) and Harza (1987). The locations of the cross sections along the Bottom Ash Pond Dam are shown in Figure 5-1. The cross sections analyzed are:

Bottom Ash Pond Cross Section 1: This cross section corresponds approximately to Section A as shown on Figure 5-1 and the as-built plan (Ebasco, 1990). This section represents the maximum section in areas where bedrock is shallow and, thus, includes an extension of the embankment clay core forming a cutoff trench that is keyed into bedrock. The embankment is approximately 73 ft high and the upstream and downstream slopes are at 3H:1V except for the top 3.3 ft of the dam where they are 1.5H:1V. The zoned embankment at this section consists of a sandy lean clay core with an outer clayey sand shell and the foundation consists of approximately 10 ft of alluvial overburden (clays, silts, and sands) overlying interbedded layers of mudstone, siltstone, and sandstone bedrock. The clay core extends to form a cutoff trench that is keyed into the top of bedrock.

Approximately 28 ft of hydraulically-placed bottom ash is impounded behind the embankment at the Cross Section 1 location, based on comparison between pre-construction topographic survey data (Ebasco, 1975) and topographic survey data collected in 2014 (Cooper Aerial Surveys, 2014).

Bottom Ash Pond Cross Section 2: This cross section corresponds approximately to Section H as shown on Figure 5-1 and the as-built plan (Ebasco, 1990). This section represents the maximum section in area of the deepest bedrock (85 ft below the ground surface). The section includes a cutoff slurry wall beneath the embankment clay core. The embankment is approximately 73 ft high and the upstream and downstream slopes are at 3H:1V except for the top 3.3 ft of the dam where they are 1.5H:1V. The zoned embankment at this section consists of a sandy lean clay core with an outer clayey sand shell and the foundation consists of approximately 85 ft of alluvial overburden (clays, silts, and sands) overlying interbedded layers of mudstone, siltstone, and sandstone bedrock. The slurry cutoff wall consists of a minimum two ft thick soil-bentonite wall that extends from the clay core of the dam to a layer of dense clay at about 15 ft above the bedrock.

5.3 Subsurface Stratigraphy

Idealized models of subsurface stratigraphic conditions for each cross section were developed based on design drawings (Ebasco, 1990) and previous geotechnical site investigations (Ebasco, 1975, Harza, 1987, and Dames & Moore, 1999). The stratigraphic units described as follows were used to develop SLOPE/W models for each cross section.

Embankment Core: The zoned embankment includes a central impervious clay core with 1H:1V side slopes and a clay cap at the embankment crest. Fine-grained material was obtained from upstream borrow pits along the dam alignment and mechanically compacted in lifts to construct the clay core. The clay core soils consist predominately of Sandy Lean Clay (CL) with isolated zones of Sandy Fat Clay (CH) based on the Unified Soil Classification System (USCS).

Embankment Shell (Random Zone): The zoned embankment includes a more pervious zone, or shell, that flanks the clay core to support and protect the impervious core. The shell provides stability against rapid drawdown (upstream shell) and drainage (downstream shell). Shell material was obtained from upstream borrow pits along the dam alignment and mechanically compacted in lifts. Shell soils consist predominately of Silty Sand (SM), Clayey Sand (SC), and Sandy Lean Clay (CL) based on the USCS.

Alluvium: Alluvial deposits overlie the bedrock beneath the embankment and are the foundation bearing layer over most of the embankment alignment. The alluvium consists of a Quaternary Age, heterogeneous mixture of unconsolidated clays, silts, and sands deposited by flows in an unnamed tributary to Tanner Wash prior to the construction of the Bottom Ash Pond.

Bedrock: Bedrock beneath the embankment consists of mudstones, siltstones, and sandstones of the Triassic-age Chinle and Moenkopi Formations.

Slurry Cutoff Wall: A slurry cutoff wall was constructed using soil-bentonite slurry where the depth to bedrock is greater than 20 ft and extended into either the bedrock or dense clay soils.

Bottom Ash: Bottom ash waste product from the power generating process is pumped from the plant to the Bottom Ash Pond and allowed to settle hydraulically in two coal combustion waste storage cells upstream of the dam. Excess water from the storage cells decants to a reservoir directly behind the dam.

5.4 Material Properties

Material properties for soil, rock and embankment construction materials were developed based on an analysis and interpretation of historical geologic and geotechnical data presented in:

- Ebasco Services Inc., “Arizona Public Services Cholla Generating Station Ash Disposal Sites Seepage and Foundation Studies: Volume I of II Engineering Report” (Ebasco, 1975),
- Harza Engineering Company, “Safety Inspection Report on Fly Ash Dam, Bottom Ash Dam, and Cooling Dike” (Harza, 1987), and
- Dames & Moore, ” Interim Report, Geotechnical Investigation for Evaluation of Dam Embankment Crack, FAP Dam, Cholla Power Plant, Joseph City, Arizona” (Dames & Moore, 1999).

The material properties developed by the dam designers and subsequent investigators were assessed for reliability and applicability to this safety factor assessment. The design report (Ebasco, 1975) indicated that soil strength parameters were obtained from laboratory testing. Specific details of the soil strength property derivations used for the original design stability analyses were not provided in the design report. The Harza investigation (1987) included more detailed documentation of the laboratory testing, soil strength derivations, and stability analyses performed in 1987. The parameters developed by Harza were used in subsequent stability analyses performed by Dames & Moore (1991). AECOM assessed the historical soil strength data and parameters used by previous investigators and found the Harza (1987) data to be the most reliable and applicable to this safety factor assessment.

The material properties selected for use in the slope stability analyses of the Bottom Ash Pond Dam are presented in Table 5-1. The drained strength values presented in Table 5-1 were taken from Harza (1987). The undrained strength value presented in Table 5-1 for the Embankment Core was derived by AECOM based on an interpretation of the Harza triaxial compression test data. Undrained strength properties were not needed for other material types for the safety factor calculations. Moist unit weight values used in this safety factor assessment were taken from Dames & Moore (1991); saturated unit weights were interpreted by AECOM based on the moist unit weights and material types reported by previous investigators. The bottom ash unit weight was selected by AECOM to be 75 pounds pcf based on engineering experience with similar materials.

Table 5-1. Selected Material Parameters – Bottom Ash Pond Safety Factor Assessment

Material	Saturated Unit Weight, γ_{sat} (pcf)	Moist Unit Weight, γ_m (pcf)	Effective Strengths		Total Strengths	
			Cohesion, c' (psf)	Friction Angle, ϕ' (degrees)	Undrained Strength, S_u (psf)	Undrained Strength Ratio
Embankment Core	125	120	0	28	-	0.38
Embankment Shell	130	125	0	33	-	-
Alluvium	120	120	0	26	-	-
Bedrock	150	150	1,000	65	-	-
Slurry Cutoff Wall	106	106	0	28	10	-
Bottom Ash	75	75	0	25	-	-

5.5 Embankment Pore Pressure Distribution

Water levels have historically been measured quarterly, but beginning in October of 2015, they are now monitored on an interval not exceeding 30 days in the piezometers installed along or near the Bottom Ash Pond and reported annually in an inspection report (AECOM & APS, 2016). These data were considered to be the most reliable indicators of pore pressure distribution within the Bottom Ash Pond Dam embankment. The pore pressure distributions were estimated for each section using water level measurements obtained from:

- Section 1: piezometers W-227, B-200, B-201, and B-218;
- Section 2: piezometers W-305, B-203, B-204, and B-205

Piezometer locations are shown on Figure 1-2. Piezometer data were used, along with pond water level under steady-state, maximum storage pool conditions (ADWR, 1986 and ADWR, 1998), and pond water levels under maximum surcharge pool conditions (Ebasco, 1975 and Dames & Moore, 1991) to estimate pore pressure distributions with the embankment sections. Piezometer data are presented in the calculation in Appendix B.

5.6 Embankment Loading Conditions

Per 40 CFR § 257.73(e)(1)(i) through (iv), the following loading conditions were analyzed for each developed stability cross section:

- Long-term, maximum storage pool,
- Maximum surcharge pool,
- Seismic loading, and
- Liquefaction

These loading conditions are described in the following sub-sections.

Long-Term, Maximum Storage Pool: The maximum storage pool loading is the maximum water level that will be maintained for a sufficient length of time for steady-state seepage or hydrostatic conditions to develop within the embankment. This loading condition is evaluated to document whether the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading.

The long-term, maximum storage pool loading condition was evaluated using the permitted water level of the pond, as stated in the ADWR operating license for the dam. Since the dam has no outlet structure and relies on pumping rate from the plant, seepage, evaporation, and the siphon return system to control water levels, the maximum storage pool was set at the maximum ADWR-permitted water levels. For the Bottom Ash Pond, the safety factor was calculated for the long-term maximum storage pool at EL 5,117.8 ft (ADWR, 1998).

Maximum Surcharge Pool: The maximum surcharge pool loading is the temporary rise in pool elevation above the maximum storage pool elevation to which the CCR surface impoundment could be subject under inflow design flood state. This loading condition is evaluated to document whether the downstream slope of the CCR surface impoundment embankment can withstand the short-term impact of a raised pool level.

The maximum surcharge pool considers a temporary pool elevation that is higher than the maximum storage pool that persists for a length of time sufficient for steady-state seepage or hydrostatic conditions to fully develop within the embankment. The maximum surcharge pool loading condition was evaluated using the expected water level raise during the design PMF of 1.5 ft (Dames & Moore, 1991). For the Bottom Ash Pond, the safety factor was calculated for the maximum surcharge pool at EL 5,119.3 ft.

Seismic Loading: Seismic loading is evaluated to document whether the embankment is capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of contents. The seismic loading condition is assessed for a seismic loading event with a two percent probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years. A pseudo-static analysis was used to represent the seismic loading condition.

The seismic response of soil embankments is incorporated into the analysis method by adding a horizontal force to simulate the seismic force acting on the embankment during an earthquake. The horizontal force is applied in the pseudo-static analyses through the addition of a seismic coefficient into the limit equilibrium calculations. The seismic coefficient was selected using the following procedure:

1. Determine the peak horizontal ground acceleration (PGA) generated in bedrock at the site by an earthquake having the 2 percent probability of exceedance in 50 years;

2. Select a Site Class, per International Building Code definitions, which incorporates the effects of seismic wave propagation through the top 100 ft of the soil profile above bedrock, and calculate the adjusted for Site Class effects, PGA_M;

3. Calculate the maximum transverse acceleration at the crest of the embankment, PGA_{crest}, using the PGA_M from step 2; and

4. Adjust the PGA_{crest} using the method developed by Makdisi and Seed (1977) to account for the variation of induced average acceleration with embankment depth to calculate the seismic coefficient.

Each of these steps is discussed in more detail in the calculation presented in Appendix B. The maximum average acceleration for the potential sliding mass was incorporated into the pseudo-static safety factor analyses as the horizontal seismic coefficient equal to 0.13, corresponding to the calculated, adjusted PGA_{crest} value.

The water level in the Bottom Ash Pond for the seismic loading analysis was set to EL 5,117.8 ft to match the long-term, maximum storage pool. The Clay Core and Cutoff Wall materials were assigned total strengths because it is anticipated that they will behave in an undrained manner due to the relatively rapid loading induced during the seismic event and the relatively low hydraulic conductivity of these materials. All other materials used effective strength parameters.

Liquefaction: The liquefaction factor of safety is evaluated for CCR embankments and foundation soils that are believed to be susceptible to liquefaction based on representative soil sampling and construction documentation or anecdotal evidence from personnel with knowledge of the CCR unit's construction., The liquefaction factor of safety is calculated to document whether the CCR unit would remain stable if the soils in the embankment and/or foundation experienced liquefaction.

Post-construction geotechnical exploration of the Bottom Ash Pond Dam (Harza, 1987 and Dames & Moore, 1999) indicated the Clay Core (embankment) and Alluvium Overburden (foundation) materials have plasticity indexes and fine contents as shown in Table 5-2. Data are not included in Table 5-2 for the Embankment Shell material due to the very limited amount of available geotechnical data. The Embankment Shell material was sourced from the Alluvium Overburden and is anticipated to have similar properties. Generally, the behavior of soils that have fines contents greater than 35 percent are dominated by the plasticity of the fines (Idriss and Boulanger 2008). Fines with Plasticity Index (PI) less the seven tend to behave more sand-like and are susceptible to soil liquefaction, while those with PI greater than seven tend to behave more clay-like and are not susceptible to liquefaction. The lowest measured value of PI for both the Clay Core and Alluvium Overburden is 12, indicating these soils would tend to behave in a clay-like manner during a seismic event and not be susceptible to soil liquefaction. Consequently, a liquefaction factor of safety analysis was not performed for this impoundment.

Table 5-2. Range of Plasticity Index and Fines Content Values for Site Materials

Material	Plasticity Index, %		Fines Contents, %	
	Minimum Value	Maximum Value	Minimum Value	Maximum Value
Clay Core	12	39	48	88
Alluvium Overburden	12	17	30	54

5.7 Safety Factor Assessment Results

Table 5-3 summarizes the results of the safety factor analysis for the Bottom Ash Pond Dam, for a more detailed discussion of the results see the safety factor calculation presented in Appendix B.

Table 5-3. Summary of Calculated Safety Factors

Loading Condition	Required Safety Factor[1]	Calculated Safety Factor	
		Section 1	Section 2
Long-term, maximum storage pool	1.50	1.58	1.55
Maximum surcharge pool	1.40	1.56	1.53
Seismic	1.00	1.05	1.07

Notes: [1] From 40 CFR § 257.73(e)(1)(i) through (iii) (EPA, 2015)

The calculated factors of safety for the two critical cross sections along the Bottom Ash Pond Dam exceeded the required minimum values for the long-term, maximum storage pool; the maximum surcharge pool; and the seismic (pseudo-static) loading conditions.

6 Conclusions

Based on the findings and results of the structural integrity assessment, AECOM provides the following conclusions for the Bottom Ash Pond at the Cholla Power Plant.

- The Bottom Ash Pond is classified as a High Hazard Potential CCR surface impoundment.
- The embankment is founded on stable foundations and abutments. Seepage is limited by a clay core that extends to the bedrock in shallow locations or a cutoff slurry wall where the depth to bedrock is greater than 20 ft. Downstream seeps are captured and monitored by drainage systems typically consisting of French drains connected to sumps.
- The embankment has adequate slope protection consisting of riprap on both the upstream and downstream slopes.
- Based on the available information and quality control test results, the Bottom Ash Pond Dam embankment was mechanically compacted to a density sufficient to withstand the range of loading conditions anticipated at the site.
- The Bottom Ash Pond impoundment is capable of adequately managing the flow during and following the peak discharge from the PMF event without a spillway or other water release structures because the pond has been designed, constructed, operated, and maintained with sufficient storage volume above the maximum storage pool water level to store the PMF inflow and maintain at least four feet of freeboard.
- Factors of safety greater than the minimum values required by the CCR Rule were calculated for two critical cross sections along the Bottom Ash Pond Dam for loading conditions associated with the maximum storage pool water level, maximum surcharge pool water level, and design level seismic event. The liquefaction factor of safety of the impoundment was not analyzed due to the low potential for soil liquefaction of the embankment and foundation soils as determined from index test results.
- Based on review of available records concerning the Bottom Ash Pond and the results of the stability analyses, no deficiencies were noted that would affect the structural condition of the dam.

7 Limitations

This report is for the sole use of APS on this project only, and is not to be used for other projects. In the event that conclusions based upon the data obtained in this report are made by others, such conclusions are the responsibility of others. The Initial Structural Stability Assessment presented in this report was based on available information identified in Reference Section of the report that AECOM has relied on but not independently verified. Therefore, the Certification of Professional Opinion is limited to the information available to AECOM at the time the Assessment was performed in accordance with current practice and the standard of care. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period. Professional judgments presented herein are primarily based on information from previous reports that were assumed to be accurate, knowledge of the site, and partly on our general experience with dam safety evaluations performed on other dams. No warranty or guarantee, either written or implied, is applicable to this work.

The use of the words “certification” and/or “certify” in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

8 References

AECOM & Arizona Public Services Company (APS), 2016, "Cholla Power Plant Fly Ash Pond, Bottom Ash Pond, Sedimentation Pond and Bottom Ash Monofill: Annual CCR Impoundment and Landfill Report 2015", January.

Arizona Department of Water Resources (ADWR), 1986, License of Approval, Cholla Bottom Ash Pond Dam and Reservoir, State File No. 09.28, October 21.

ADWR, 1998, License of Approval, Cholla Bottom Ash Pond Dam and Reservoir, State File No. 09.27, December 11.

APS, 1991, "Cholla S.E. Station: Bottom Ash Dam – Toe Drain System," Drawing No. D-82671, Revision No. 2, July 26.

APS, 2016, "Cholla Power Plant Bottom and Fly Ash Ponds & Cooling Reservoir Basic Data Report. "Cooper Aerial Surveys Co., 2014, "Cholla Ash 2014: June 13, 2009 Topographic Mapping," Prepared for Arizona Public Service Company, Drawing No. 1, Sheet No. 1.

Dames & Moore, 1991, "Design Report for Cholla S.E.S. Units 1 – 4 Raising Bottom Ash Dam To Elevation 123.3 Feet MSL," Prepared for Arizona Public Service Company, July.

Dames & Moore, 1999, "Interim Report, Geotechnical Investigation for Evaluation of Dam Embankment Crack, FAP Dam, Cholla Power Plant, Joseph City, Arizona," Prepared for Arizona Public Service Company, D&M Job No. 02353-143-022, May 9.

Ebasco Services Inc. (Ebasco), 1975, "Arizona Public Services Cholla Generating Station Ash Disposal Sites Seepage and Foundation Studies: Volume I of II Engineering Report," Prepared for Arizona Public Service Company, August.

Ebasco, 1976, "Arizona Public Services Cholla Steam Electric Station, Flood Routing Studies for Bottom Ash and Fly Ash Ponds," May.

Ebasco, 1977, "Ash Disposal System: Bottom Ash Pond – Sections & Details," Prepared for Arizona Public Service Company, Drawing No. G-44556, As-built, November 8.

Ebasco, 1977, "Arizona Public Services Cholla Steam Electric Station Units 2, 3, & 4 Ash Pond Construction, November 1977 – Final Report," December 5.

Ebasco, 1979, "Ash Disposal System: Bottom Ash Pond – Instrumentation," Prepared for Arizona Public Service Company, Drawing No. SK-CH-J21, Revision No. 4, March 7.

Ebasco, 1990, "Ash Disposal System: Bottom Ash Pond – Sections & Details," Prepared for Arizona Public Service Company, Drawing No. G-44556, Revision No. 12 (Crest Restoration 1990), August 28.

Ebasco, 1993, "Ash Disposal System: Bottom Ash Pond – Siphon System & Floating Pipeline," Prepared for Arizona Public Service Company, Drawing No. G-44556 Sheet 2 (APS Drawing No. G-556-A02), As-built, February 26.

GEOSLOPE International, 2012, GeoStudio 2012, Version 8.15.4.11512, August 2015 Release.

Harza Engineering Company (Harza), 1987, "Cholla S.G.S., Safety Inspection Report on Fly Ash Dam, Bottom Ash Dam, and Cooling Dike," Prepared for Arizona Public Service Company, February 27.

Idriss, I.M. and Boulanger, R.W., 2008, "Soil Liquefaction During Earthquakes," Earthquake Engineering Research Institute, Monograph No MNO-12.

Makdisi, F.I. and Seed, H.B., 1977, “A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments,” Report No. UCB/EERC-77/19, University of California, Berkeley, August.

Stantec Consulting Inc (Stantec), 2000, “APS Cholla Dambreak Study,” Prepared for Arizona Public Service Company, November.

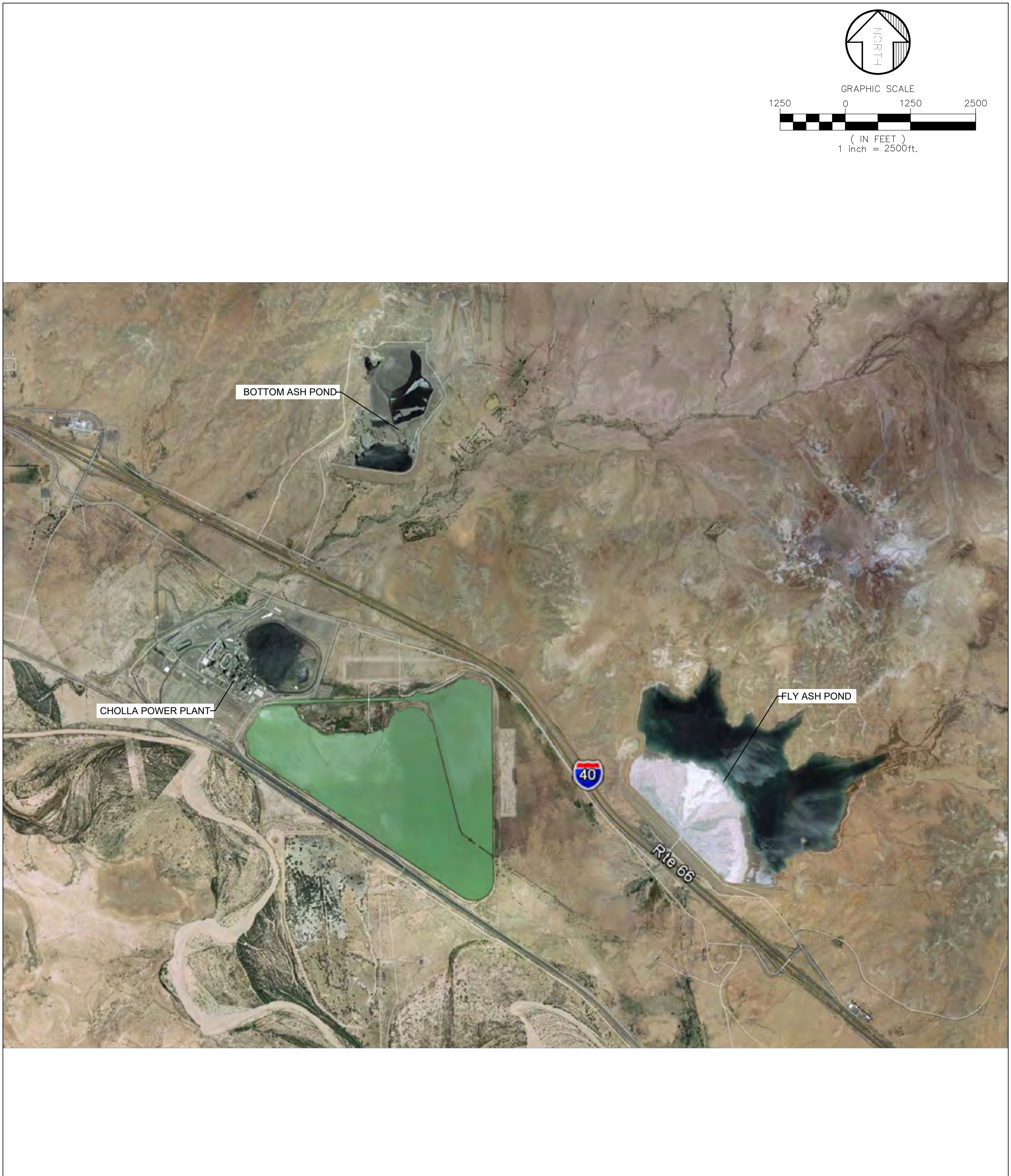
Temchin, M., 1977, “Arizona Public Service Company Cholla Steam Electric Station Units 2, 3, & 4 Ash Pond Construction November 1977 – Final Report,” Memorandum to G.W. Strengham of Arizona Public Service, Ebasco Services Inc., December 5.

United States Environmental Protection Agency (EPA), 2015, 40 CFR Parts 257 and 261 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, Federal Register Vol. 80, No. 74, April 17.

United States Geological Survey (USGS), 2013, 7.5-Minute Series Joseph City, AZ Quadrangle Map

Figures

L□□□□□□□d □□: ALEISA□KRUG(2016-06-16) L□□□P□□□□d: 2016-06-16
F□□□□□ □: P:□ARIZONA PUBLIC SERVICE□60445840□APS□CHOLLA□STRUCTURAL□INTEGRITY□CADD FILES□FIGURES□FIGURE 1-1□SITE VICINITY MAP.DWG



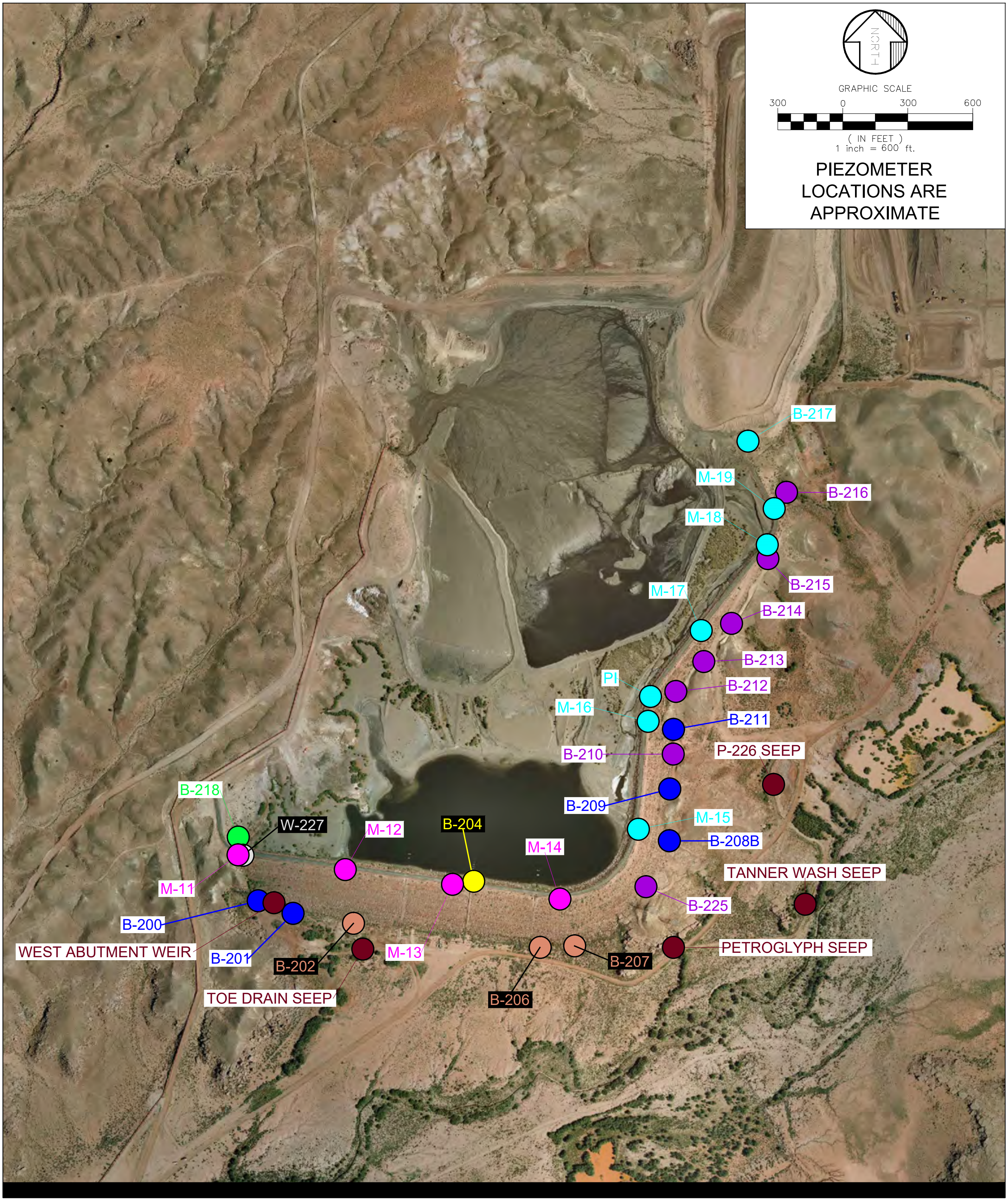
CHOLLA POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Pr□□□□□N□. 60445840

SITE VICINITY MAP

AECOM

FIGURE 1-1

L□□□□□□d □□: ALEISA□KRUG(2016-06-16) L□□□P□□□d: 2016-06-16
F□□□□□ □: P:□ARIZONA PUBLIC SERVICE□60445840□APS□CHOLLA□STRUCTURAL□INTEGRITY□CADD FILES□FIGURES□FIGURE 1-2□INSTRUMENT LOCATIONS.DWG



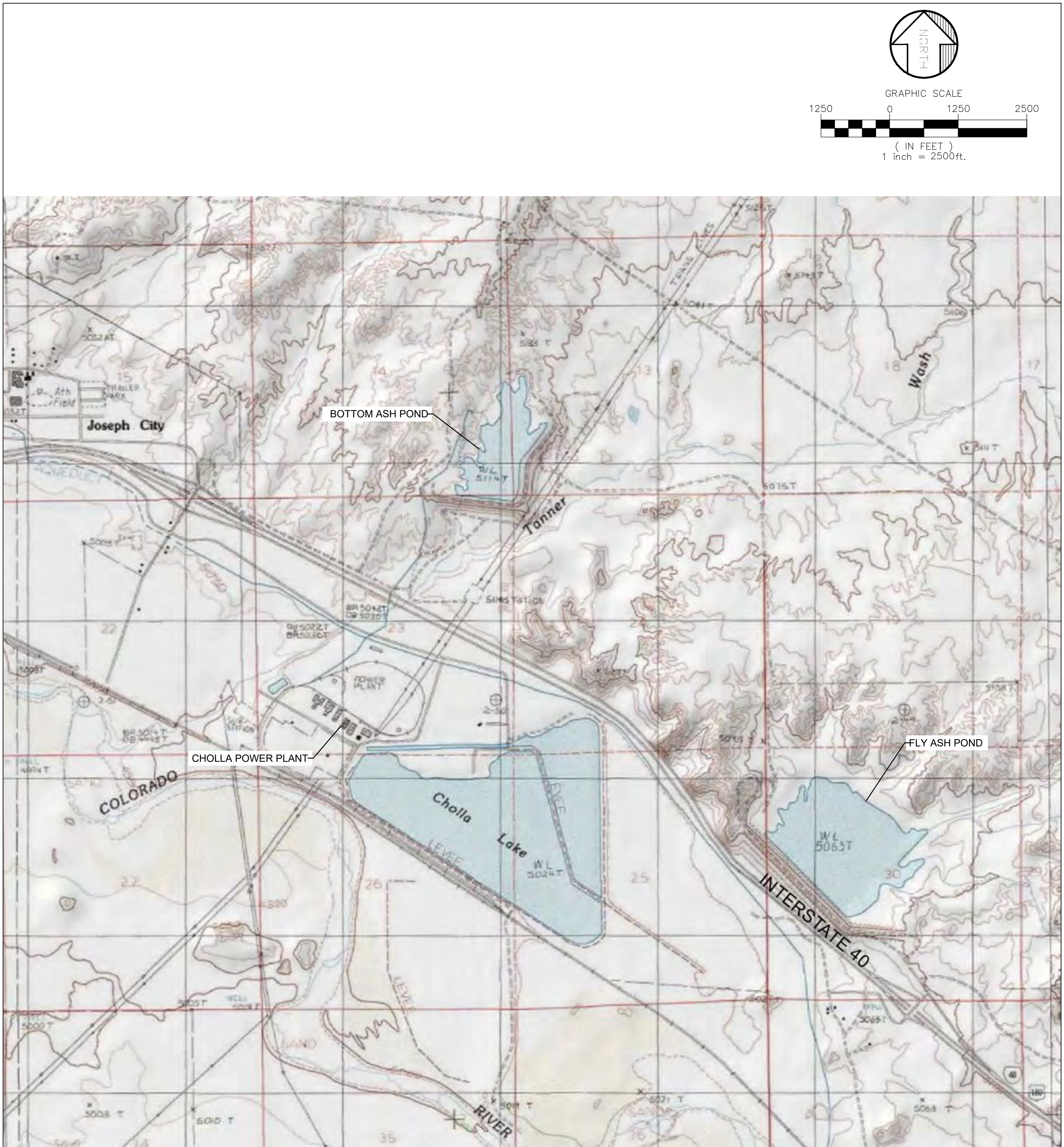
CHOLLA POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Pr□□□□□N□. 60445840

BOTTOM ASH POND
MONITORED INSTRUMENTATION
AND SEEP LOCATION MAP

AECOM

FIGURE 1-2

Last saved by: ALEISA.KRUG(2016-06-16) Last Plotted: 2016-06-16
Filename: P:\ARIZONA PUBLIC SERVICE\60445840\APS\CHOLLA\STRUCTURAL\INTEGRITY\CADD FILES\FIGURES\FIGURE 4-1\SITE TOPO MAP.DWG



SOURCE: ARCGIS NATIONAL GEOGRAPHIC WORLD BASEMAP, 2013

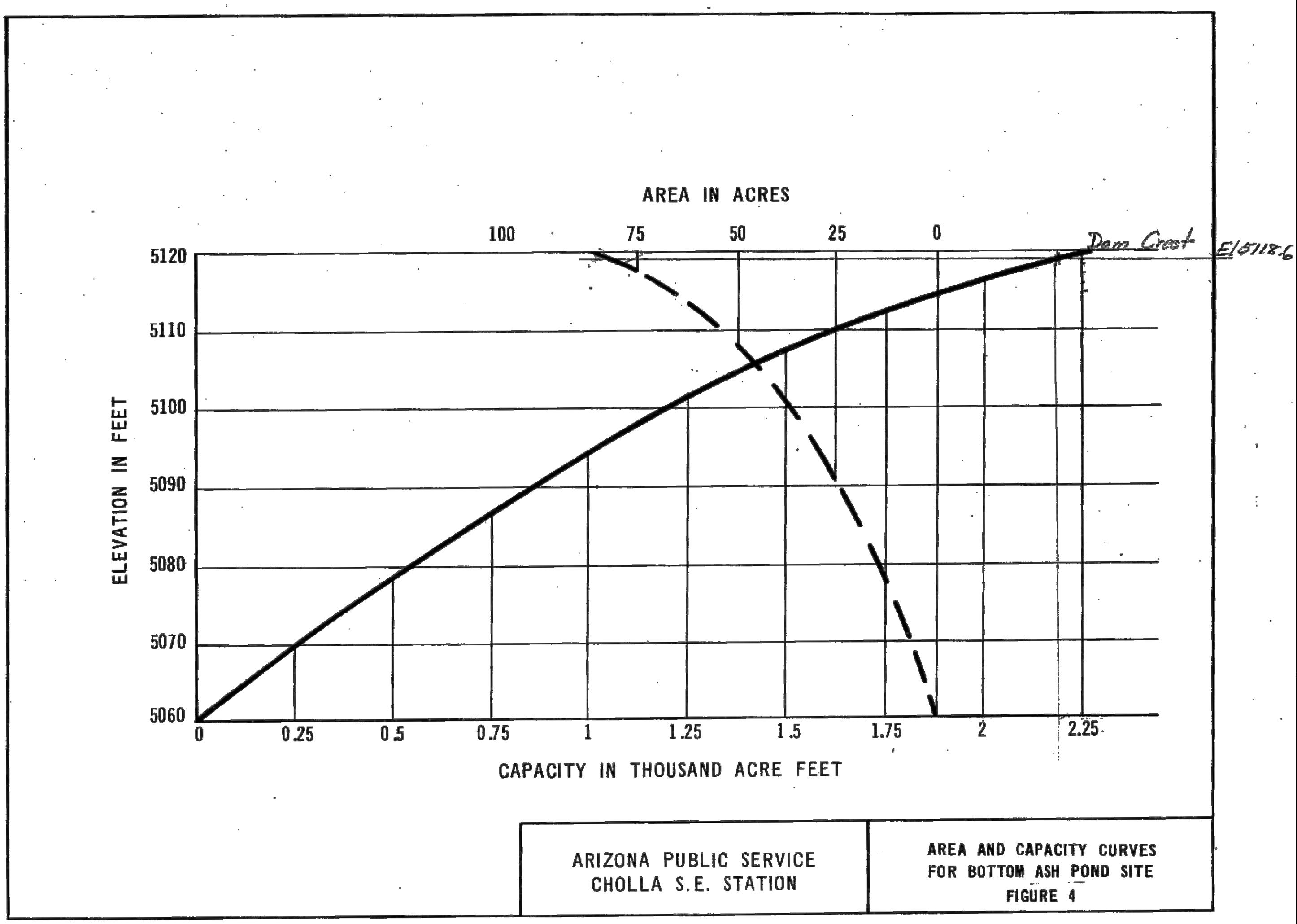
CHOLLA POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Project No. 60445840

SITE TOPOGRAPHIC MAP

AECOM

FIGURE 3-1

L□□□□□□□d □□: ALEISA□KRUG(2016-06-16) L□□□P□□□□d: 2016-06-16
F□□□□□ □: P:□ARIZONA PUBLIC SERVICE□60445840□APS□CHOLLA□STRUCTURAL□INTEGRITY□CADD FILES□FIGURES□FIGURE 4-2□AREA CAPACITY CURVE.DWG



SOURCE:

SEEPAGE AND FOUNDATION STUDIES: VOLUME I OF II ENGINEERING REPORT (EBASCO,1975)

CHOLLA POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Pr□□□□□N□. 60445840

AREA CAPACITY CURVE

FIGURE 3-2

L□□□□□□□d □□: ALEISA□KRUG(2016-08-10) L□□□P□□□□d: 2016-08-11 ANSI A 8.5" □11"
F□□□□□ □: P:□ARIZONA PUBLIC SERVICE□60445840□APS□CHOLLA□STRUCTURAL□INTEGRITY□CADD FILES□FIGURES□FIGURE 5-1□CROSS SECTION LOCATIONS SFA - BAP.DWG

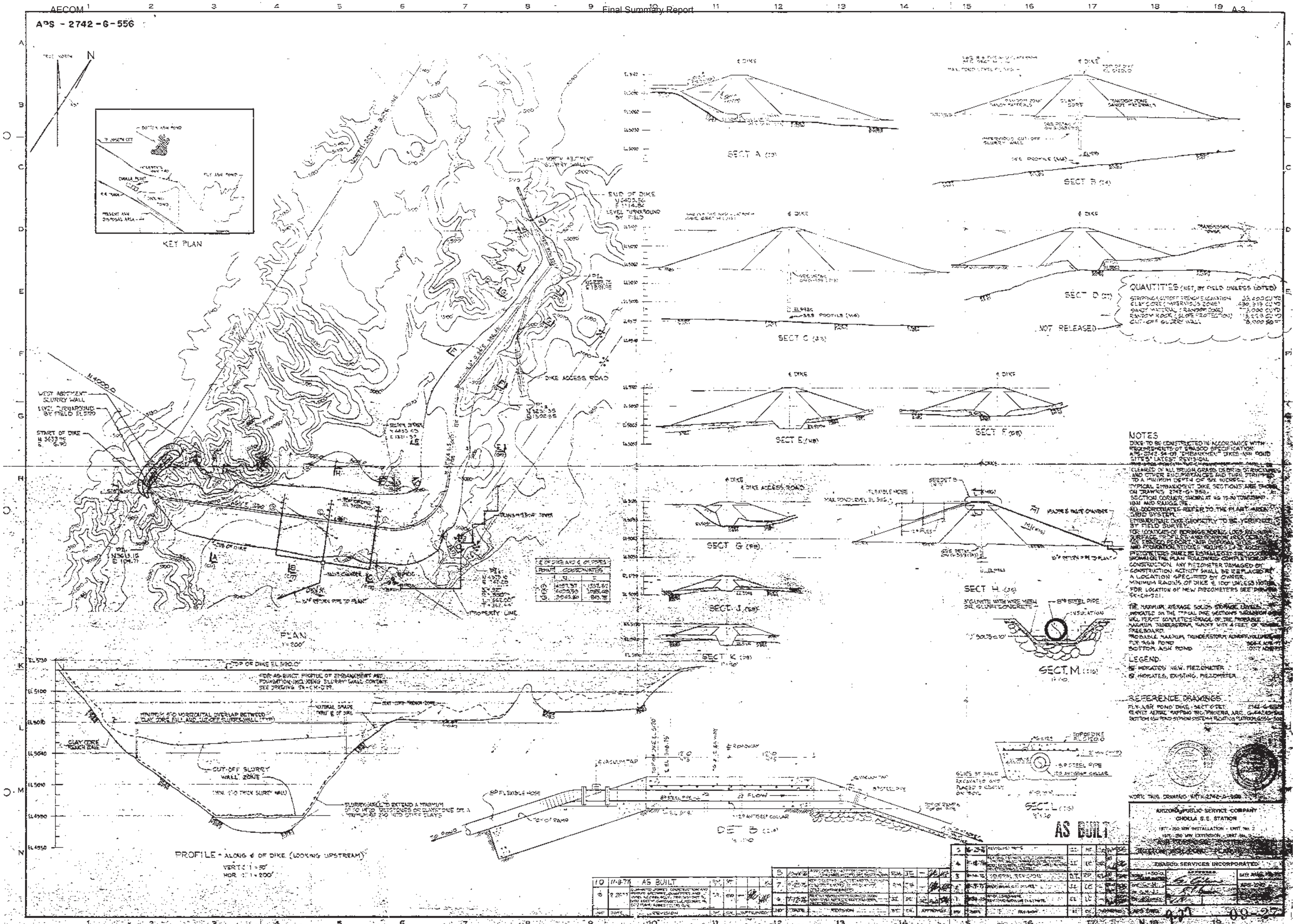
FOUR CORNERS POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Pr□□□□□N□. 60445840

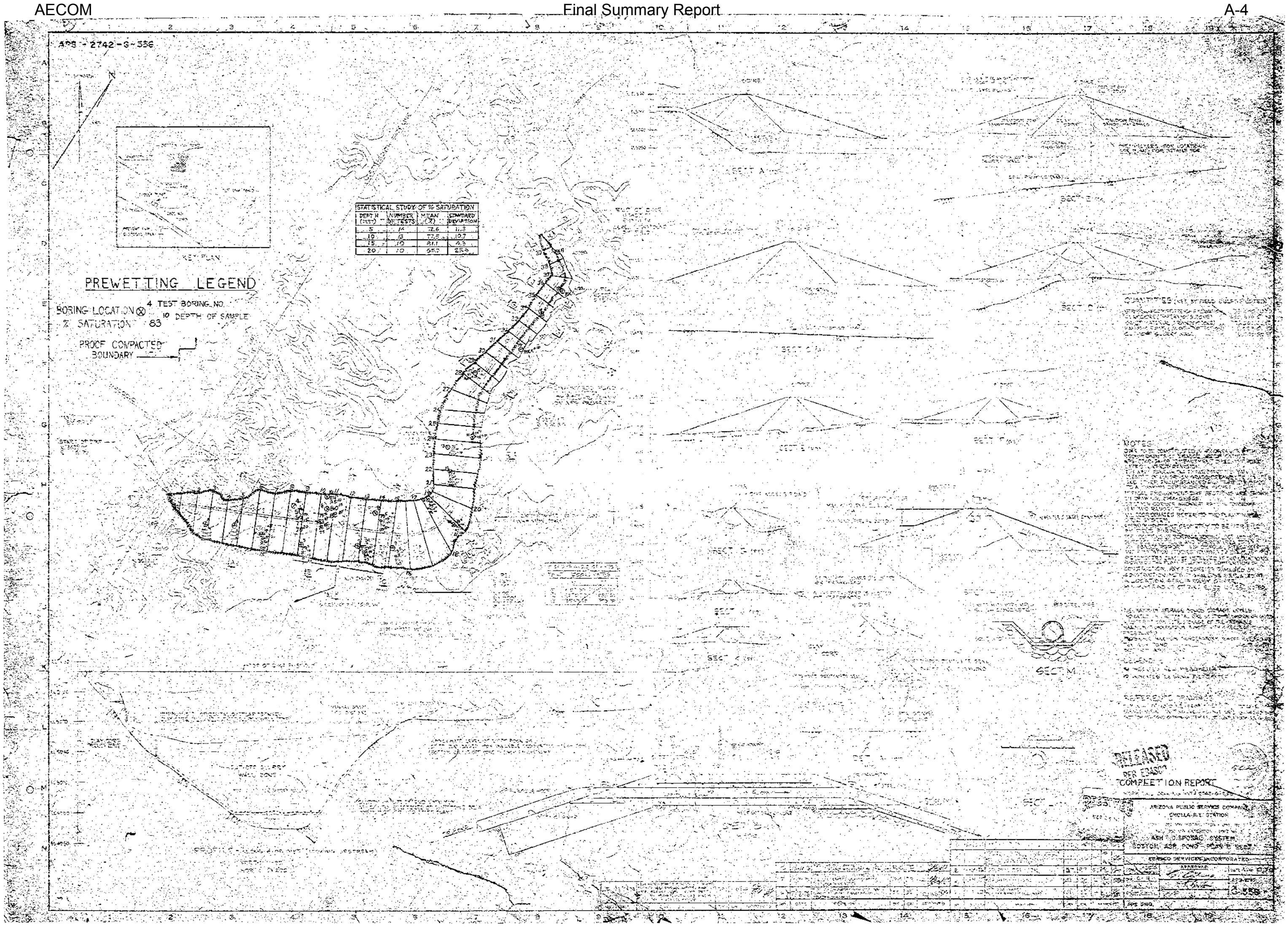
CROSS SECTION LOCATIONS
SAFETY FACTOR ASSESSMENT

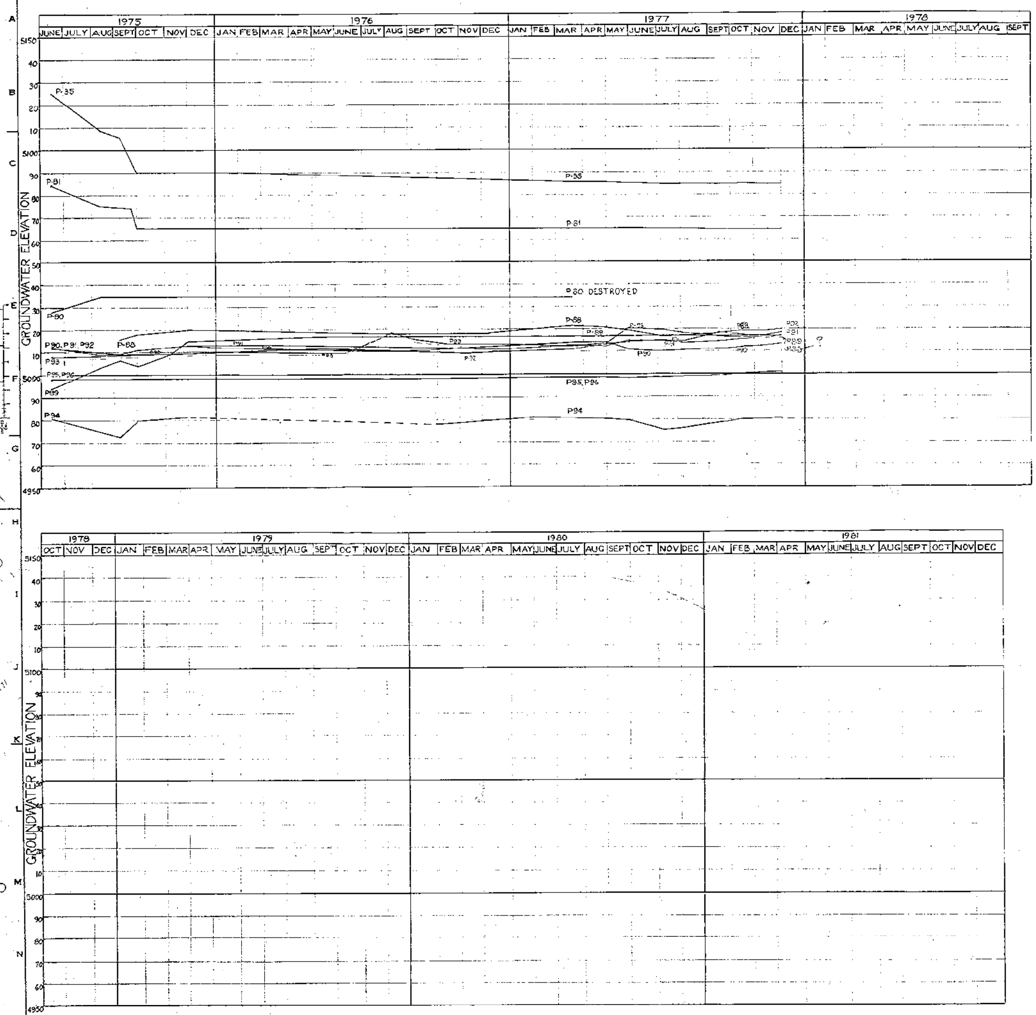
AECOM

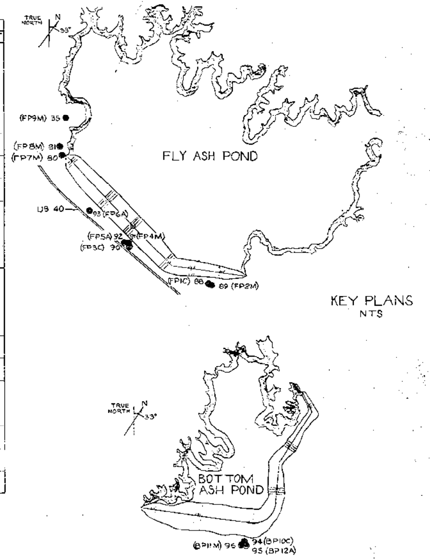
FIGURE 5-1

Appendix A. Historic Drawings


APS - 2742 - G - 556
N
KEY PLAN
BOTTOM ASH POND
FLY ASH POND
END OF DIKE
NORTH ABUTMENT SLURRY WALL
WEST ABUTMENT SLURRY WALL
START OF DIKE
DIKE ACCESS ROAD
PROPERTY LINE
PLAN
SECT. A
SECT. B
SECT. C
SECT. D
SECT. E
SECT. F
SECT. G
SECT. H
SECT. J
SECT. K
SECT. L
SECT. M
NOT RELEASED
QUANTITIES
NOTES
LEGEND
REFERENCE DRAWINGS
TOP OF DIKE EL 5120.0'
CUT-OFF SLURRY WALL ZONE
PROFILE - ALONG ℄ OF DIKE (LOOKING UPSTREAM)
DET. B
FLOW
AS BUILT
WORK THIS DRAWING WITH 2742-G-
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
EBASCO SERVICES INCORPORATED
APS DWG.
09-27


APS - 2742 - G - 556
KEY PLAN
STATISTICAL STUDY OF % SATURATION
DEPTH (FEET) | NUMBER OF TESTS | MEAN (X̄) | STANDARD DEVIATION
5 | 14 | 72.6 | 11.3
10 | 13 | 77.5 | 10.7
15 | 10 | 81.1 | 4.3
20 | 10 | 55.0 | 25.6
PREWETTING LEGEND
BORING LOCATION ⊗ 4 TEST BORING NO.
% SATURATION 83 10 DEPTH OF SAMPLE
PROOF COMPACTED BOUNDARY
NOTES:
SECT. M
RELEASED
COMPLETION REPORT





PIEZOMETER LEGEND:

F - FLY ASH
B - BOTTOM ASH
P - PIEZOMETER
C - COCONINO
M - MOENKOPI
A - ALLUVIUM

INSTALLATION DATA 6-75

PIEZOMETER NUMBER	DRILLED DEPTH	DEPTH TO SCREEN	TOP OF RISER PIPE ELEVATION	RISER HEIGHT
35 (FP9M)	132	32	5191.3	3.2
80 (FP7M)	58	43	5083.0	1.7
81 (FP8M)	112	32	5164.0	1.5
88 (FP1C)	191	175	5086.5	2.0
89 (FP2M)	92	52	5085.9	1.8
90 (FP3C)	146	133	5036.7	3.0
91 (FP4M)	77	57	5035.1	1.5
92 (FP5A)	56	41	5034.9	1.5
93 (FP6A)	26	16	5034.2	2.0
94 (BP10C)	292	277	5050.7	3.0
95 (BP12A)	102	87	5049.3	2.4
96 (BP11M)	154	114	5049.9	3.1

NOTES:

COMPLETION REPORT

ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1976-250 MW INSTALLATION - UNIT No. 2
1977-250 MW EXTENSION-UNIT No 3

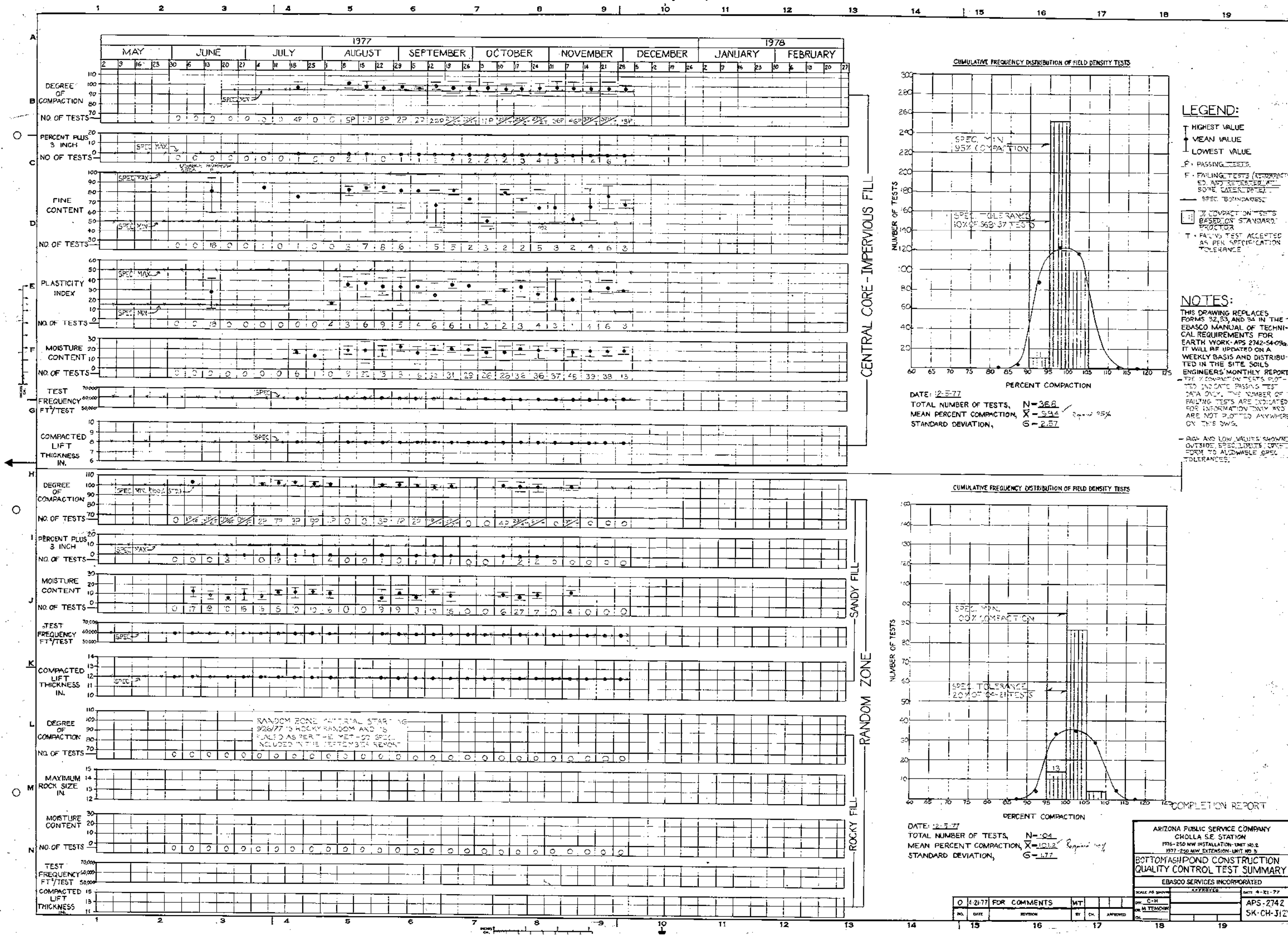
ASH POND PIEZOMETERS
GROUNDWATER ELEVATIONS

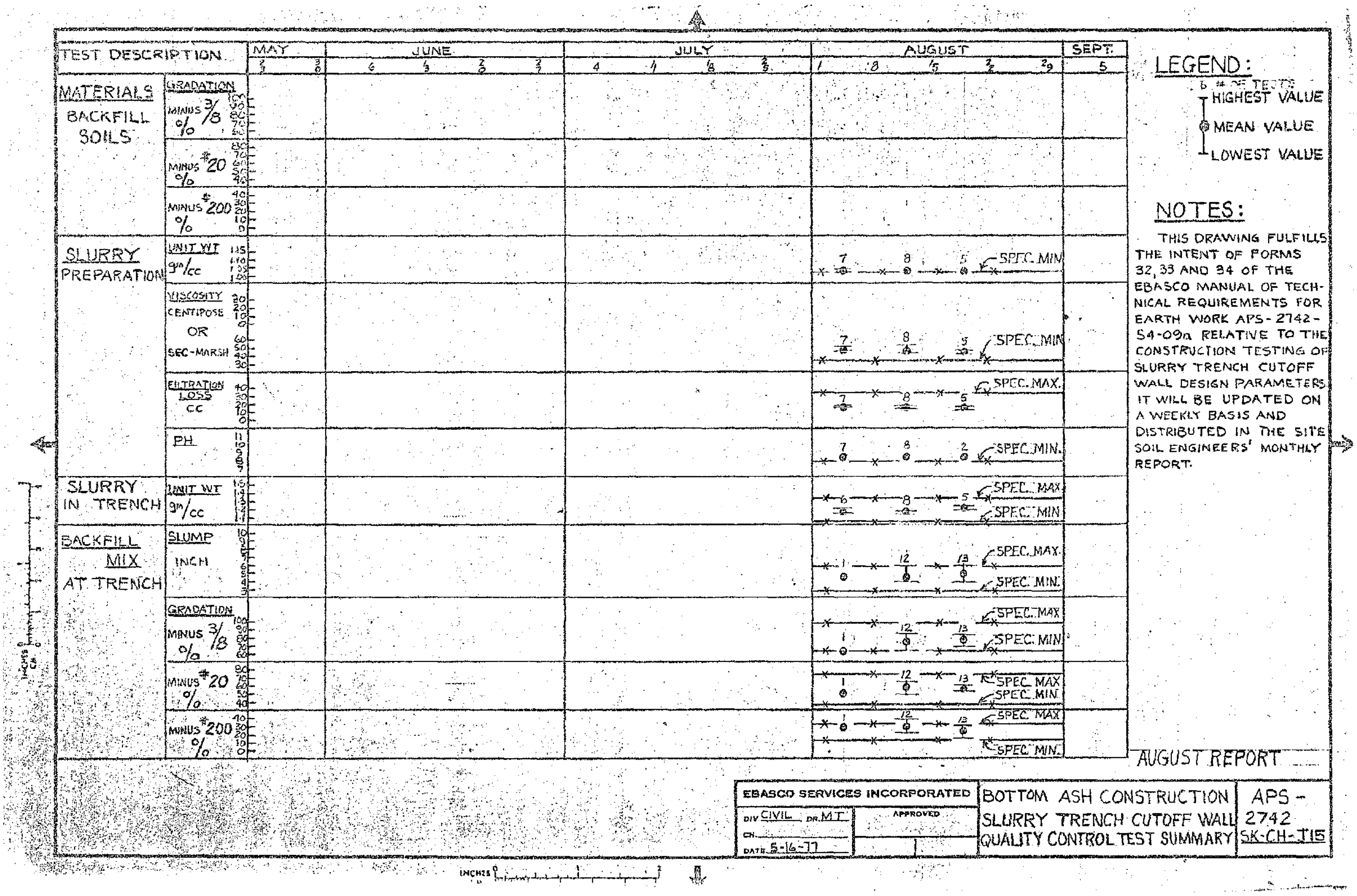
EBASCO SERVICES INCORPORATED

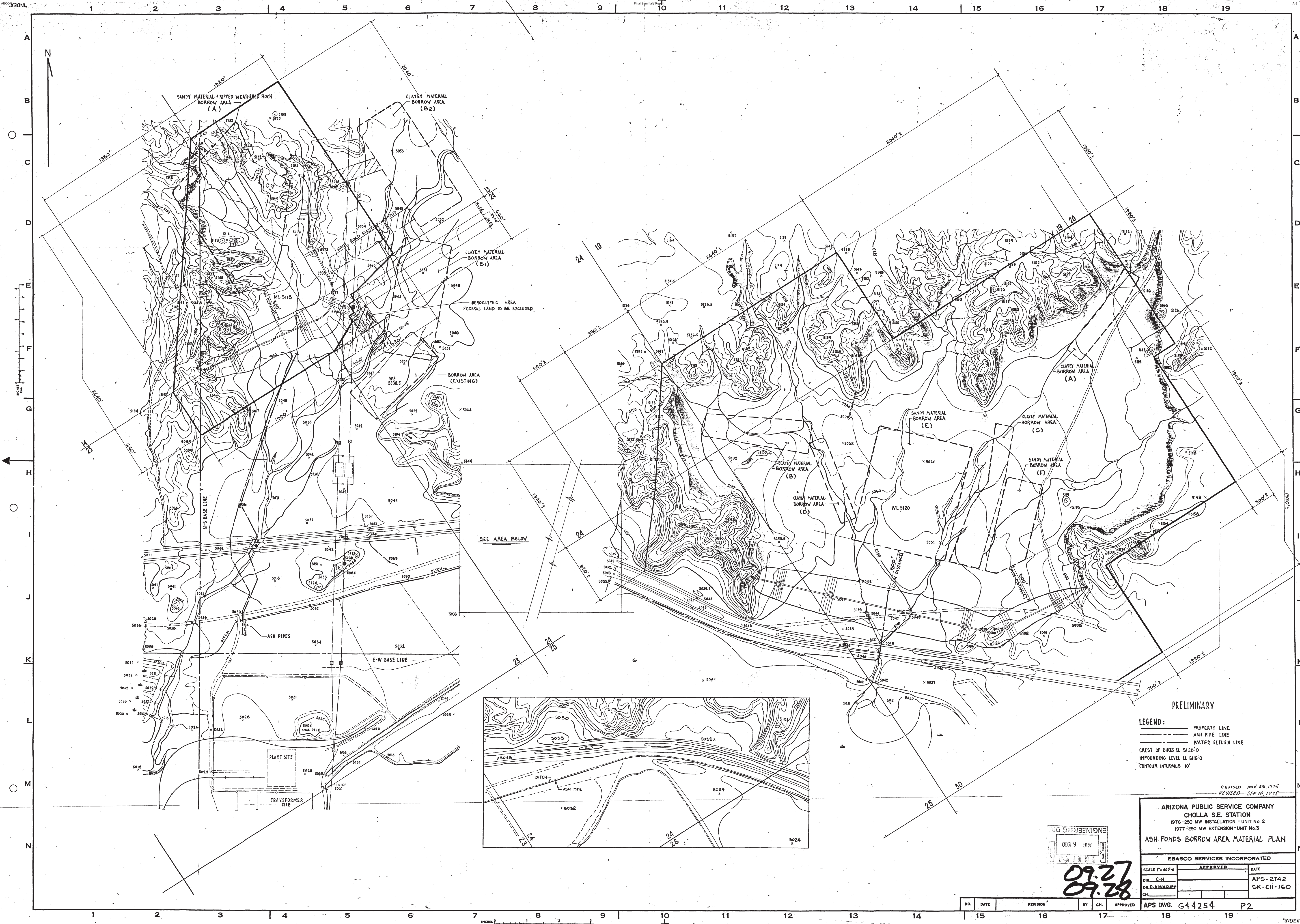
SCALE: AS SHOWN | DATE: 3-28-77 | DW. C-H | DR. M. TEMKIN

APS-2742
SK-CH-J11

NO.	DATE	REVISION	BY	CH.	APPROVED
0	3-29-77	FOR COMMENTS	MT		


1977
1978
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
DEGREE OF COMPACTION
NO. OF TESTS
PERCENT PLUS 3 INCH
FINE CONTENT
PLASTICITY INDEX
MOISTURE CONTENT
TEST FREQUENCY FT³/TEST
COMPACTED LIFT THICKNESS IN.
MAXIMUM ROCK SIZE IN
CENTRAL CORE - IMPERVIOUS FILL
SANDY FILL
RANDOM ZONE
ROCKY FILL
CUMULATIVE FREQUENCY DISTRIBUTION OF FIELD DENSITY TESTS
NUMBER OF TESTS
PERCENT COMPACTION
DATE: 12-5-77
TOTAL NUMBER OF TESTS, N=368
MEAN PERCENT COMPACTION, X̄=99.4
STANDARD DEVIATION, σ=2.57
TOTAL NUMBER OF TESTS, N=104
STANDARD DEVIATION, σ=1.77
LEGEND:
HIGHEST VALUE
MEAN VALUE
LOWEST VALUE
NOTES:
THIS DRAWING REPLACES FORMS 32, 33, AND 34 IN THE EBASCO MANUAL OF TECHNICAL REQUIREMENTS FOR EARTH WORK-APS 2742-54-09a. IT WILL BE UPDATED ON A WEEKLY BASIS AND DISTRIBUTED IN THE SITE SOILS ENGINEERS' MONTHLY REPORT.
COMPLETION REPORT
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
BOTTOM ASH POND CONSTRUCTION
QUALITY CONTROL TEST SUMMARY
EBASCO SERVICES INCORPORATED
FOR COMMENTS
APS-2742
SK-CH-312

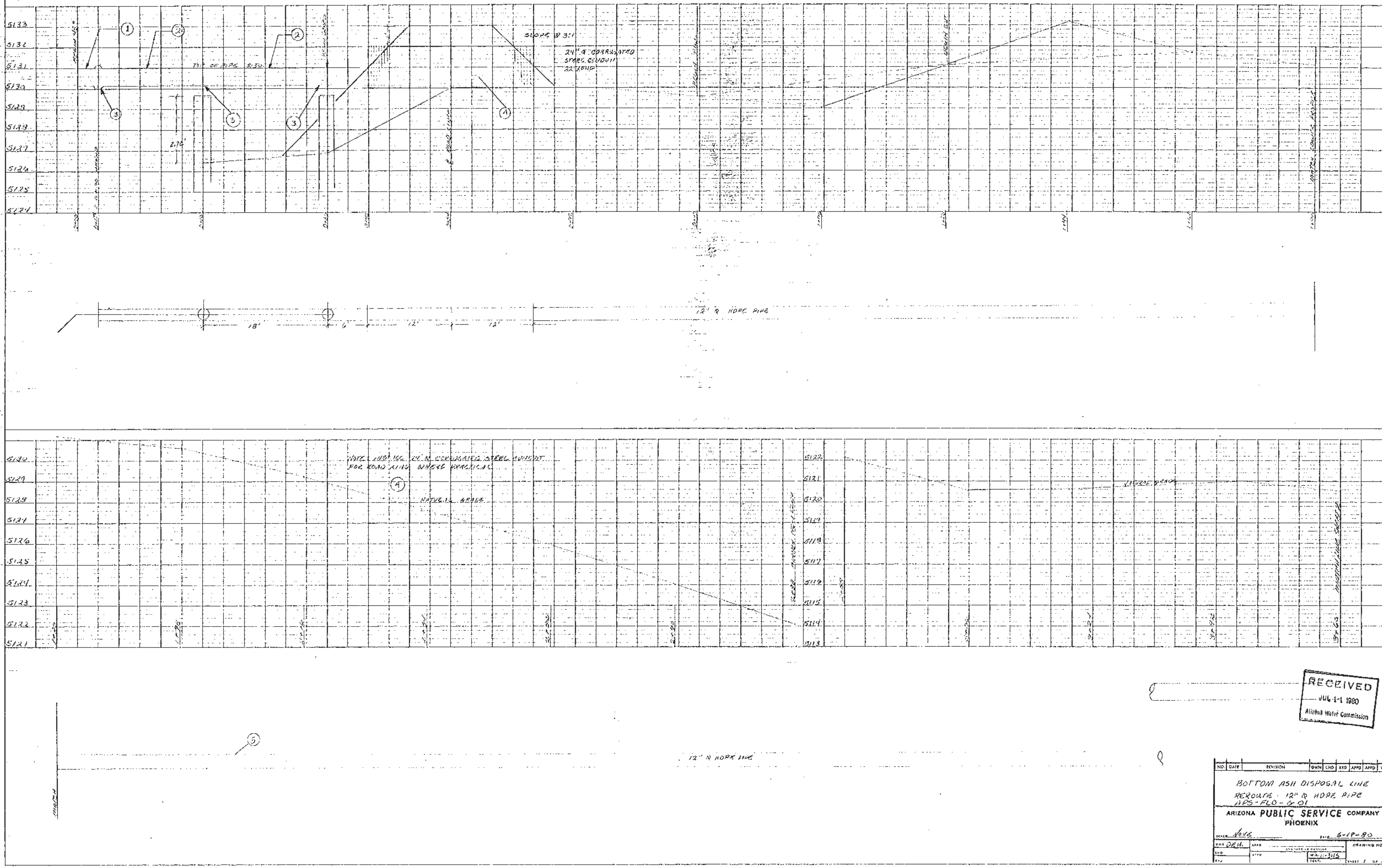

TEST DESCRIPTION
MAY
JUNE
JULY
AUGUST
SEPT.
MATERIALS BACKFILL SOILS
GRADATION MINUS 3/8 %
MINUS #20 %
MINUS #200 %
SLURRY PREPARATION
UNIT WT gm/cc
VISCOSITY CENTIPOSE OR SEC-MARSH
FILTRATION LOSS cc
PH
SLURRY IN TRENCH
UNIT WT gm/cc
BACKFILL MIX AT TRENCH
SLUMP INCH
GRADATION MINUS 3/8 %
MINUS #20 %
MINUS #200 %
SPEC. MIN
SPEC. MAX.
LEGEND:
OF TESTS
HIGHEST VALUE
MEAN VALUE
LOWEST VALUE
NOTES:
THIS DRAWING FULFILLS THE INTENT OF FORMS 32, 33 AND 34 OF THE EBASCO MANUAL OF TECHNICAL REQUIREMENTS FOR EARTH WORK APS-2742-S4-09a RELATIVE TO THE CONSTRUCTION TESTING OF SLURRY TRENCH CUTOFF WALL DESIGN PARAMETERS. IT WILL BE UPDATED ON A WEEKLY BASIS AND DISTRIBUTED IN THE SITE SOIL ENGINEERS' MONTHLY REPORT.
AUGUST REPORT
EBASCO SERVICES INCORPORATED
DIV CIVIL DR. MT
APPROVED
DATE 5-16-77
BOTTOM ASH CONSTRUCTION
SLURRY TRENCH CUTOFF WALL
QUALITY CONTROL TEST SUMMARY
APS-2742
SK-CH-T15



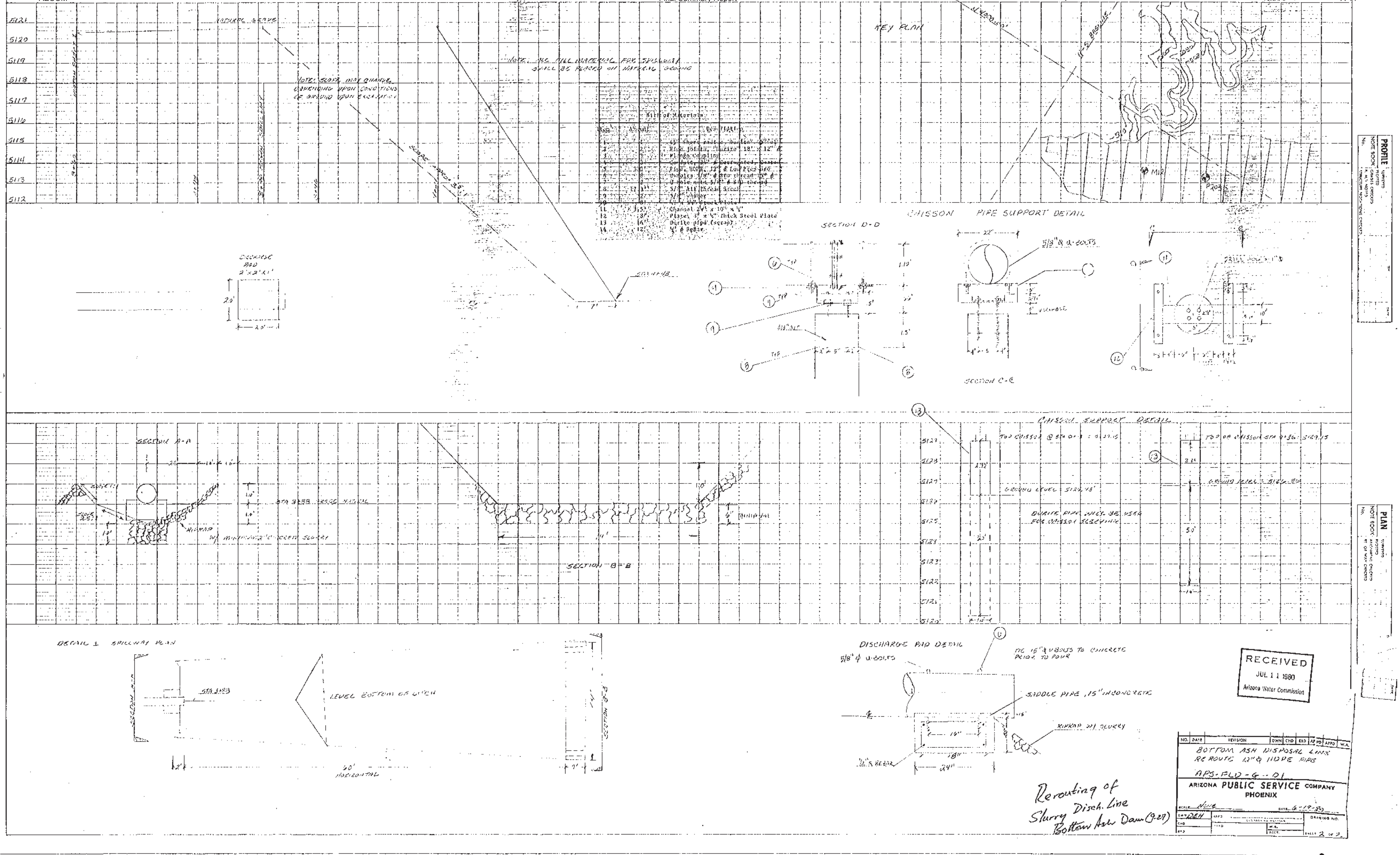
SANDY MATERIAL & RIPPED WEATHERED ROCK BORROW AREA (A)
CLAYEY MATERIAL BORROW AREA (B2)
CLAYEY MATERIAL BORROW AREA (B1)
HIEROGLYPHIC AREA FEDERAL LAND TO BE EXCLUDED
BORROW AREA (EXISTING)
N-S BASE LINE
E-W BASE LINE
ASH PIPES
COAL PILE
PLANT SITE
TRANSFORMER SITE
SEE AREA BELOW
DITCH
ASH PIPE
CLAYEY MATERIAL BORROW AREA (A)
SANDY MATERIAL BORROW AREA (E)
CLAYEY MATERIAL BORROW AREA (C)
SANDY MATERIAL BORROW AREA (F)
CLAYEY MATERIAL BORROW AREA (B)
CLAYEY MATERIAL BORROW AREA (D)
WL 5120
WL 5118
PRELIMINARY
LEGEND:
PROPERTY LINE
ASH PIPE LINE
WATER RETURN LINE
CREST OF DIKES EL 5120'0
IMPOUNDING LEVEL EL 5116'0
CONTOUR INTERVALS 10'
REVISED NOV 25, 1975
REVISED SEP 10, 1975
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1976-250 MW INSTALLATION - UNIT No. 2
1977-250 MW EXTENSION - UNIT No. 3
ASH PONDS BORROW AREA MATERIAL PLAN
EBASCO SERVICES INCORPORATED
SCALE 1"=400'-0
APPROVED
DATE
DIV. C-H
DR. D. KOVACHEV
CH.
APS-2742
SK-CH-160
NO. DATE REVISION BY CH. APPROVED
APS DWG. G44254 P2
09.27
09.28

[illegible]

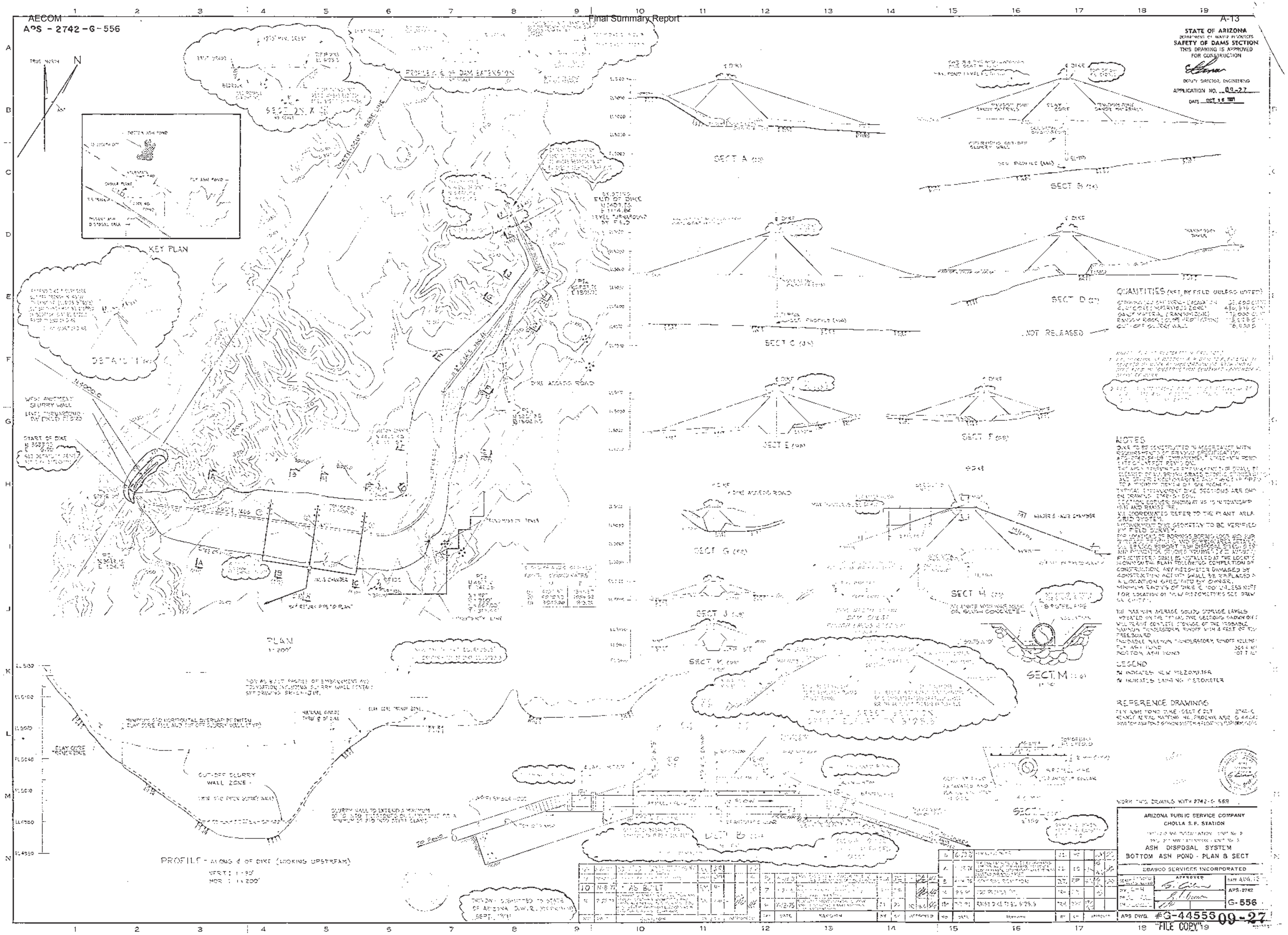
[illegible]

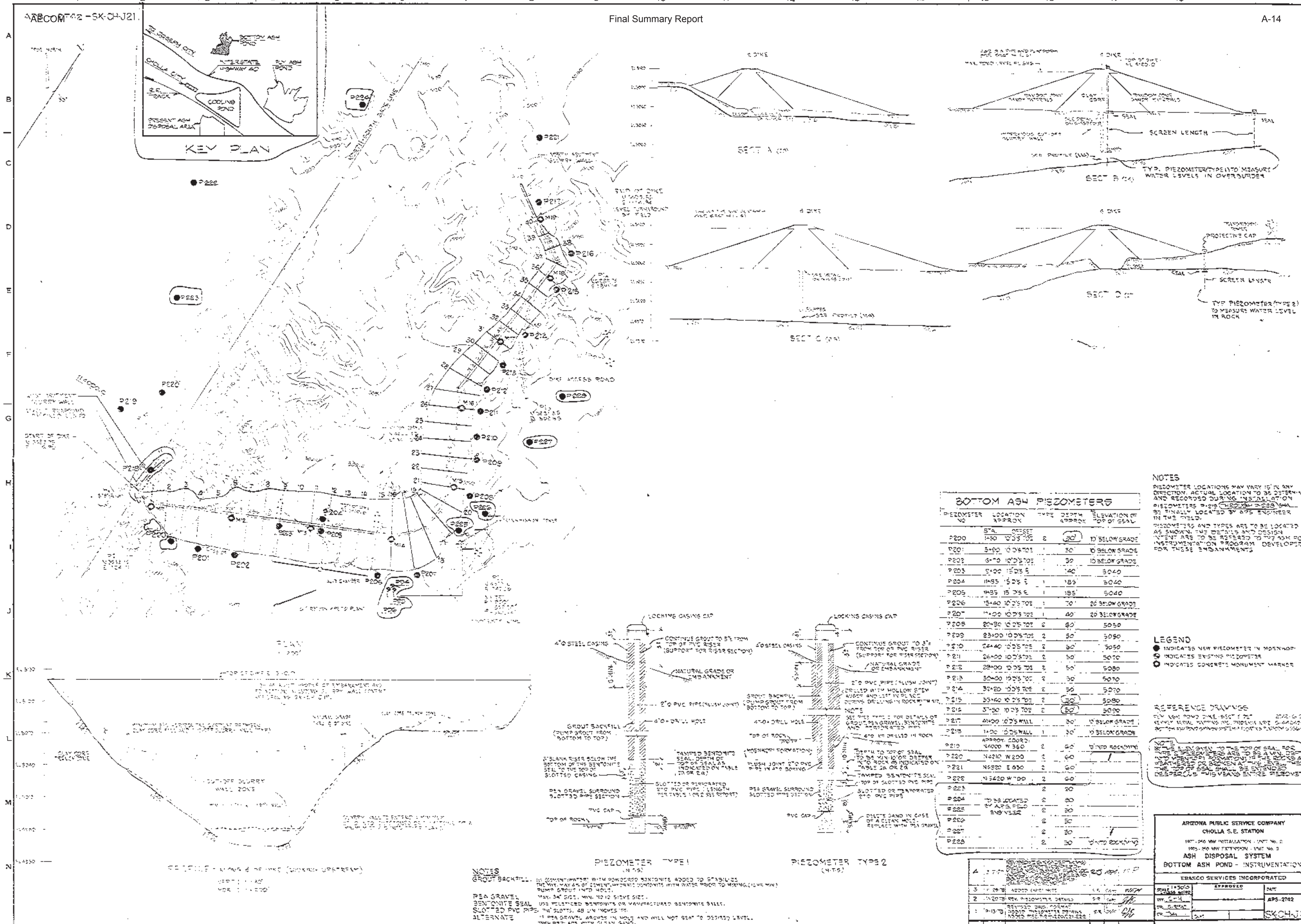

5133
5132
5131
5130
5129
5128
5127
5126
5125
5124
TOP OF PIPE 5130
SLOPE @ 3:1
24" Ø CORRUGATED STEEL CONDUIT 22' LONG
2.75'
18'
12'
12' Ø HDPE PIPE
PROFILE
NOTE: INSTALL 24" Ø CORRUGATED STEEL CONDUIT FOR ROAD XING WHERE PRACTICAL
NATURAL GRADE
PLAN
12" Ø HDPE LINE
RECEIVED
JUL 1-1 1980
Arizona Water Commission
NO. DATE REVISION DWN CHD EXD APPD APPD W.A.
BOTTOM ASH DISPOSAL LINE
REROUTE - 12" Ø HDPE PIPE
APS-FLO-G-01
ARIZONA PUBLIC SERVICE COMPANY
PHOENIX
SCALE NONE
DATE 6-19-80
DWN DEH.
DRAWING NO.
SHEET 1 OF 2

9.27


KEY PLAN
CAISSON PIPE SUPPORT DETAIL
SECTION D-D
SECTION C-C
SECTION A-A
SECTION B-B
CAISSON SUPPORT DETAIL
DETAIL 1 SPILLWAY PLAN
DISCHARGE PAD DETAIL
LEVEL BOTTOM OF DITCH
SADDLE PIPE 15" IN CONCRETE
RIPRAP W/ SLURRY
Bill of Materials
RECEIVED
JUL 11 1980
Arizona Water Commission
BOTTOM ASH DISPOSAL LINE
RE ROUTE 12" & HDPE PIPE
APS-FLD-G-01
ARIZONA PUBLIC SERVICE COMPANY
PHOENIX
Rerouting of
Slurry Disch. Line
Bottom Ash Dam (927)
PROFILE
PLAN

927


APS - 2742 - G - 556
STATE OF ARIZONA
SAFETY OF DAMS SECTION
THIS DRAWING IS APPROVED FOR CONSTRUCTION
APPLICATION NO. 09-27
KEY PLAN
DETAIL 1
SECT A
SECT B
SECT C
SECT D
SECT E
SECT F
SECT G
SECT H
SECT J
SECT K
SECT M
NOT RELEASED
QUANTITIES
NOTES
LEGEND
REFERENCE DRAWINGS
PLAN
PROFILE - ALONG ℄ OF DIKE (LOOKING UPSTREAM)
CUT-OFF SLURRY WALL ZONE
AS BUILT
WORK THIS DRAWING WITH 2742-G-559
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
ASH DISPOSAL SYSTEM
BOTTOM ASH POND - PLAN & SECT
EBASCO SERVICES INCORPORATED
APPROVED
APS-2742
G-556
APS DWG. #G-44555
09-27
"FILE COPY"



BOTTOM ASH PIEZOMETERS

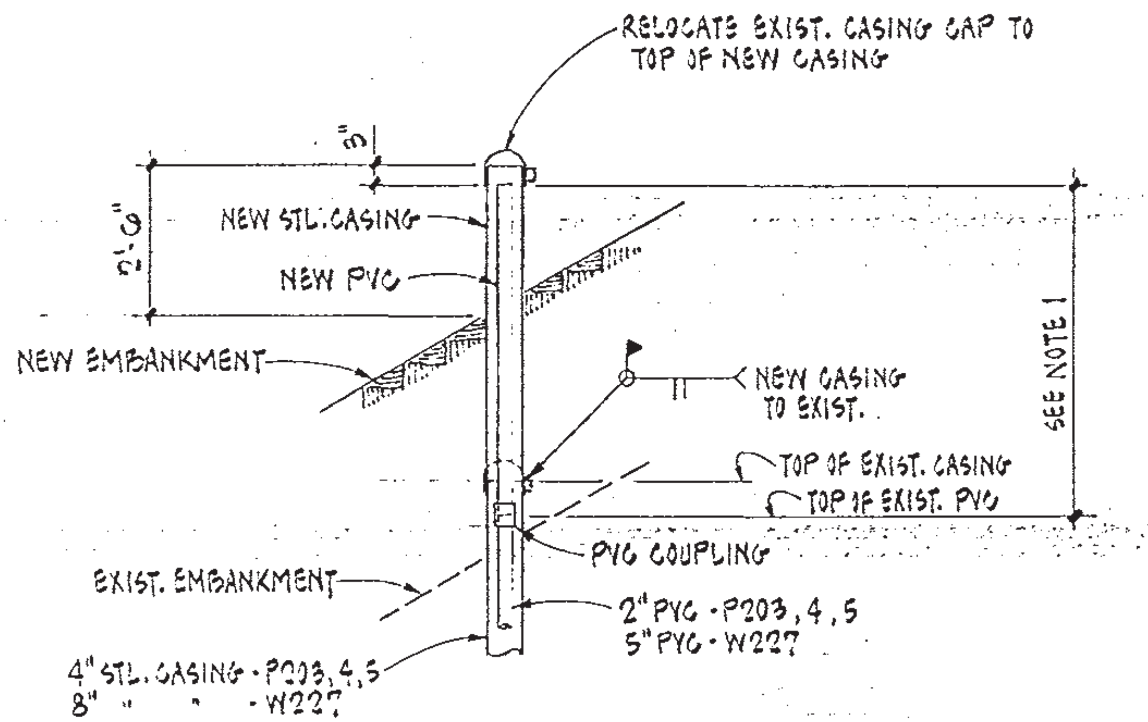
PIEZOMETER NO.	LOCATION APPROX. STA.	LOCATION APPROX. OFFSET	TYPE	DEPTH APPROX.	ELEVATION OF TOP OF SEAL
P200	1+50	10' D/S TOE	2	30'	10' BELOW GRADE
P201	5+00	10' D/S TOE	1	30'	10' BELOW GRADE
P202	6+70	10' D/S TOE	1	30'	10' BELOW GRADE
P203	5+00	15' D/S ℄	1	140'	5040
P204	11+85	15' D/S ℄	1	185'	5040
P205	11+85	15' D/S ℄	1	185'	5040
P206	15+40	10' D/S TOE	1	70'	20' BELOW GRADE
P207	17+00	10' D/S TOE	1	40'	20' BELOW GRADE
P208	20+30	10' D/S TOE	2	60'	5050
P209	23+00	10' D/S TOE	2	50'	5050
P210	24+40	10' D/S TOE	2	50'	5050
P211	26+00	10' D/S TOE	2	50'	5070
P212	28+00	10' D/S TOE	2	50'	5080
P213	30+00	10' D/S TOE	2	50'	5070
P214	32+20	10' D/S TOE	2	50'	5070
P215	33+40	10' D/S TOE	2	50'	5090
P216	37+50	10' D/S TOE	2	50'	5090
P217	41+00	10' D/S WALL	1	30'	10' BELOW GRADE
P218	1+00	10' D/S WALL	1	30'	10' BELOW GRADE
P219	APPROX. COORD.: N4000	W 360	2	60'	10' INTO ROCK (MIN)
P220	N4210	W 200	2	60	
P221	N6820	E 630	2	60'	
P222	N5420	W 700	2	60'	
P223	TO BE LOCATED BY A.P.S. FIELD ENGINEER		2	20	
P224			2	80	
P225			2	30	
P226			2	50	
P227			2	50	
P228			2	30	10' INTO ROCK (MIN)

09-27

"FILE COPY"

NOTES:

1. DOCUMENT DISTANCE FROM TOP OF EXIST. PVC TO TOP OF NEW PVC AT EACH LOCATION.
2. NEW CASING & PVC SIZE & MATERIAL TO MATCH EXIST.



STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES
SAFETY OF DAMS SECTION
THIS DRAWING IS APPROVED FOR CONSTRUCTION

[signature]

DEPUTY DIRECTOR, ENGINEERING

APPLICATION NO. 09-27

DATE OCT 11 2001

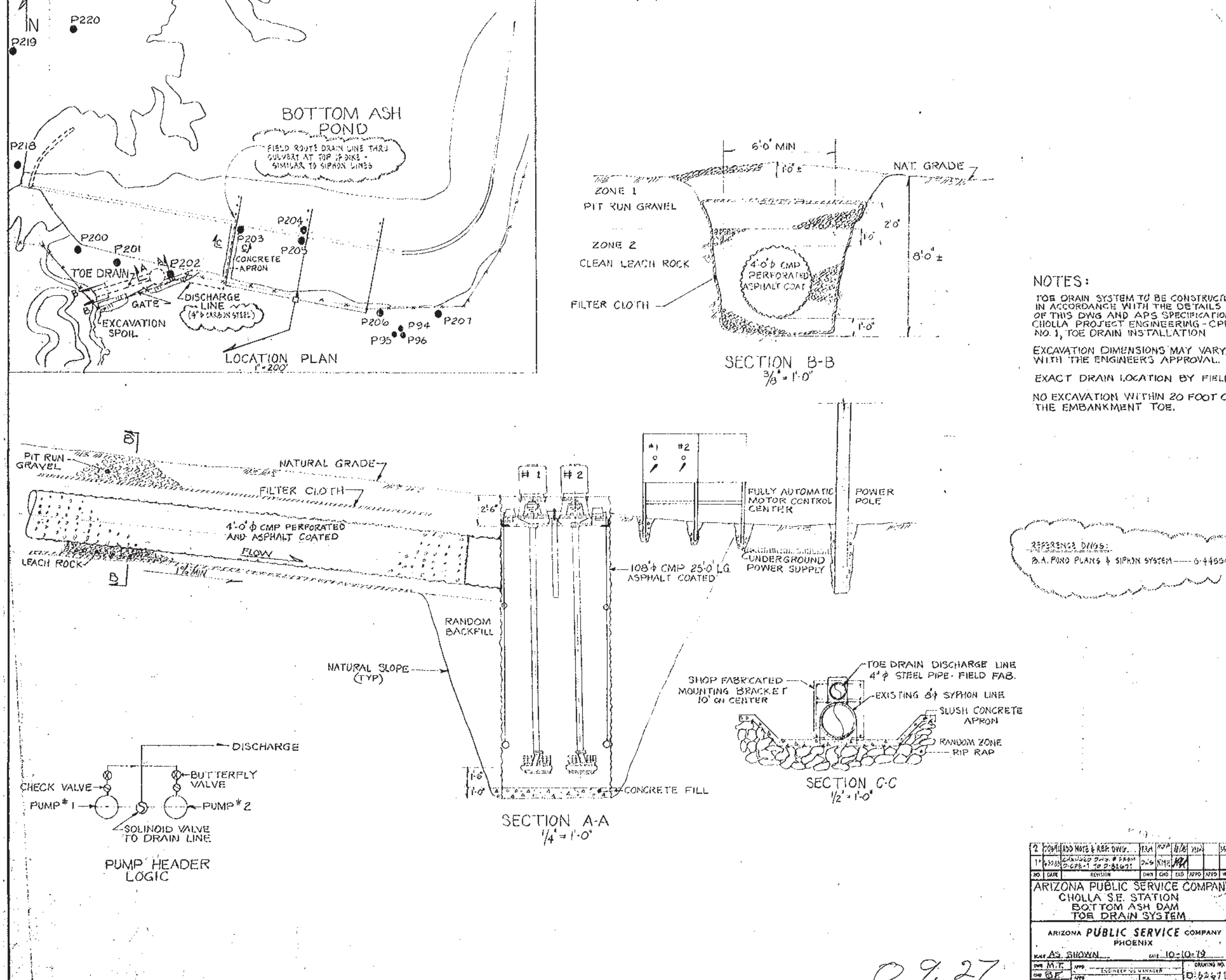
Registered Professional Engineer (Civil) Certificate No. 15294 Marta M. [signature] Arizona, U.S.A.

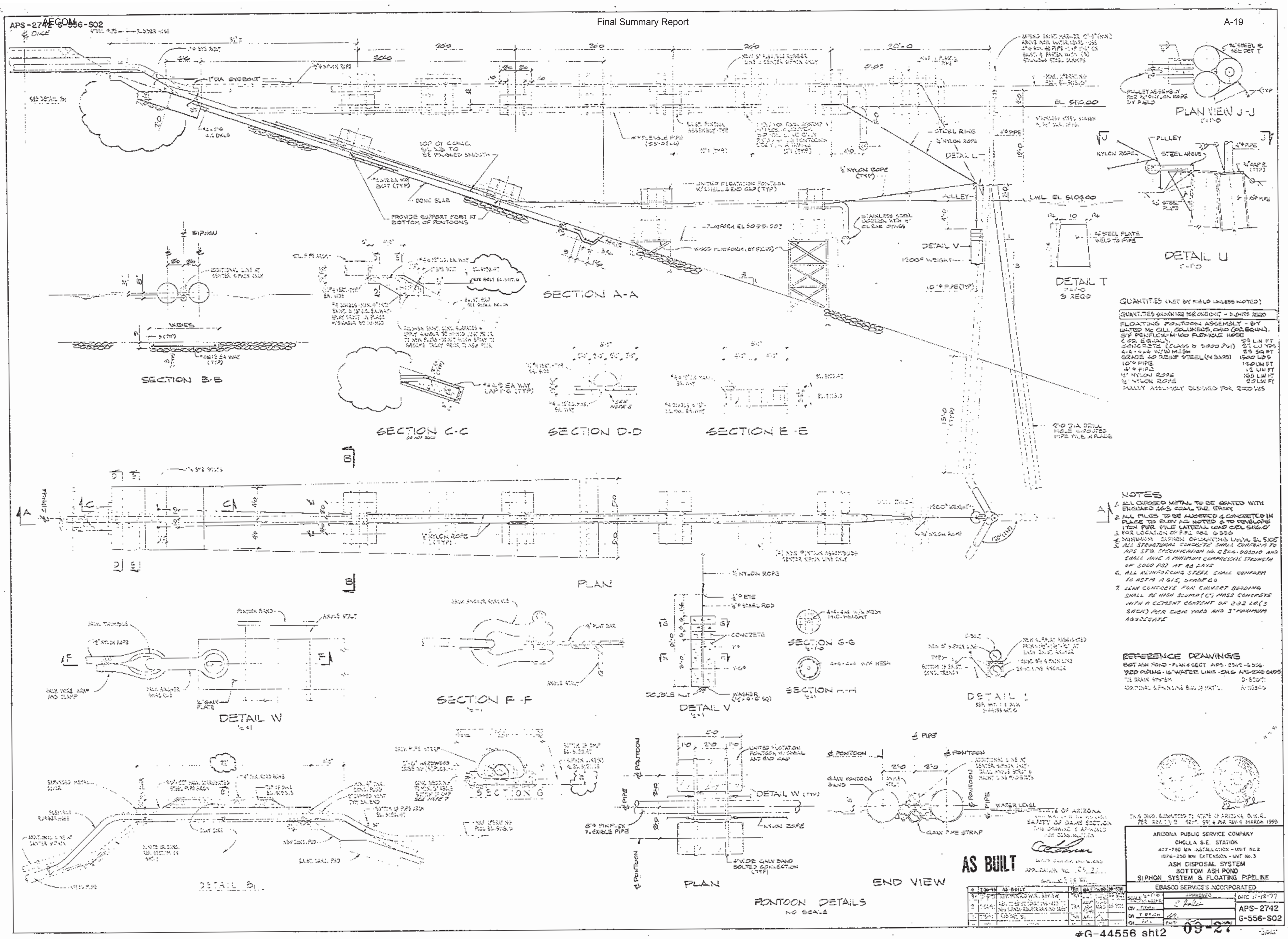
DWN: TRH CHD: [initials] APPD: [initials]

CHOLLA S.E.S. B.A. POND
PIEZOMETER & WELL
EXTENSION DETAILS
CKA-7009:TRH

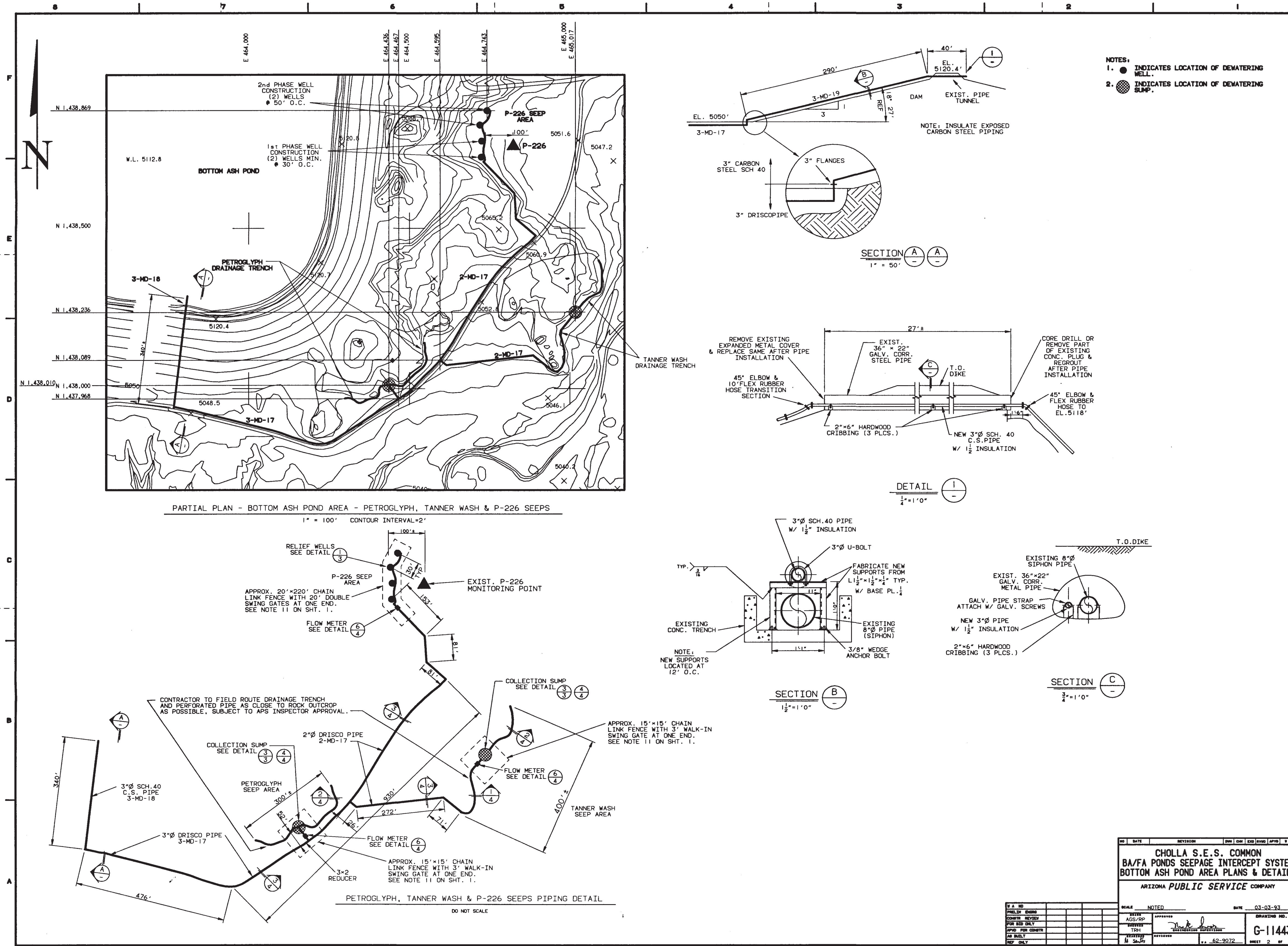
DR I M

R

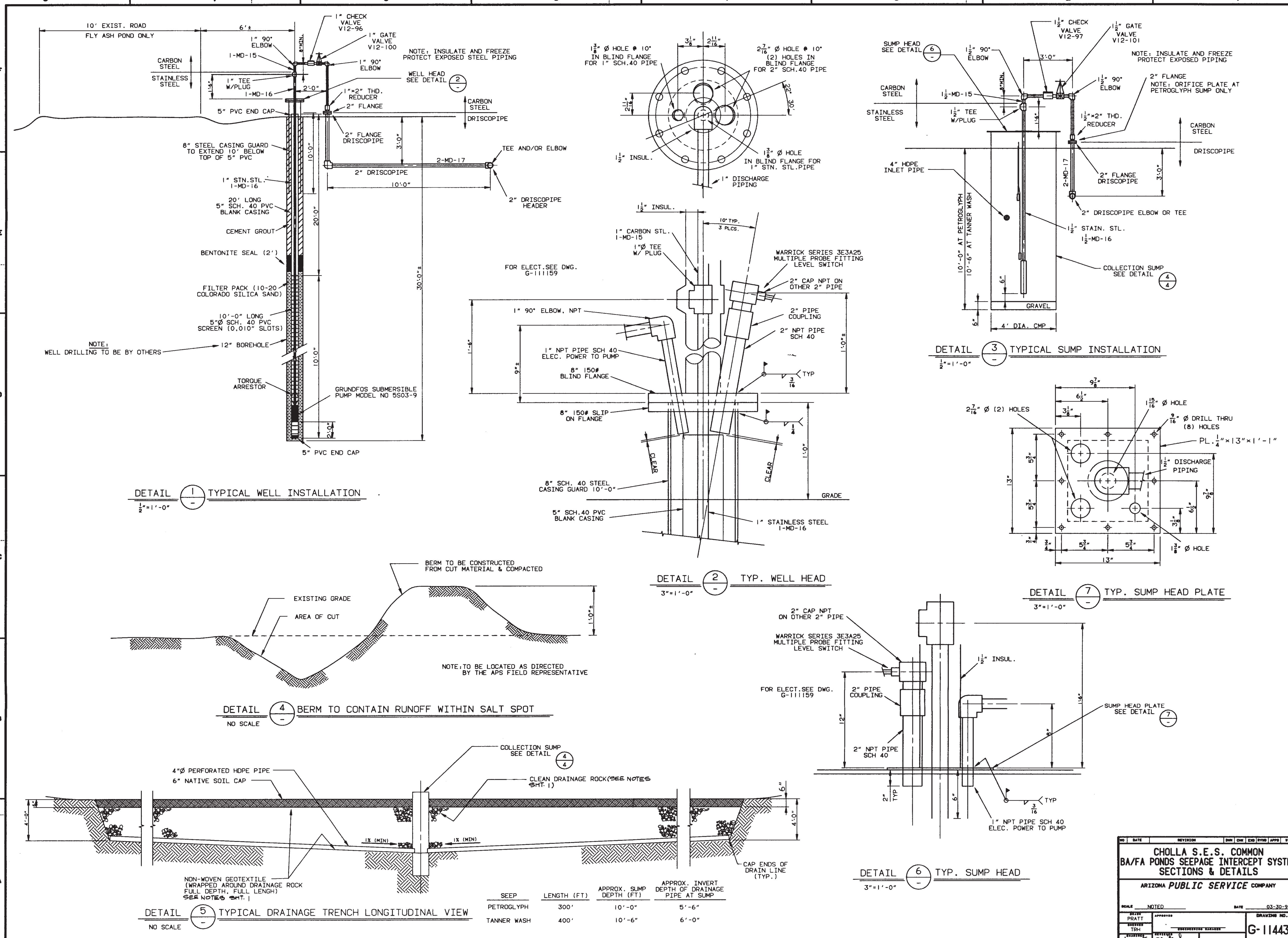

N
BOTTOM ASH POND
FIELD ROUTE DRAIN LINE THRU CULVERT AT TOP OF DIKE - SIMILAR TO SIPHON LINES
P220
P219
P218
P200
P201
P202
P203
P204
P205
P206
P207
P94
P95
P96
TOE DRAIN
GATE
CONCRETE APRON
DISCHARGE LINE (4" ϕ CARBON STEEL)
EXCAVATION SPOIL
LOCATION PLAN
1" = 200'
6'-0" MIN
1'-0" ±
NAT. GRADE
ZONE 1
PIT RUN GRAVEL
ZONE 2
CLEAN LEACH ROCK
FILTER CLOTH
4'-0" ϕ CMP PERFORATED ASPHALT COAT
2'-0"
1'-0"
8'-0" ±
SECTION B-B
3/8" = 1'-0"
NOTES:
TOE DRAIN SYSTEM TO BE CONSTRUCTED IN ACCORDANCE WITH THE DETAILS OF THIS DWG AND APS SPECIFICATION - CHOLLA PROJECT ENGINEERING - CPE NO. 1, TOE DRAIN INSTALLATION
EXCAVATION DIMENSIONS MAY VARY WITH THE ENGINEER'S APPROVAL.
EXACT DRAIN LOCATION BY FIELD
NO EXCAVATION WITHIN 20 FOOT OF THE EMBANKMENT TOE.
PIT RUN GRAVEL
NATURAL GRADE
FILTER CLOTH
4'-0" ϕ CMP PERFORATED AND ASPHALT COATED
FLOW
LEACH ROCK
1% MIN
#1
#2
2'-6"
FULLY AUTOMATIC MOTOR CONTROL CENTER
POWER POLE
UNDERGROUND POWER SUPPLY
108" ϕ CMP 25'-0" LG. ASPHALT COATED
RANDOM BACKFILL
NATURAL SLOPE (TYP)
1'-6"
1'-0"
CONCRETE FILL
SECTION A-A
1/4" = 1'-0"
REFERENCE DWGS:
B.A. POND PLANS & SIPHON SYSTEM ---- G-44596
TOE DRAIN DISCHARGE LINE 4" ϕ STEEL PIPE - FIELD FAB.
SHOP FABRICATED MOUNTING BRACKET 10' ON CENTER
EXISTING 8" ϕ SYPHON LINE
SLUSH CONCRETE APRON
RANDOM ZONE RIP RAP
SECTION C-C
1/2" = 1'-0"
DISCHARGE
CHECK VALVE
BUTTERFLY VALVE
PUMP #1
PUMP #2
SOLINOID VALVE TO DRAIN LINE
PUMP HEADER LOGIC
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
BOTTOM ASH DAM
TOE DRAIN SYSTEM
ARIZONA PUBLIC SERVICE COMPANY
PHOENIX
AS SHOWN
10-10-79
D-62471
09.27


APS-2742-G-556-S02
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
PLAN VIEW J-J
DETAIL U
DETAIL T
DETAIL V
DETAIL W
SECTION F-F
SECTION G
SECTION G-G
SECTION H-H
PLAN
END VIEW
PONTOON DETAILS
NO SCALE
QUANTITIES (NOT BY FIELD UNLESS NOTED)
FLOATING PONTOON ASSEMBLY - BY UNITED MC GILL, COLUMBUS, OHIO (OR EQUAL).
10" PIPE
4" PIPE
NYLON ROPE
NOTES
1. ALL EXPOSED METAL TO BE COATED WITH ENDURO 463 COAL TAR EPOXY
3. FOR LOCATION OF PIPE SEE G556
6. ALL REINFORCING STEEL SHALL CONFORM TO ASTM A 615, GRADE 60
REFERENCE DRAWINGS
STATE OF ARIZONA
SAFETY OF DAMS SECTION
AS BUILT
ARIZONA PUBLIC SERVICE COMPANY
CHOLLA S.E. STATION
1976-250 MW EXTENSION - UNIT No. 3
ASH DISPOSAL SYSTEM
BOTTOM ASH POND
SIPHON SYSTEM & FLOATING PIPELINE
EBASCO SERVICES INCORPORATED
APPROVED
APS-2742
G-556-S02
#G-44556 sht2
09-27

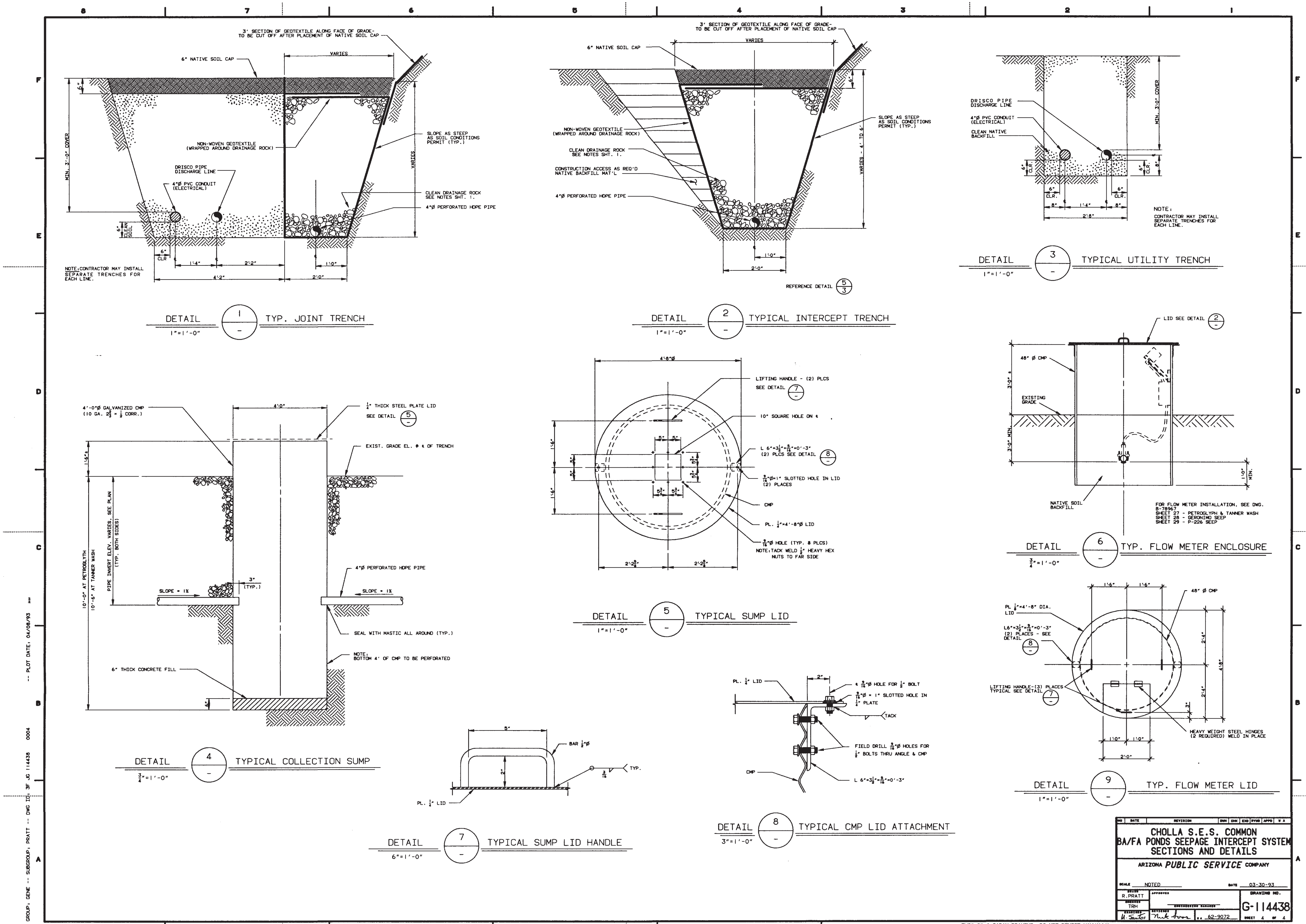
I R M DR I


PARTIAL PLAN - BOTTOM ASH POND AREA - PETROGLYPH, TANNER WASH & P-226 SEEPS
1" = 100' CONTOUR INTERVAL=2'
BOTTOM ASH POND
W.L. 5112.8
2nd PHASE WELL CONSTRUCTION (2) WELLS @ 50' O.C.
1st PHASE WELL CONSTRUCTION (2) WELLS MIN. @ 30' O.C.
P-226 SEEP AREA
P-226
PETROGLYPH DRAINAGE TRENCH
3-MD-18
3-MD-17
2-MD-17
TANNER WASH DRAINAGE TRENCH
NOTES:
1. INDICATES LOCATION OF DEWATERING WELL.
2. INDICATES LOCATION OF DEWATERING SUMP.
EL. 5050'
EL. 5120.4'
DAM
EXIST. PIPE TUNNEL
NOTE: INSULATE EXPOSED CARBON STEEL PIPING
3" CARBON STEEL SCH 40
3" FLANGES
3" DRISCOPIPE
SECTION A-A 1" = 50'
REMOVE EXISTING EXPANDED METAL COVER & REPLACE SAME AFTER PIPE INSTALLATION
EXIST. 36" × 22" GALV. CORR. STEEL PIPE
T.O. DIKE
CORE DRILL OR REMOVE PART OF EXISTING CONC. PLUG & REGROUT AFTER PIPE INSTALLATION
45° ELBOW & 10' FLEX RUBBER HOSE TRANSITION SECTION
45° ELBOW & FLEX RUBBER HOSE TO EL. 5118'
2"×6" HARDWOOD CRIBBING (3 PLCS.)
NEW 3"Ø SCH. 40 C.S. PIPE W/ 1½" INSULATION
DETAIL 1 ¼"=1'0"
3"Ø SCH.40 PIPE W/ 1½" INSULATION
3"Ø U-BOLT
FABRICATE NEW SUPPORTS FROM L1½"×1½"×¼" TYP. W/ BASE PL.¼
EXISTING CONC. TRENCH
EXISTING 8"Ø PIPE (SIPHON)
3/8" WEDGE ANCHOR BOLT
NOTE: NEW SUPPORTS LOCATED AT 12' O.C.
SECTION B 1½"=1'0"
EXISTING 8"Ø SIPHON PIPE
EXIST. 36"×22" GALV. CORR. METAL PIPE
GALV. PIPE STRAP ATTACH W/ GALV. SCREWS
NEW 3"Ø PIPE W/ 1½" INSULATION
2"×6" HARDWOOD CRIBBING (3 PLCS.)
SECTION C ¾"=1'0"
RELIEF WELLS SEE DETAIL
P-226 SEEP AREA
EXIST. P-226 MONITORING POINT
APPROX. 20'×220' CHAIN LINK FENCE WITH 20' DOUBLE SWING GATES AT ONE END. SEE NOTE 11 ON SHT. 1.
FLOW METER SEE DETAIL
COLLECTION SUMP SEE DETAIL
CONTRACTOR TO FIELD ROUTE DRAINAGE TRENCH AND PERFORATED PIPE AS CLOSE TO ROCK OUTCROP AS POSSIBLE, SUBJECT TO APS INSPECTOR APPROVAL.
2"Ø DRISCO PIPE 2-MD-17
APPROX. 15'×15' CHAIN LINK FENCE WITH 3' WALK-IN SWING GATE AT ONE END. SEE NOTE 11 ON SHT. 1.
PETROGLYPH SEEP AREA
3"Ø SCH.40 C.S. PIPE 3-MD-18
3"Ø DRISCO PIPE 3-MD-17
3×2 REDUCER
TANNER WASH SEEP AREA
PETROGLYPH, TANNER WASH & P-226 SEEPS PIPING DETAIL
DO NOT SCALE
CHOLLA S.E.S. COMMON
BA/FA PONDS SEEPAGE INTERCEPT SYSTEM
BOTTOM ASH POND AREA PLANS & DETAILS
ARIZONA PUBLIC SERVICE COMPANY
SCALE NOTED
DATE 03-03-93
G-114438
THIS IS A CADAM DRAWING, DO NOT REVISE MANUALLY

09.27
09.28



SEEP	LENGTH (FT)	APPROX. SUMP DEPTH (FT)	APPROX. INVERT DEPTH OF DRAINAGE PIPE AT SUMP
PETROGLYPH	300'	10'-0"	5'-6"
TANNER WASH	400'	10'-6"	6'-0"


3' SECTION OF GEOTEXTILE ALONG FACE OF GRADE-TO BE CUT OFF AFTER PLACEMENT OF NATIVE SOIL CAP
6" NATIVE SOIL CAP
VARIES
NON-WOVEN GEOTEXTILE (WRAPPED AROUND DRAINAGE ROCK)
SLOPE AS STEEP AS SOIL CONDITIONS PERMIT (TYP.)
DRISCO PIPE DISCHARGE LINE
4"Ø PVC CONDUIT (ELECTRICAL)
CLEAN DRAINAGE ROCK SEE NOTES SHT. 1.
4"Ø PERFORATED HDPE PIPE
MIN. 3'-0" COVER
NOTE: CONTRACTOR MAY INSTALL SEPARATE TRENCHES FOR EACH LINE.
DETAIL 1 TYP. JOINT TRENCH 1"=1'-0"
CONSTRUCTION ACCESS AS REQ'D NATIVE BACKFILL MAT'L
VARIES - 4' TO 6'
REFERENCE DETAIL 5/3
DETAIL 2 TYPICAL INTERCEPT TRENCH 1"=1'-0"
CLEAN NATIVE BACKFILL
DETAIL 3 TYPICAL UTILITY TRENCH 1"=1'-0"
4'-0"Ø GALVANIZED CMP (10 GA. 2⅔ × ½ CORR.)
¼" THICK STEEL PLATE LID SEE DETAIL 5
EXIST. GRADE EL. @ ℄ OF TRENCH
PIPE INVERT ELEV. VARIES, SEE PLAN (TYP. BOTH SIDES)
10'-0" AT PETROGLYPH 10'-6" AT TANNER WASH
SLOPE = 1%
SEAL WITH MASTIC ALL AROUND (TYP.)
NOTE: BOTTOM 4' OF CMP TO BE PERFORATED
6" THICK CONCRETE FILL
DETAIL 4 TYPICAL COLLECTION SUMP ¾"=1'-0"
LIFTING HANDLE - (2) PLCS SEE DETAIL 7
10" SQUARE HOLE ON ℄
L 6"×3½"×5/16"×0'-3" (2) PLCS SEE DETAIL 8
9/16"Ø×1" SLOTTED HOLE IN LID (2) PLACES
CMP
PL. ¼"×4'-8"Ø LID
9/16"Ø HOLE (TYP. 8 PLCS) NOTE: TACK WELD ½" HEAVY HEX NUTS TO FAR SIDE
DETAIL 5 TYPICAL SUMP LID 1"=1'-0"
BAR ½"Ø
PL. ¼" LID
DETAIL 7 TYPICAL SUMP LID HANDLE 6"=1'-0"
FIELD DRILL 9/16"Ø HOLES FOR ½" BOLTS THRU ANGLE & CMP
DETAIL 8 TYPICAL CMP LID ATTACHMENT 3"=1'-0"
LID SEE DETAIL 2
48" Ø CMP
EXISTING GRADE
NATIVE SOIL BACKFILL
FOR FLOW METER INSTALLATION, SEE DWG. B-78967 SHEET 27 - PETROGLYPH & TANNER WASH SHEET 28 - GERONIMO SEEP SHEET 29 - P-226 SEEP
DETAIL 6 TYP. FLOW METER ENCLOSURE ¾"=1'-0"
PL ¼"×4'-8" DIA. LID
LIFTING HANDLE-(3) PLACES TYPICAL SEE DETAIL 7
HEAVY WEIGHT STEEL HINGES (2 REQUIRED) WELD IN PLACE
DETAIL 9 TYP. FLOW METER LID 1"=1'-0"
CHOLLA S.E.S. COMMON BA/FA PONDS SEEPAGE INTERCEPT SYSTEM SECTIONS AND DETAILS
ARIZONA PUBLIC SERVICE COMPANY
NOTED 03-30-93
R.PRATT
G-114438
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Appendix B.
Safety Factor Calculation

URS Quality - *It's Good Business*

QMS Form 3-4 (MM)

Date: September 2014

IE QMS

Check and Review Record

Project Name	CHPP SIA	**Client Name**	APS
Project Location	Cholla Power Plant	**PM Name**	Frances Ackerman, R.G., P.E.
Project Number / Office Code	60445840	**PIC Name**	Alexander Gourlay, P.E.

Type

☒ Detail Check	☐ Coordination Review	☐ Constructability Review	☐ Bidability Review
☐ Independent Technical Review (ITR)	☐ Calculation Check *(can also use QMS Form 3-3)*	☐ Other:	*For Subconsultant, Client, or Third-Party Information Review, use Form 3-11.*

Identifying Information

(This section is to be completed by the Project Manager or the PM's Designee.)

Individual Assigned:	Tafwachi Chamunda, P.E.	Comments Required by:	3/23/16
Work Product Originator:	Jed Stoken, P.E.	Title of Work Product:	Safety Factor Calculation Package

Review Scope

- ☒ Technical edit for elements such as grammar, punctuation and formatting.
- ☒ Detail Check of calculations and graphics.
- ☐ Completion of Detail Check
- ☐ Other:
- ☐ Completion of review of client and third-party information.
- ☒ Soundness of approach/design.
- ☒ Conformance with standards
- ☒ Basis and validity of conclusion / recommendation.
- ☒ Organization, clarity and completeness.
- ☐ Application of Statements of Limitations.

[signature] 8/12/16

Project Manager (or Designee) Signature **Date**

Comments

Select:

☐ Checker / Reviewer has no comments.

or

☒ Comments have been provided on:

- ☒ Marked directly on work product (electronically or on hard copy).
- ☐ Comment and Disposition Record (QMS Form 3-5).
- ☐ Other:

[signature] 3/23/16

Checker / Reviewer Signature **Date**

Verification

(Note: Reviews and Checks are often iterative, requiring multiple rounds to verify accuracy and completeness of the work product. This section is to be completed by the Checker/Reviewer after verification of comment incorporation to include subsequent or new comments.)

Select:

☒ Checker / Reviewer has verified that comments have been adequately addressed. There are no outstanding issues.

or

☐ Checker / Reviewer has verified that comments have been adequately addressed. Any unresolved issues have been submitted to the Project Manager or Designee for final resolution.

and

☒ Checker / Reviewer confirms that the work product Check / Review is complete.

[signature] 4/13/16

Checker / Reviewer Signature **Date**

URS Quality - It's Good Business	QMS Form 3-4 (MM)
	Date: September 2014

IE QMS	Check and Review Record

Approval	*(This section is to be completed by the Project Manager or PM's designee.)* ☐ Project Manager or Designee confirms that the Check / Review process has been followed. [signature] 8/12/16 **Project Manager (or Designee) Signature** **Date**
DISTRIBUTION	Project Central File – Quality File Folder Other – Specify:

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 1 of 15

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Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 2 of 15

1 INTRODUCTION

The purpose of this calculation is to perform limit equilibrium slope stability analyses to assess the stability of the existing Coal Combustion Residual (CCR) surface impoundment dam Bottom Ash Pond (BAP) Dam, ADWR Dam #09.27,at Arizona Public Service (APS)'s Cholla Power Plant near Joseph City, AZ.

2 ANALYSIS CRITERIA

The analyses were performed to meet the regulations set forth in the United States Environmental Protection Agency (EPA) 40 CFR Part 257.73(e) Structural Integrity Criteria for Existing CCR Surface Impoundments (EPA 2015). The code requires safety factor assessments for units containing CCRs. The safety factors for various embankment loading and tailwater conditions must meet the values outlined. For the BAP Dam, the following safety factors must be met:

- Long-term, maximum storage pool FS = 1.50;
- Maximum surcharge pool FS = 1.40;
- Seismic loading FS = 1.00; and
- Liquefaction loading FS = 1.20 (only for sites with liquefiable soils).

3 ANALYSIS INPUTS

The following inputs were used in the analysis:

- Surface profiles were developed from 2009 elevation contour drawings of the BAP Dam and surrounding terrain (Cooper Aerial Surveys Co. 2014).
- Subsurface stratigraphies were developed from as-built cross section drawings of the BAP Dam (Ebasco 1990).
- Material properties used in the model were developed in a separate calculation (AECOM 2016).
- Pore pressure distribution within the dam was developed from interpretation of water level readings for piezometers installed at the dam and surrounding area. Water level measurements are presented in the annual dam inspection report (APS 2016).

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- The maximum storage pool water level of the CCR Pond was based on the maximum permissible water level stated in the permitting license for the BAP (ADWR 1998).

- The surcharge pool water level of the CCR Pond was developed based on estimated water level for the design probable maximum flood (PMF) of the BAP (D&M 1991).

- The seismic loading for the BAP dam was developed from the deaggregated seismic hazard at the site based on the 2008 United States Geological Survey (USGS) National Earthquake Hazards Reduction Program (NEHRP) Provisions (USGS 2008).

The slope stability analyses were performed using the software program SLOPE/W, commercially available through GEO-SLOPE International, Ltd. (GEO-SLOPE International 2012).

4 ASSUMPTIONS

The following assumptions were used in the analysis:

- No bathymetry data was available for the BAP; therefore, the upstream slope of the BAP is assumed to be 3H:1V (horizontal:vertical) below the reservoir water level with negligible accumulation of bottom ash deposits. This slope angle is based on the as-built BAP Dam cross section drawings (Ebasco 1990).

- The surface profile for the site was developed based on the most recent topographic survey available, from June of 2009. It is assumed that the surface topography shown in this survey is sufficiently representative of the current topography so as not to produce significant differences in the estimated safety factors. This seems reasonable since there have been no significant alterations to the BAP Dam or the immediate surrounding areas since the survey was conducted, except for additional accumulation of bottom ash within the impoundment.

- The divider dikes associated with the waste coal combustion waste storage cells, located upstream of the BAP Dam, are internal dividers within the CCR surface impoundment and are not relied upon to maintain containment of the CCR. Consequently, the stability of the divider dikes is not analyzed in this calculation.

5 STABILITY ANALYSIS

Slope stability analyses were performed to document minimum factors of safety for loading conditions identified by 40 CFR Section 257.73(e) using the software program SLOPE/W (GEO-SLOPE International, Ltd. 2012). The analyses were performed using Spencer's Method, a limit

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equilibrium method of slices that satisfies both force and moment equilibrium in addition to incorporating the effects of interslice forces.

5.1 Critical Stability Cross Sections

Factors of safety were calculated for critical cross-sections of the BAP Dam. The critical cross section is the cross section that is anticipated to be most susceptible to structural failure for a given loading condition. The critical cross section thus represents a "most-severe" case. Section locations were selected based on variation in the embankment height and stratigraphic conditions to represent the most-severe case.

The safety factor assessments were performed for two cross-sections along the BAP Dam:

BAP Dam Cross Sections

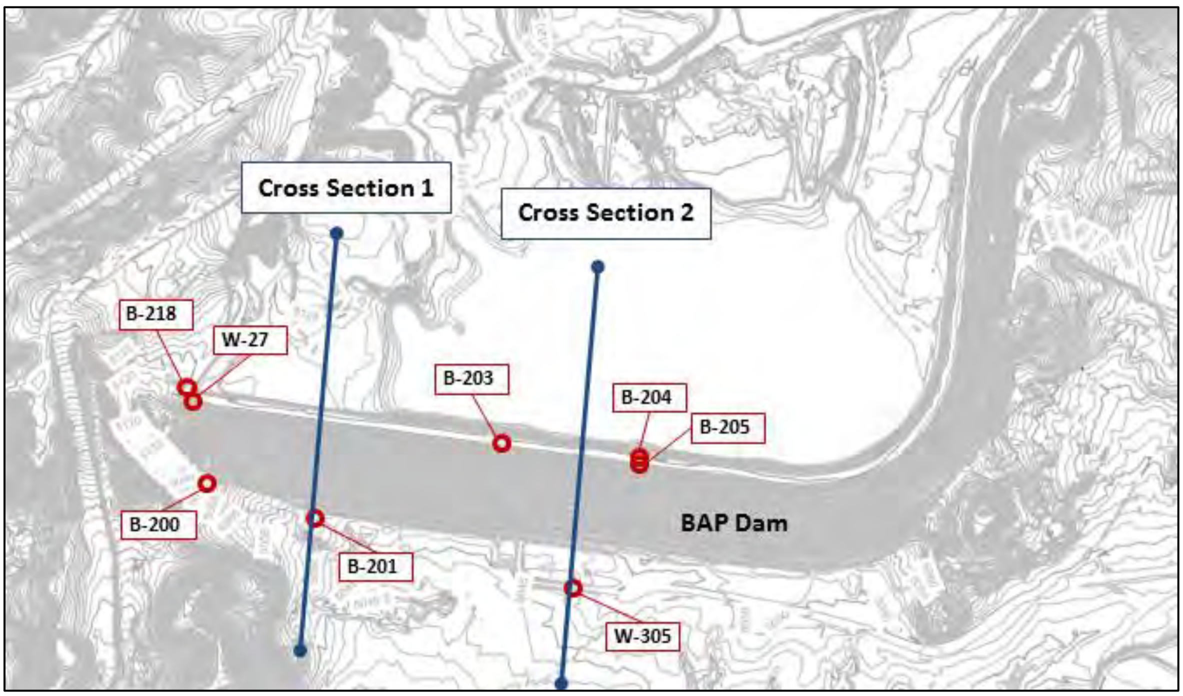

Figure 1. Slope Stability Cross Section and Piezometer Locations Along the BAP Dam

BAP Cross Section 1:

Cross Section 1 at the BAP was located near the left abutment of the dam, near piezometers W-227, B-200, and B-201. At this location, the dam intersects a rock outcropping forming the left abutment along its upstream slope. Consequently the upstream and downstream slope heights are considerably different at approximately 31 ft versus 73 ft, respectively although both slope angles are about 3H:1V. The dam at this cross section consists of a sandy lean clay core with an outer clayey sand shell. The dam lies on a foundation of alluvial overburden consisting of clays, silts, and sands; overlying bedrock consisting of mudstones, siltstones, and sandstones. The depth to bedrock is approximately 10 ft bgs. A cutoff trench filled with compacted clay extends from the clay core down to the bedrock and is used to control seepage beneath the dam. The upstream slope of the dam is confined by up to about 28 ft of hydraulically-placed bottom ash based on comparison between initial topographic surveys of the area (Ebasco 1975) and more recent surveys (Cooper Aerial Surveys 2014).

BAP Cross Section 2:

Cross Section 2 at the BAP was located near the center of the southern portion of the dam near piezometers W-305, B-203, B-204, and B-205. At this location, the dam is approximately 73 ft in height from EL 5,050 ft at the downstream toe to 5,123.3 ft at the crest; with upstream and downstream slope angles of about 3H:1V. Similar to Cross Section 1, the dam consists of a sandy lean clay core with an outer clayey sand shell. At this location the depth to bedrock is greatest along the dam at approximately 85 ft bgs. A cement-bentonite cutoff wall extends from the clay core of the dam to a layer of dense clay at about 15 ft above the bedrock and is used to control seepage beneath the dam. Water from the upstream coal combustion waste storage cells drains into a reservoir that lies upstream of the dam.

5.2 Material Properties

A material properties calculation package was prepared to present the methods and information supporting the parameter selection for the materials at the BAP Dam (AECOM 2016). The material properties identified in the calculation and used in the slope stability analyses are presented in Table 1 below.

Table 1. Material Properties for the BAP Dam Safety Factor Analyses

Material	Sat. Unit Weight, γ_{sat} (pcf)	Moist Unit Weight, γ_m (pcf)	Drained Strengths		Undrained Strengths	
			Cohesion, c' (psf)	Friction Angle, ϕ' (degrees)	Undrained Strength, S_u (psf)	Undrained Strength Ratio
Clay Core	125	120	0	28	-	0.38
Shell	130	125	0	33	-	-
Alluvium	120	120	0	26	-	-
Bedrock	150	150	1,000	65	-	-
Cutoff Wall	106	106	0	28	10	-
Bottom Ash	75	75	0	25	-	-

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5.3 Embankment Pore Pressure Distribution

Based on guidance from the EPA Regulations (EPA 2015), pore-water pressures are estimated from the most reliable of the following: *"1) Field measurements of pore pressures in existing slopes; 2) past experience and judgment of the Engineer; 3) hydrostatic pressures calculated for the no-flow condition; or 4) steady-state seepage analysis using flow nets or finite element analyses."* For the BAP Dam analysis, the pore pressure distribution was assigned using water level readings obtained from piezometers located near the stability cross sections (APS 2016). This distribution was adjusted based on engineering judgement to correspond with pond water level under steady-state, maximum storage pool conditions (ADWR 1998), and pond water level under maximum surcharge pool conditions (D&M 1991). The piezometers used to estimate the pore water pressure within the dam cross sections are shown in Figures 1.

The BAP (upstream) water level under maximum storage pool condition was based on the permitted water level of the ponds as stated in the ADWR operating license for the dam. Since the dam has no outlet work structures and rely on pumping rate from plant, seepage, evaporation, and a siphon system to control water levels, the maximum storage pool was set at the maximum permitted water levels. For the BAP this is EL 5,117.8 ft (ADWR 1998). The surcharge pool level is based on the expected water level raise during the design PMF and is EL 5,119.3 ft for the BAP (D&M 1991).

5.4 Embankment Loading Conditions

Per 40 CFR Section 257.73(e), the following loading conditions were considered for each selected stability cross section:

- Long-term, maximum storage pool;
- Maximum surcharge pool;
- Seismic loading; and
- Liquefaction.

These loading conditions are described below.

<u>Long-Term, Maximum Storage Pool</u>

The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. This loading condition is evaluated to document whether the CCR surface impoundments can withstand the maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The maximum storage pool considers a pool elevation in the CCR unit that is equivalent to the maximum permitted water levels using shear strengths expressed as effective stress with pore water pressures that correspond to the long-term condition.

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For this analysis, the long-term, maximum storage pool in the BAP was set at EL 5,117.8 ft. Since the piezometric conditions within the dam are at steady-state flow, drained material strengths were used in the analysis.

Maximum Surcharge Pool

The maximum surcharge pool loading is the temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment is normally subject under the inflow design flood state. This loading condition is evaluated to document whether the CCR surface impoundments can withstand a short-term impact of a raised pool level on the stability of the downstream slope. The maximum surcharge pool considers a temporary pool elevation that is higher than the maximum storage pool assuming that it persists for a length of time sufficient for steady-state seepage or hydrostatic conditions to fully develop within the embankment.

For this analysis, the maximum surcharge pool in the BAP was set at EL 5,119.3 ft. Since the piezometric conditions within the dam are at steady-state flow for this loading condition, drained material strengths were used in the analysis.

Seismic Loading

Seismic loading was evaluated to document whether the CCR surface impoundments are capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. The seismic loading is assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years. A pseudo-static analysis was used to represent the seismic loading.

The peak horizontal bedrock acceleration for a site classification of B “Rock” based on the USGS 2008 NEHRP seismic hazard map with a 2% probability of exceedance in 50 years is 0.0807g as presented in Attachment A (USGS 2008). Based on previous site explorations, a sit classification of D “Stiff Soil” was assigned to the site as illustrated in Table 1615.1.1 from the IBC (2003) shown in Figure 2.

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TABLE 1615.1.1
SITE CLASS DEFINITIONS

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100 feet, AS PER SECTION 1615.1.5		
		Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \bar{v}_s \le 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_s \le 2{,}500$	$\bar{N} > 50$	$\bar{s}_u \ge 2{,}000$
D	Stiff soil profile	$600 \le \bar{v}_s \le 1{,}200$	$15 \le \bar{N} \le 50$	$1{,}000 \le \bar{s}_u \le 2{,}000$
E	Soft soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	$\bar{s}_u < 1{,}000$
E	—	Any profile with more than 10 feet of soil having the following characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \ge 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H >$ 10 feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H >$25 feet with plasticity index $PI >$75) 4. Very thick soft/medium stiff clays ($H >$120 feet)		

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kPa. N/A = Not applicable

Figure 2. Table 161.1.1 Site Class Definitions (IBC 2003)

The PGA at the ground surface for Site Class D, or PGA_M, was determined by amplifying the PGA for rock (Site Class B) using the following equation presented in NEHRP, 2009:

$$PGA_M = F_{PGA}(PGA)$$

$$PGA_M = 1.6(0.0807g)$$

$$PGA_M = 0.129g$$

Where:

PGA_M = Maximum considered earthquake geometric mean peak ground acceleration adjusted for Site Class effects

PGA = Mapped maximum considered earthquake geometric mean peak ground acceleration

F_{PGA} = Site coefficient from Table 11.8-1 (Figure 3)

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Table 11.8-1 Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.1	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA ≥ 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of PGA.

Figure 3. Table 11.8-1 Site Coefficient F_{PGA} (NEHRP 2009)

The PGA at the ground surface for Site Class D (PGA_M) was then used to estimate the peak transverse acceleration at the crest of the embankment, PGA_{crest} = 0.307g, as shown on Figure 4 and based on variations in recorded peak crest accelerations versus those recorded at the base of earth and rock fill dams by Idriss (2015) and on recorded values for Loma Prieta, and other earthquakes, by Holzer (USGS, 1998).

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 10 of 15

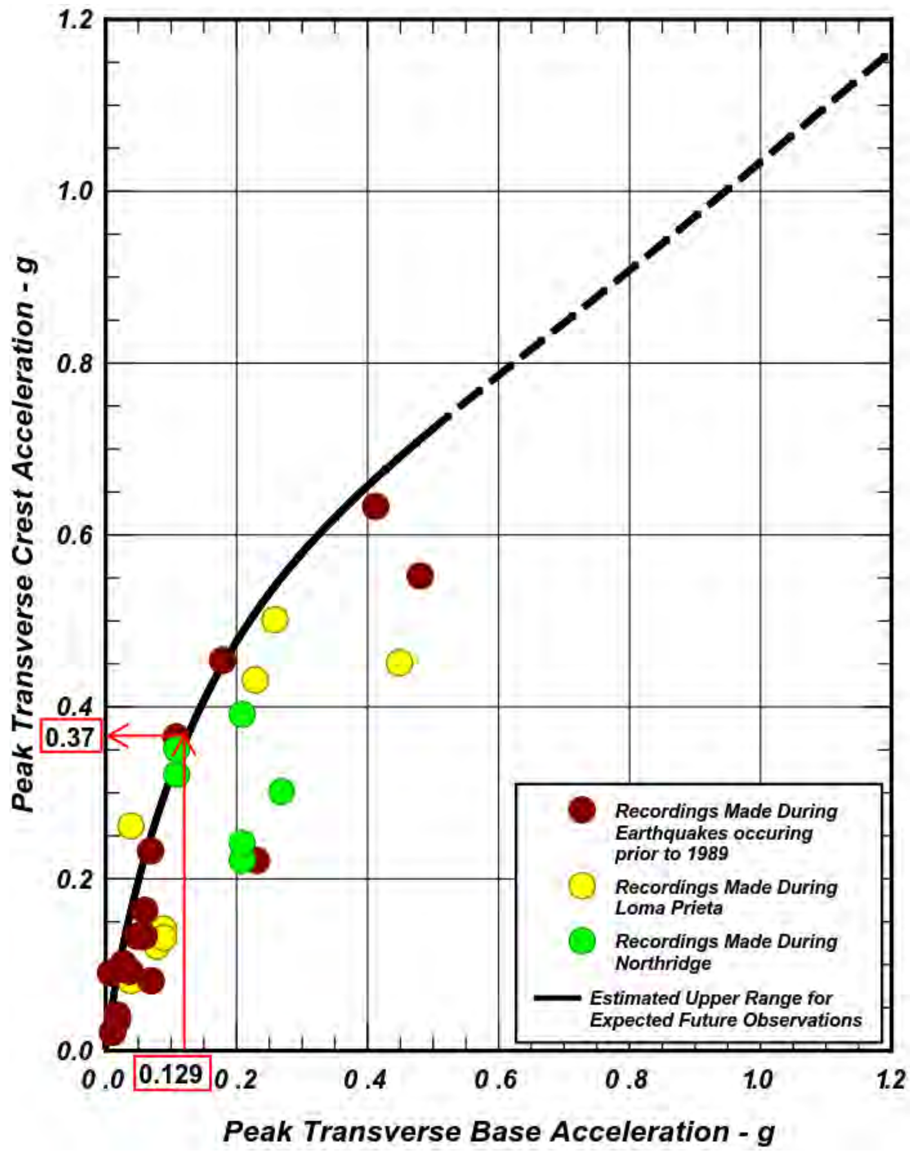


Figure 4. Variations of Peak Transverse Crest Acceleration vs. Peak Transverse Base Acceleration Based on Holzer (1998)

Makdisi and Seed (1977) notes that the "maximum acceleration ratio" varies with the depth of the sliding mass relative to the embankment height. Figure 5 (shown below) presents the relationship between maximum acceleration ratio (k_{max}/u_{max}) and depth of sliding mass (y/h). For deep-seated failure surfaces that involve the entire vertical profile of the dam slope and extend from the crest to the toe or below the toe of the embankment into the foundation soils, the acceleration at the crest can be as low as approximately 34 percent of the maximum value:

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 11 of 15

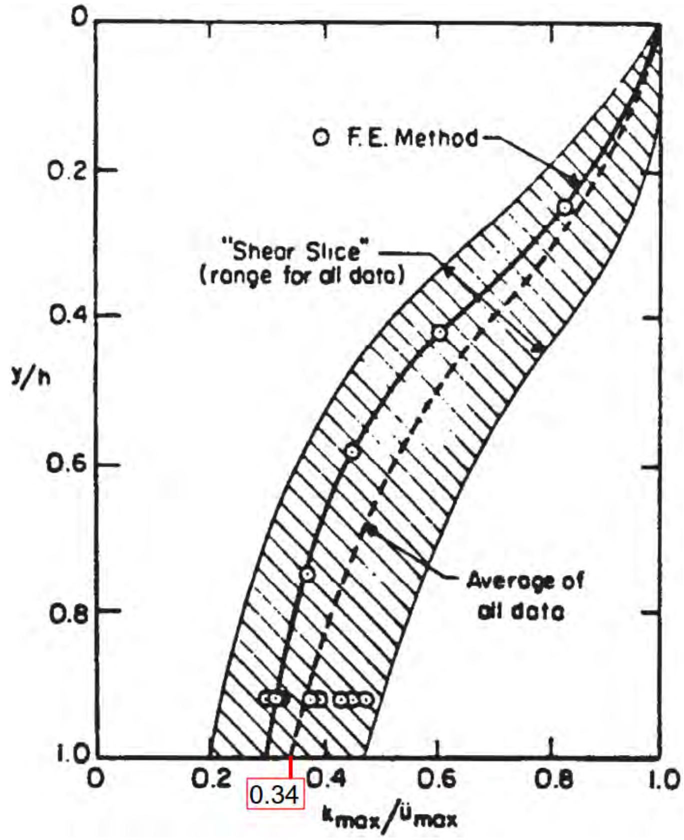


Figure 5. Variation of "Maximum Acceleration Ratio" with Depth of Sliding Mass after Makdisi and Seed (1977)

Therefore:

$$\frac{k_{max}}{u_{max}} = 0.34$$

Where: k_{max} = the maximum average acceleration for the potential sliding mass
u_{max} = the maximum crest acceleration

$$k_{max} = 0.34(u_{max})$$

$$k_{max} = 0.34(0.37g)$$

$$k_{max} = 0.13g$$

The pseudo-static analyses incorporated a horizontal seismic coefficient of 0.13g.

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 12 of 15

The water level in the BAP for the seismic loading analysis was set to EL 5,117.8 ft to match the long-term, maximum storage pool. The Clay Core and Cutoff Wall materials were assigned undrained strength. Due to the relatively rapid loading induced during the seismic event and these materials' relatively low hydraulic conductivity, it is anticipated that the Clay Core and Cutoff Wall materials would behave in an undrained manner. All, other materials used drained strength parameters.

Liquefaction

The liquefaction factor of safety is evaluated for CCR units that show, through representative soil sampling and construction documentation that soils of the embankment and/or foundation are susceptible to liquefaction. The liquefaction factor of safety is calculated to document whether the CCR unit would remain stable if the soils in the embankment and/or foundation experienced liquefaction.

Post-construction geotechnical exploration of the BAP and Fly Ash Pond Dams (Harza 1987 and D&M 1999) indicated the Clay Core (embankment) and Alluvium Overburden (foundation) materials have plasticity indexes and fine contents as shown in Table 2 below. Generally, the behavior of soils that have fines contents greater than 35 percent are dominated by the plasticity of their fines (Idriss and Boulanger 2008). Fines with Plasticity Index (PI) less the 7 tend to behave more sand-like and are susceptible to soil liquefaction, while those with PI greater than 7 tend to behave more clay-like and are not susceptible to liquefaction. The lowest measured value of PI for both the Clay Core and Alluvium Overburden is 12, indicating these soils would tend to behave in a clay-like manner during a seismic event and not be susceptible to soil liquefaction. Consequently, a liquefaction factor of safety analysis was not performed for these structures.

Table 2. Range of Plasticity Index and Fines Content Values for Site Materials

	Plasticity Index		Fines Contents, %	
Material	**Minimum Value**	**Maximum Value**	**Minimum Value**	**Maximum Value**
Clay Core	12	39	48	88
Alluvium Overburden	12	17	30	54

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 13 of 15

6 ANALYSIS RESULTS AND CONCLUSIONS

The results of the slope stability analysis are presented in Attachment B. Tables below summarize the results of the safety factor analysis.

Table 3. Safety Factor Results for the BAP Dam

Loading Condition	Required Safety Factor	Calculated Minimum Safety Factor	
		Cross Section 1	Cross Section 2
Long-term, maximum storage pool	1.50	1.58	1.55
Maximum surcharge pool	1.40	1.56	1.53
Seismic (Pseudo-Static)	1.00	1.05	1.07

The results of the safety factor analyses show that the BAP Dams exceed the minimum required factors of safety for the long-term, maximum storage pool; the maximum surcharge pool; and the seismic (pseudo-static) loading conditions.

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 14 of 15

7 REFERENCES

The following references were used in performing this calculation:

AECOM, 2016, "Material Properties Calculation Package," Prepared for Arizona Public Service Company, March 7.

Arizona Department of Water Resources (ADWR), 1998, *License of Approval*, Cholla Bottom Ash Pond Dam and Reservoir, State File No. 09.27, December 11.

Arizona Public Services Company (APS), 2016, "Cholla Power Plant Fly Ash Pond, Bottom Ash Pond, Sedimentation Pond and Bottom Ash Monofill Annual CCR Impoundment and Landfill Inspection Report 2015."

Cooper Aerial Surveys Co., 2014, "Cholla Ash 2014: June 13, 2009 Topographic Mapping," Prepared for Arizona Public Service Company, Drawing No. 1, Sheet No. 1.

Dames and Moore (D&M), 1999, "Interim Report, Geotechnical Investigation for Evaluation of Dam Embankment Crack, FAP Dam, Cholla Power Plant, Joseph City, Arizona," Prepared for Arizona Public Service Company, D&M Job No. 02353-143-022, May 9.

Ebasco Services Inc. (Ebasco), 1975, "Arizona Public Services Cholla Generating Station Ash Disposal Sites Seepage and Foundation Studies: Volume I of II Engineering Report," Prepared for Arizona Public Service Company, August.

Ebasco Services Inc. (Ebasco), 1990, "Ash Disposal System: Bottom Ash Pond – Sections & Details," Prepared for Arizona Public Service Company, APS Drawing No. G-44556, Revision No. 12 (Crest Restoration 1990), August 28.

GEOSLOPE International, 2012, GeoStudio 2012, Version 8.15.4.11512, August 2015 Release.

Harza Engineering Company (Harza), 1987, "Cholla S.G.S., Safety Inspection Report on Fly Ash Dam, Bottom Ash Dam, and Cooling Dike," Prepared for Arizona Public Service Company, February 27.

Holzer, Thomas L., 1998, "The Loma Prieta Earthquake of October 17, 1989, Earth Structures and Engineering Characterization of Ground Motion," USGS Professional Paper 1552-D, U.S. Government Printing Office.

Idriss, I.M. and Boulanger, R.W., 2008, "Soil Liquefaction During Earthquakes," Earthquake Engineering Research Institute, Monograph No MNO-12.

International Code Council (ICC), Inc., 2003, "2003 International Building Code [IBC]," May.

DESIGN CALCULATION				
Calculation Title: Bottom Ash Pond Safety Factor Assessment	**Project Title:** APS Cholla Structural Integrity Assessment	**Project No:** 60445840	**Date:** 4/13/16	**Page No:** Page 15 of 15

National Earthquake Hazard Reduction Program (NEHRP), 2009, “Recommended Seismic Provisions for New and Other Structures,” Document No. FEMA P-750, 2009 Ed.

Makdisi, F.I. and Seed, H.B., 1977, “A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments,” Report No. UCB/EERC-77/19, University of California, Berkeley, August.

United States Environmental Protection Agency (EPA), 2015, 40 CFR § 257 and 261 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, Federal Register Vol. 80, No. 74, April 17.

United States Geological Survey (USGS), 2008. *2008 Interactive Deaggregations*. http://geohazards.usgs.gov/deaggint/2008/. Accessed March 11, 2016.

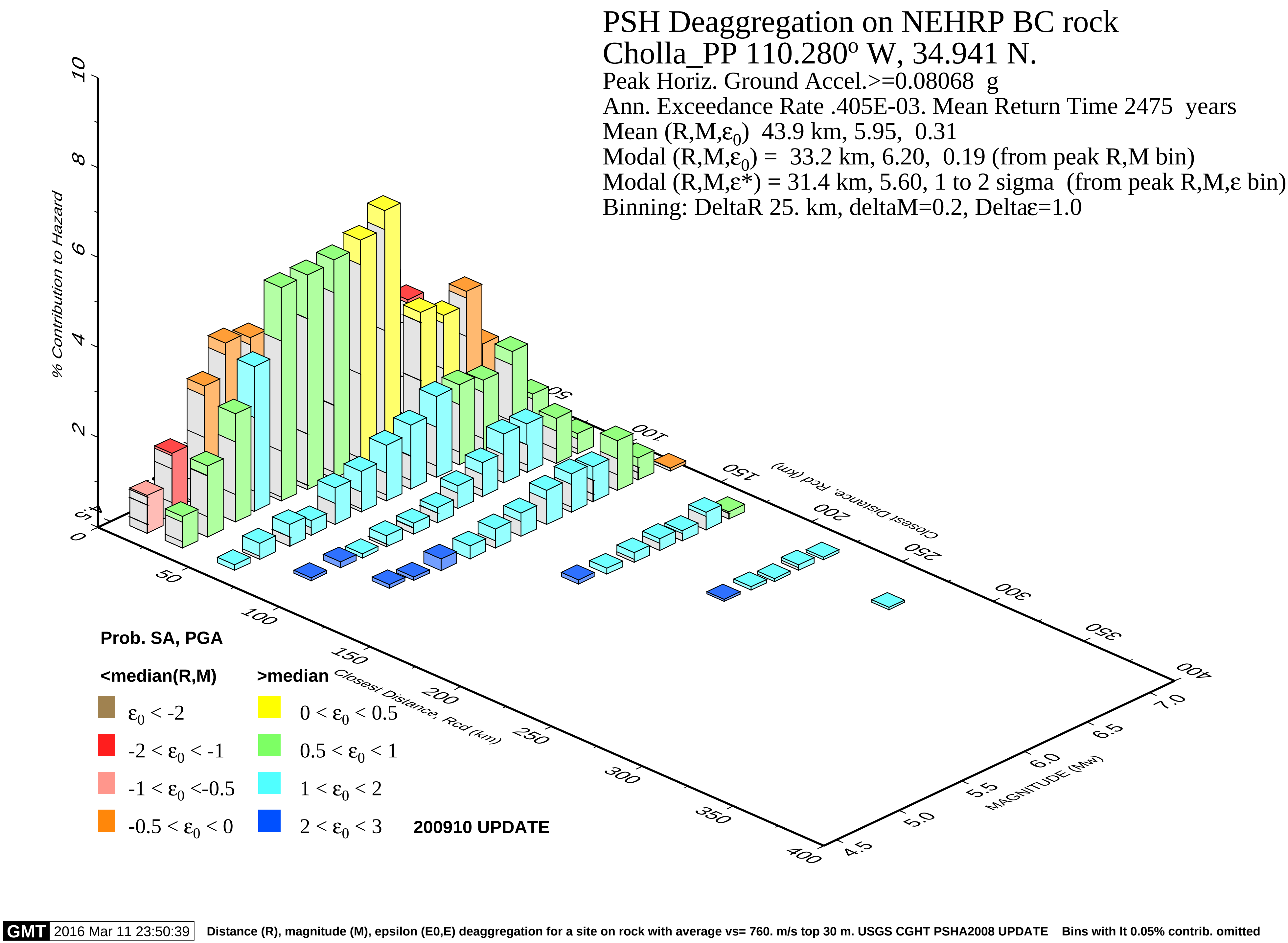
8 ATTACHMENTS

ATTACHMENT A USGS 2008 Seismic PSH Deaggregation

ATTACHMENT B Slope/W Output Figures

ATTACHMENT A

USGS 2008 Seismic PSH Deaggregation


PSH Deaggregation on NEHRP BC rock
Cholla_PP 110.280° W, 34.941 N.
Peak Horiz. Ground Accel.>=0.08068 g
Ann. Exceedance Rate .405E-03. Mean Return Time 2475 years
Mean (R,M,ε0) 43.9 km, 5.95, 0.31
Modal (R,M,ε0) = 33.2 km, 6.20, 0.19 (from peak R,M bin)
Modal (R,M,ε*) = 31.4 km, 5.60, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0
% Contribution to Hazard
Closest Distance, Rcd (km)
MAGNITUDE (Mw)
Prob. SA, PGA
<median(R,M)
>median
ε0 < -2
-2 < ε0 < -1
-1 < ε0 <-0.5
-0.5 < ε0 < 0
0 < ε0 < 0.5
0.5 < ε0 < 1
1 < ε0 < 2
2 < ε0 < 3
200910 UPDATE
GMT 2016 Mar 11 23:50:39
Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

ATTACHMENT B

Slope/W Output Figures

Slope Stability Analysis
Cross Section 1
Bottom Ash Pond

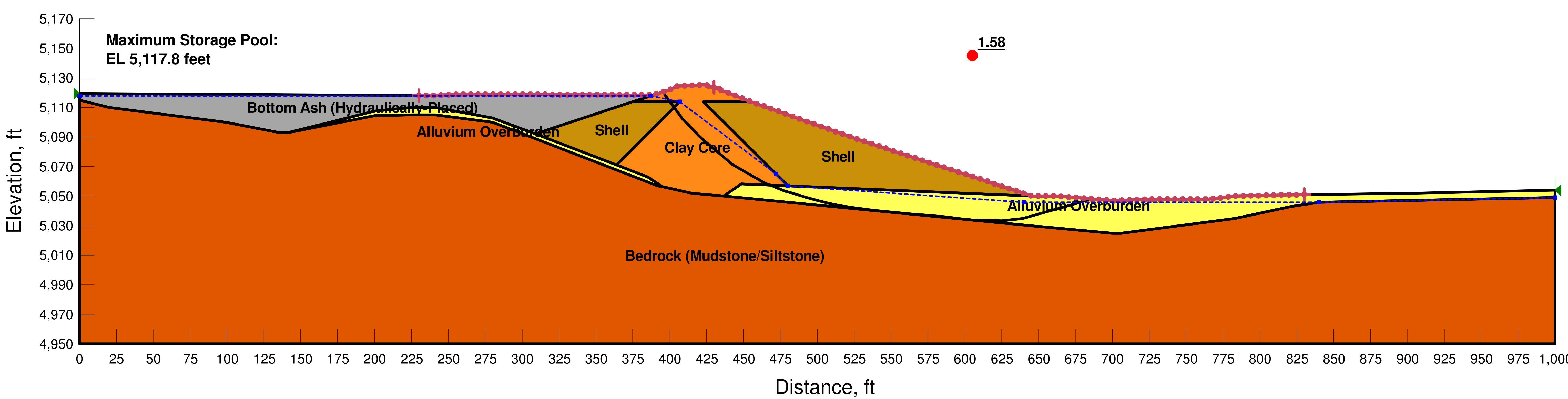
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B1) Static Maximum Storage Pool
File Name: APS Cholla BAP Section 1 - Static.gsz
Date: 6/21/2016
Method: Spencer

Factor of Safety: 1.58

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Bottom Ash (Hydraulically-Placed)	75 pcf	75 pcf	0 psf	25 °



Slope Stability Analysis
Cross Section 1
Bottom Ash Pond

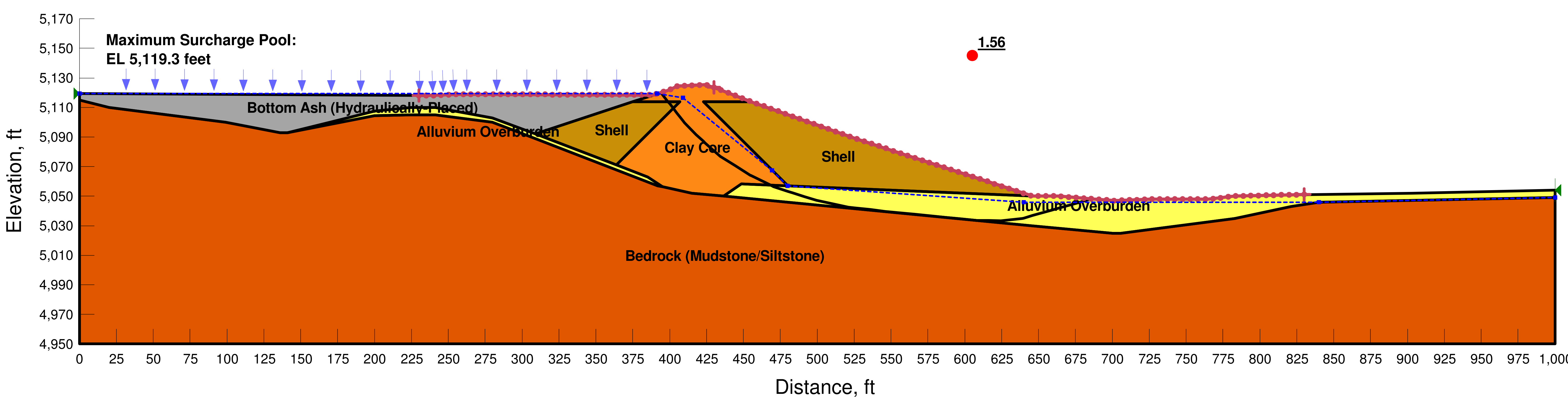
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B2) Static Maximum Surcharge Pool
File Name: APS Cholla BAP Section 1 - Static.gsz
Date: 6/21/2016
Method: Spencer

Factor of Safety: 1.56

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Bottom Ash (Hydraulically-Placed)	75 pcf	75 pcf	0 psf	25 °



Slope Stability Analysis
Cross Section 1
Bottom Ash Pond

Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

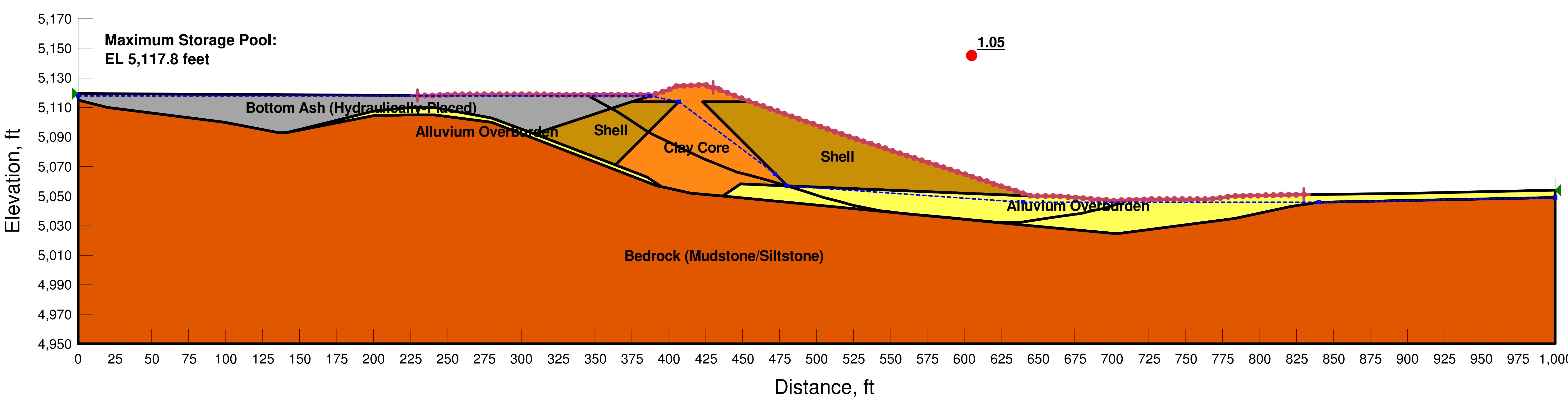
Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B3) Seismic Maximum Storage Pool
File Name: APS Cholla BAP Section 1 - Seismic.gsz
Date: 6/21/2016
Method: Spencer

Factor of Safety: 1.05

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:	Undrained Strength Ratio:
Clay Core	125 pcf	120 pcf	--	--	0.38
Shell	130 pcf	125 pcf	0 psf	33 °	--
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °	--
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °	--
Bottom Ash (Hydraulically-Placed)	75 pcf	75 pcf	0 psf	25 °	--

Horz Seismic Coef.: 0.13



Slope Stability Analysis
Cross Section 2
Bottom Ash Pond

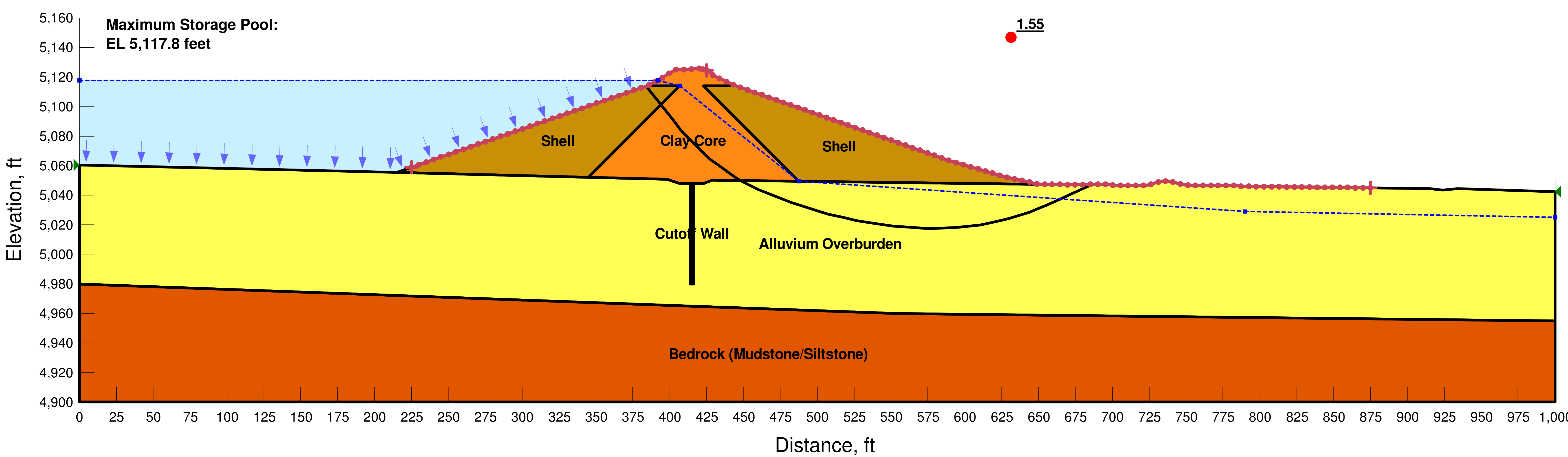
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B4) Static Maximum Storage Pool
File Name: APS Cholla BAP Section 2 - Static.gsz
Date: 6/21/2016
Method: Spencer

Factor of Safety: 1.55

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Cutoff Wall	106 pcf	106 pcf	0 psf	28 °



Slope Stability Analysis
Cross Section 2
Bottom Ash Pond

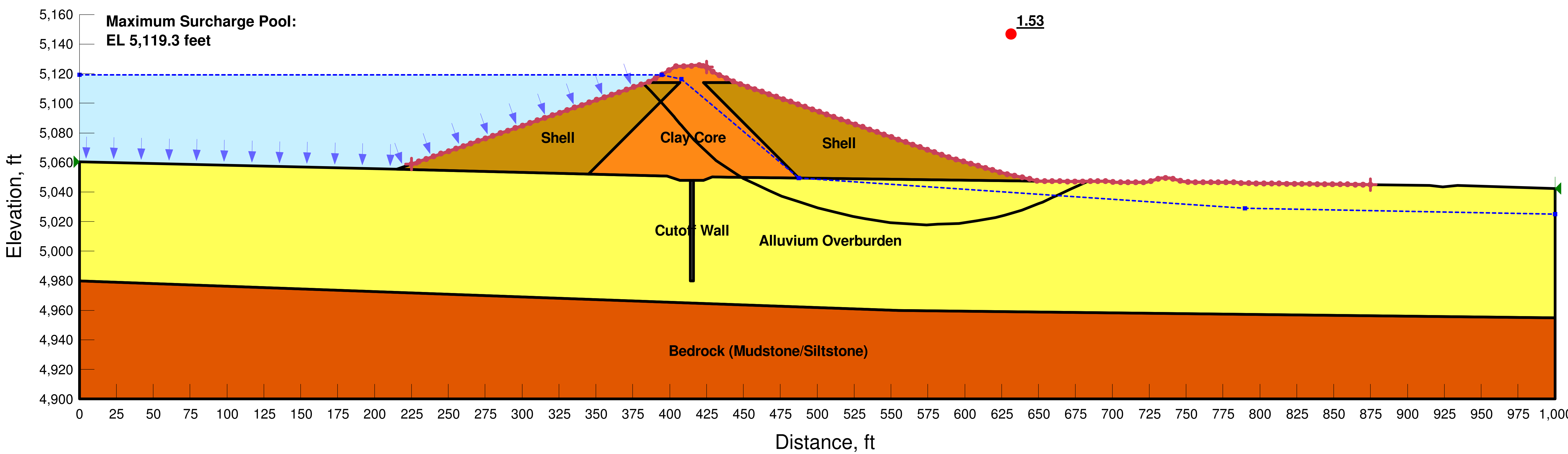
Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B5) Static Maximum Surcharge Pool
File Name: APS Cholla BAP Section 2 - Static.gsz
Date: 6/21/2016
Method: Spencer

Factor of Safety: 1.53

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:
Clay Core	125 pcf	120 pcf	0 psf	28 °
Shell	130 pcf	125 pcf	0 psf	33 °
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °
Cutoff Wall	106 pcf	106 pcf	0 psf	28 °



Slope Stability Analysis
Cross Section 2
Bottom Ash Pond

Cholla Power Plant
Joseph City, Arizona
Arizona Public Service

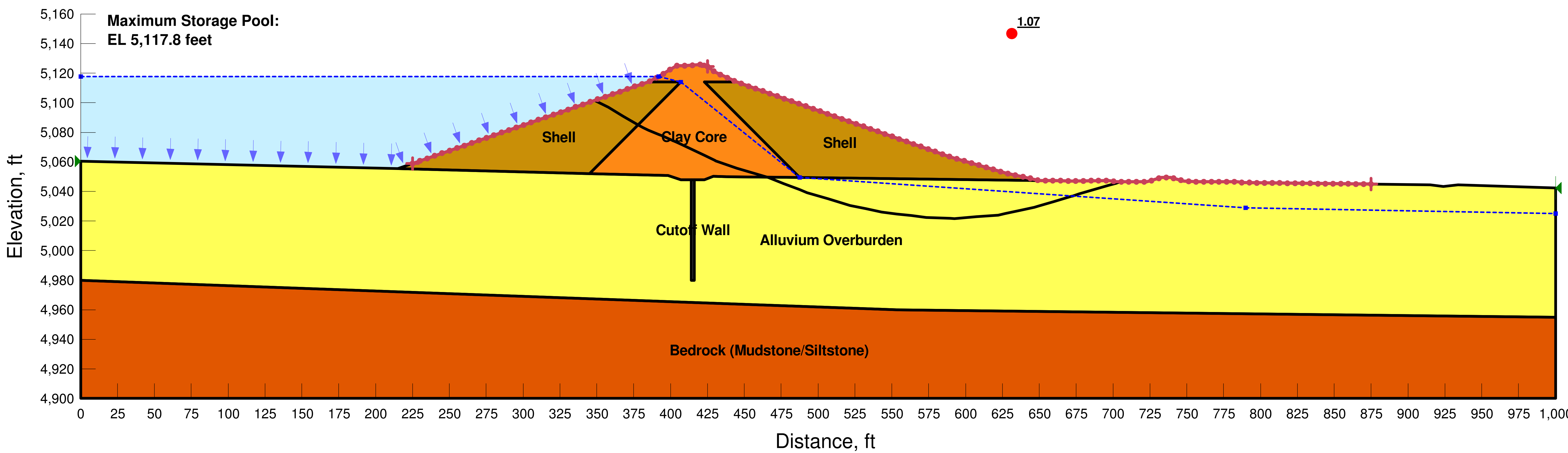
Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Figure B6) Seismic Maximum Storage Pool
File Name: APS Cholla BAP Section 2 - Seismic.gsz
Date: 6/21/2016
Method: Spencer

Factor of Safety: 1.07

Material Type:	Unit Weight Saturated:	Unit Weight Above Water:	Cohesion:	Friction Angle:	Undrained Strength Ratio:
Clay Core	125 pcf	120 pcf	--	--	0.38
Shell	130 pcf	125 pcf	0 psf	33 °	--
Alluvium Overburden	120 pcf	120 pcf	0 psf	26 °	--
Bedrock (Mudstone/Siltstone)	150 pcf	150 pcf	1,000 psf	65 °	--
Cutoff Wall	106 pcf	106 pcf	10 psf	0 °	--

Horz Seismic Coef.: 0.13



Attachment D

CHOLLA POWER PLANT
CLOSURE PLAN §257.102(b)
FLY ASH POND
Amendment 2 (November 23, 2020)

Closure Plan Contents §257.102(b)(1)

The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section.

Prepared for Arizona Public Service by AECOM Technical Services, Inc. (AECOM)	
CLOSURE PLAN AMENDMENT HISTORY	
Initial	August 30, 2016
Amendment 1	October 2, 2020 - Updated regulatory framework information and dates
Amendment 2	November 23, 2020 – Deleted reference to closure of Sedimentation Pond being performed concurrently with closure of Fly Ash Pond. Added reference to “closure by removal” of CCR-impacted materials within the reservoir area to a consolidated CCR solids mound for “closure in place”. Added new Figure 1, renumbered remaining figure numbers.
SITE INFORMATION	
Site Name / Address	Cholla Power Plant / 4801 I-40 Frontage Road, Joseph City, AZ 86032
Owner Name / Address	Arizona Public Service / 400 North 5th Street, Phoenix, AZ 85004
CCR Unit	Fly Ash Pond
Location	36° 55′ 60″ N, 110° 15′ 51″ W
Reason for Initiating Closure	Permanent cessation of a coal-fired boiler(s) by a date certain
Final Cover Type	Evapotranspiration Cover
Closure Method	Closure by leaving CCR in place

CLOSURE PLAN DESCRIPTION	
(b)(1)(i) – A narrative description of how the CCR unit will be closed in accordance with this section.	The Fly Ash Pond is an existing Coal Combustion Residual (CCR) impoundment constructed for the storage of fly ash generated by the Cholla Power Plant. The Fly Ash Pond has a capacity of 18,000 acre-feet. The maximum impoundment area, which has never been reached, is approximately 430 acres. The Fly Ash Pond is regulated by the United States Environmental Protection Agency per 40 CFR parts 257 and 261. The Fly Ash Pond embankment dam is regulated by the Arizona Department of Water Resources (ADWR) Dam Safety Program (ADWR Dam #09.28). The Fly Ash Pond consists of an engineered earthen embankment, an impounded reservoir of free water, and an impounded beach of CCR solids (fly ash and flue gas desulfurization (FGD) solids), both above and below the water reservoir level, that is identified herein as the "CCR solids mound". The Fly Ash Pond will be dewatered to facilitate initiation of closure of the facility. CCR-impacted materials (CCR transport water evaporates, shallow soils and drowned vegetation) from the estimated 157-acre impacted area within the reservoir will be excavated and transported for disposal within the CCR solids mound to complete "closure-by-removal" for the reservoir portions of the facility. The consolidated CCR material within the 153-acre footprint of the CCR solids mound will be closed in place by regrading and construction of a final cover system. The final cover will be constructed over a graded and prepared CCR

	subgrade. The final cover will be sloped to promote drainage and the storm water runoff will be discharged off the Fly Ash Pond via sheet flow into storm water diversion channels. The channels will collect and convey runoff from the closed Fly Ash Pond and divert storm water run-on around the perimeter of the closed Fly Ash Pond. Each storm water diversion channel will drain into a detention basin that will convey the storm water under Interstate 40. Closure operations will consist of: 1) Dewatering, 2) Consolidating CCR-impacted materials from the reservoir area within the CCR solids mound, 3) Re-grading CCR solids mound to create acceptable grades for closure, 4) Installing the final cover system, and 5) Constructing the perimeter drainage channels. In accordance with §257.102(b)(3), this Amendment 2 revises information in the initial and subsequently amended written closure plan regarding consolidation of CCR material from the reservoir into the CCR solids mound that will receive the final closure cover system. This amended written closure plan will be amended to provide additional details after the final engineering design for the grading and cover system is completed. The current version of the closure plan reflects the information and planning available at the time of issuance.

(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.	Applicable. A portion of the Fly Ash Pond will be closed by removal of shallow, CCR-impacted materials within the reservoir area and relocation and permanent disposal within the remaining CCR solids mound. Areas with the reservoir exposed by recently lowered water levels evidence crusting by CCR evaporites. No investigation of depth or extent has yet been performed. APS anticipates that decontamination of these areas of the CCR unit will be performed by physical removal of CCR-impacted materials to the CCR solids mound area, followed by visual verification of the absence of remaining surficial impacts.
(b)(1)(iii) – If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section.	Applicable. The CCR solids mound area of the Fly Ash Pond, including CCR materials consolidated from the reservoir area, will be closed by leaving CCR in place. The closure will be designed in accordance with §257.102(d). The site is in a semi-arid to arid climate with precipitation on the order of 6 inches per year and evaporation losses (pan evaporation rate) on the order of 50 inches per year. Therefore, this environment is appropriate for using a water-balance soil cover system that relies on the net water losing climate to reduce infiltration into the subgrade of the cover. The final cover system will be installed in direct contact with a sloped subgrade of CCR or other fill to achieve final subgrade elevations designed for positive drainage of storm water. The alternative final cover (“evapotranspiration cap”) system, designed in accordance with requirements of §257.102(d)(3)(ii), will consist of the following (from bottom to top):

	1) a minimum of 18 inches of compacted earthen material with a discharge (flux) through the cover material equivalent to a cover system with a single geomembrane; 2) Six inches of soil capable of sustaining native plant growth and resisting erosion (erosion layer); and 3) Seeded with native vegetation. CCR material will be re-graded and earthen fill material placed, as required, to bring the grades to the design slopes. Earthen material for the infiltration layer will be placed, graded, and compacted to meet the specified thickness and permeability. The final cover surface will be seeded with native vegetation types. Figures 1 through 3 show the general grading concept for the closure of the Fly Ash Pond. The final cover will have minimum as-constructed top slopes of 0.5 to 1.0 percent. The outside slopes of the existing dam will not be re-graded as the existing outside slopes already feature erosion protection and previous geotechnical analyses have shown the slopes to be stable in their current condition. Storm water runoff will be discharged off the Fly Ash Pond via sheet flow into storm water diversion channels. The channels will collect and convey runoff from the closed Fly Ash Pond and provide diversion of storm water run-on around the perimeter of the closed Fly Ash Pond. The storm water diversion channel will drain into detention basins, which will outfall into culverts that convey storm water under Interstate 40.

(b)(1)(iii) – How the final cover system will achieve the performance standards in §257.102(d). **Five Performance Standards:**	
1. (d)(1)(i) – Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere.	The infiltration (flux) through the final cover will be demonstrated to be equivalent to or less than flux through the unlined native soil comprising the bottom of the Fly Ash Pond. The demonstration of the alternative final cover system will be completed during final engineering design for the grading and cover system and issued in an amended closure plan.
2. (d)(1)(ii) – Preclude the probability of future impoundment of water, sediment, or slurry.	The final cover will have a minimum as-constructed top slope of 0.5 to 1.0 percent to preclude the probability of ponding. The final cover will generally slope from thickest to thinnest deposited CCR; the final design of the top slope for the final cover system will consider the magnitude of expected settlement of the wastes and the potential and locations of possible differential settlement. The post-closure plan includes maintenance measures to correct local grading deficiencies.
3. (d)(1)(iii) – Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.	The downstream slopes of the embankment dam will remain at 2H:1V and not be re-graded for the final closed configuration of the Fly Ash Pond. The final engineering design for the grading and cover system will include geotechnical analyses to demonstrate that the final outer slopes and cover will satisfy the stability requirements for the closed impoundment.
4. (d)(1)(iv) – Minimize the need for further maintenance of the CCR unit.	The final cover will be seeded with native vegetation to minimize erosion maintenance. Drainage channels will have appropriate erosion protection measures to minimize erosion maintenance.

5. (d)(1)(v) – Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.	Closure is expected to occur in coordination with the schedule for cessation of coal-fired electricity generation at the Cholla Power Plant. Coal-fired electricity generation is scheduled to cease in 2025. APS is seeking a time extension to initiate closure in accordance with the separate "Site-specific alternative deadlines to initiate closure of CCR surface impoundments" provisions of §257.103(f)(2). The Fly Ash Pond is scheduled to close no later than October 17, 2028. The Fly Ash Pond closure will include sufficient dewatering and ash material stabilization for construction of the final grading and cover. These activities will be performed concurrently with the cessation of coal-fired electricity generation at the Cholla Power Plant in 2025 and the closure of the Bottom Ash Pond and Bottom Ash Monofill. Stabilization is expected to take several years to complete because the majority of the impounded CCR is hydraulically placed (loose) fly ash and FGD sludge (a weak material). APS may elect to reduce the volume of water sent to the impoundment prior to commencing dewatering activities to help achieve a dewatered and stabilized condition within one year of the receipt of final waste.
(d)(2)(i) – Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.	The CCR will be dewatered to remove incidental free liquids and to provide a stable base for the construction of the final cover system. As the free water pond is drawn down due to decreased Plant discharge and evaporation, water is expected to drain out of the deposited solids. The form and extent of any additional dewatering have not yet been identified.

(d)(2)(ii) – Remaining wastes must be stabilized sufficiently to support the final cover system.	The existing CCR will be re-graded so as to provide a stable base for the final cover. The form and extent of required stabilization have not yet been identified.
(d)(3) – A final cover system must be installed to minimize infiltration and erosion, and at minimum, meets the requirements of (d)(3)(i) of this section, or the requirements of the alternative final cover system specified in paragraph (d)(3)(ii) of this section. (d)(3)(i) – The design of the final cover system must be included in the written closure plan.	The alternative final cover system will meet the requirements of §257.102(d)(3)(ii). The requirements of §257.102(d)(3)(ii) will be achieved using the clayey and silty soils present at the site to construct an infiltration layer that promotes runoff and evapotranspiration. The infiltration layer will be a minimum of 18 inches thick and will be constructed to reduce infiltration or flux into the Fly Ash Pond. On-site soils or an off-site aggregate source will be used to provide an erosion layer to protect the infiltration layer. The engineering design for the final cover system will be issued in an amended closure plan when the final cover system is completed.
EITHER (d)(3)(i)(A) – The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less. (d)(3)(i)(B) – The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer than contains a minimum of 18 inches of earthen material. OR (d)(3)(ii)(A) – The design of the final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (d)(3)(i)(A) and (B).	 The alternative final cover system will meet the requirements of §257.102(d)(3)(ii). The permeability of the final cover will be demonstrated prior to closure.

EITHER (d)(3)(i)(C) – The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth. OR (d)(3)(ii)(B) – The design of the final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified in paragraph (d)(3)(i)(C) of this section.	The final cover will include either: a) a minimum of 6 inches of a soil erosion layer that is capable of sustaining native plant growth (erosion layer) that will be seeded and vegetated to meet the requirements of §257.102(d)(3)(i)(C); or b) a minimum of 6 inches of rock armor erosion protection to meet the requirements of §257.102(d)(3)(ii)(B).
(d)(3)(i)(D), (d)(3)(ii)(C) – The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.	The engineering design for the final cover system will consider the magnitude of the expected settlement of the wastes and the potential and locations of possible differential settlement. The final cover will incorporate an 18-inch thick, loosely compacted evapotranspiration layer that will behave in a flexible manner so as to minimize the risk of disrupting the continuity of the cap due to settlement.
INVENTORY AND AREA ESTIMATES	
(b)(1)(iv) – An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.	9,300,000 cubic yards
(b)(1)(v) – An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life.	153 acres
CLOSURE SCHEDULE	
(b)(1)(vi) – A schedule for completing all activities necessary to satisfy the closure criteria in this 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/milestones that will be taken to close the CCR unit, and the estimated timeframes to complete each step or phase of CCR unit closure. If closure timeframe is anticipated to exceed the timeframes specified in paragraph §257.102(f)(1) of this section, the written closure plan must include the site-	

specific information, factors and considerations that would support any time extension sought under paragraph §257.102(f)(2).	
APS is seeking a time extension to initiate closure in accordance with the separate "Site-specific alternative deadlines to initiate closure of CCR surface impoundments" provisions of §257.103(f)(2). The milestones and the associated timeframes are initial estimates. Some of the activities associated with the milestones will overlap. Amendments to the milestones and timeframes will be made as more information becomes available.	
Initial Written Closure Plan Completed	August 2016
Closure Plan Amendment 1	October 2020
Closure Plan Amendment 2	November 2020
Permits and Approvals from Agencies	October 2024 (estimated)
Date of Final Receipt of CCR	April 2025
Closure Activities Initiated	March 2021 (assumed early start of dewatering)
Complete Dewatering	November 2026 (estimated – assuming early start date)
Complete CCR Stabilization	November 2027 (estimated)
Installation of Final Cover	Prior to October 17, 2028
Estimated Completion of Closure Activities	Prior to October 17, 2028

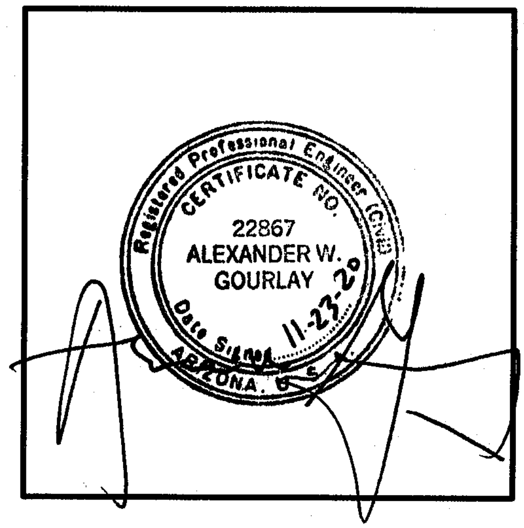
Certification Statement 40 CFR § 257.102(b)(4) – Amended Written Closure Plan for a CCR Surface Impoundment

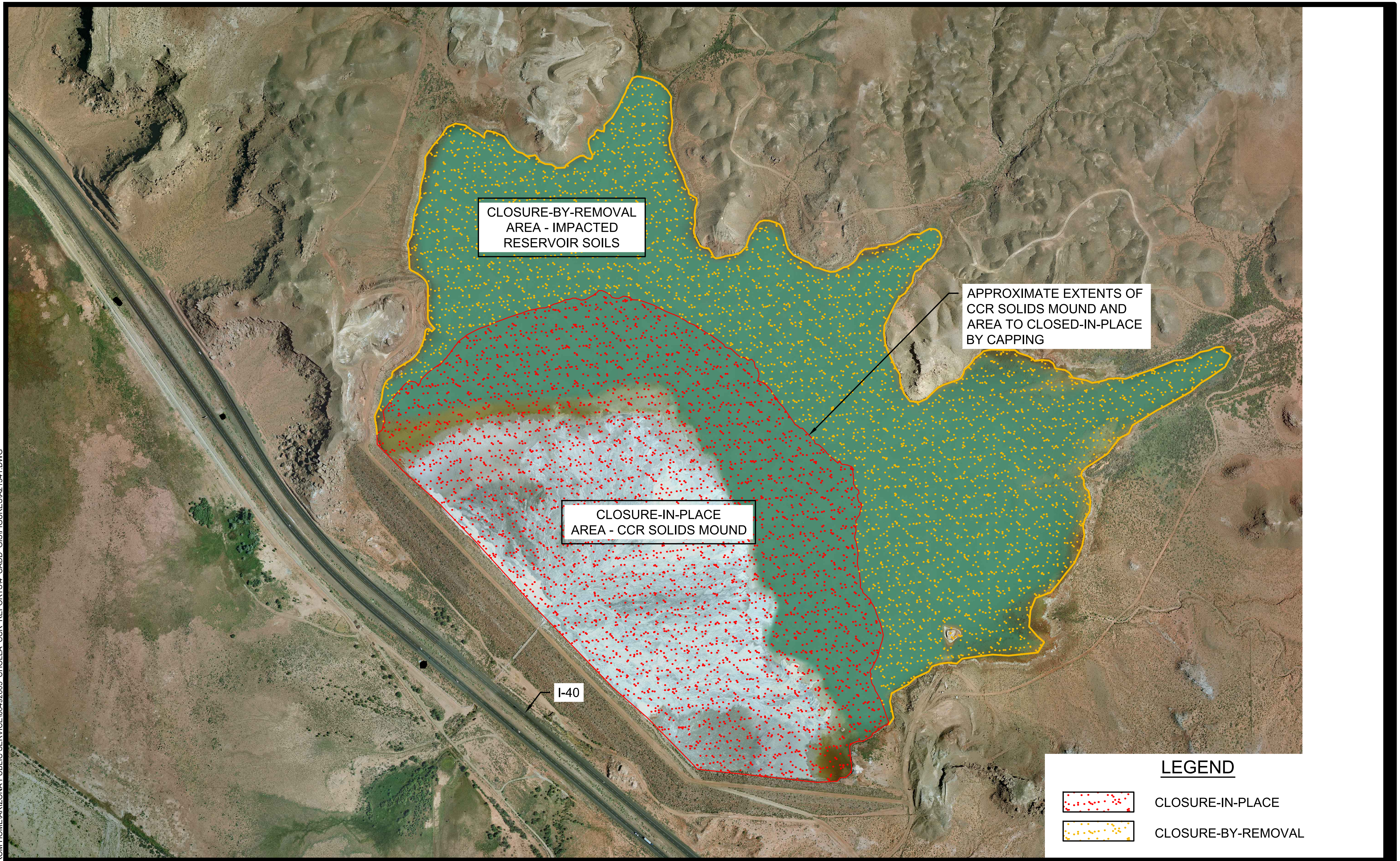
CCR Unit: Arizona Public Service; Cholla Power Plant; Fly Ash Pond

I, Alexander W. Gourlay, being a Registered Professional Engineer in good standing in the State of Arizona, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in the amended written closure plan dated November 23, 2020 meets the requirements of 40 CFR § 257.102.

Alexander W. Gourlay, P.E.
Printed Name

November 23, 2020
Date





0 300 600 1200 2400
SCALE IN FEET
1"=600'

AECOM

Figure: 1

Cholla Fly Ash Pond Closure
Approximate Delineation of "Closure-In-Place" and "Closure-By-Removal" Areas

Cholla Power Plant
Arizona Public Service
Cholla Power Plant, Joseph City, AZ
60522477 8
Date: 2020-11-18

Project Management Initials: Designer: SDU Checked: JBH Approved: AWG ANSI B 11" x 17"

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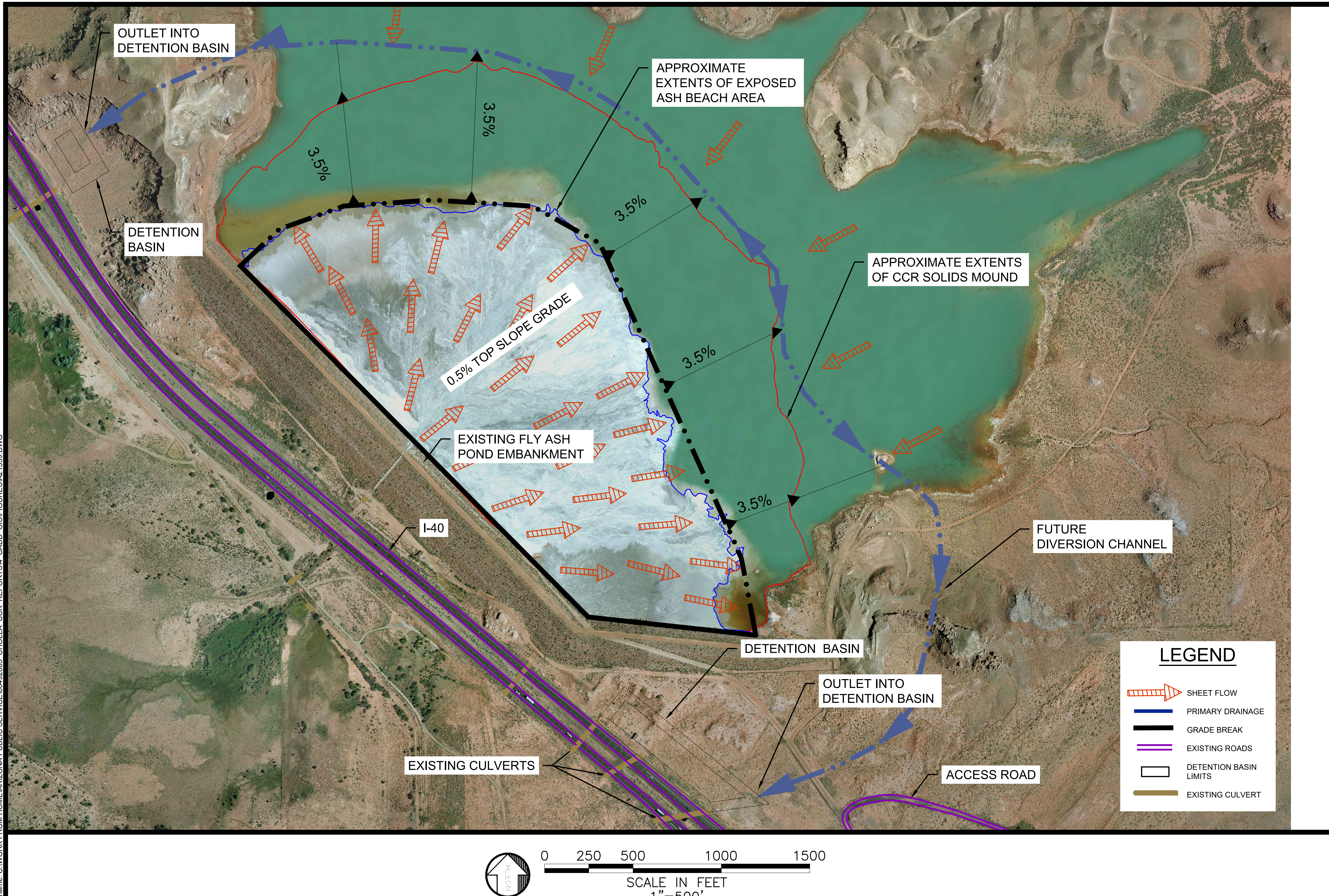

Figure: 2

Cholla Fly Ash Pond Closure
Plan View: Extents

Cholla Power Plant
Arizona Public Service
Cholla Power Plant, Joseph City, AZ
605224778
Date: 2016-06-28
Revised: 2020-11-18

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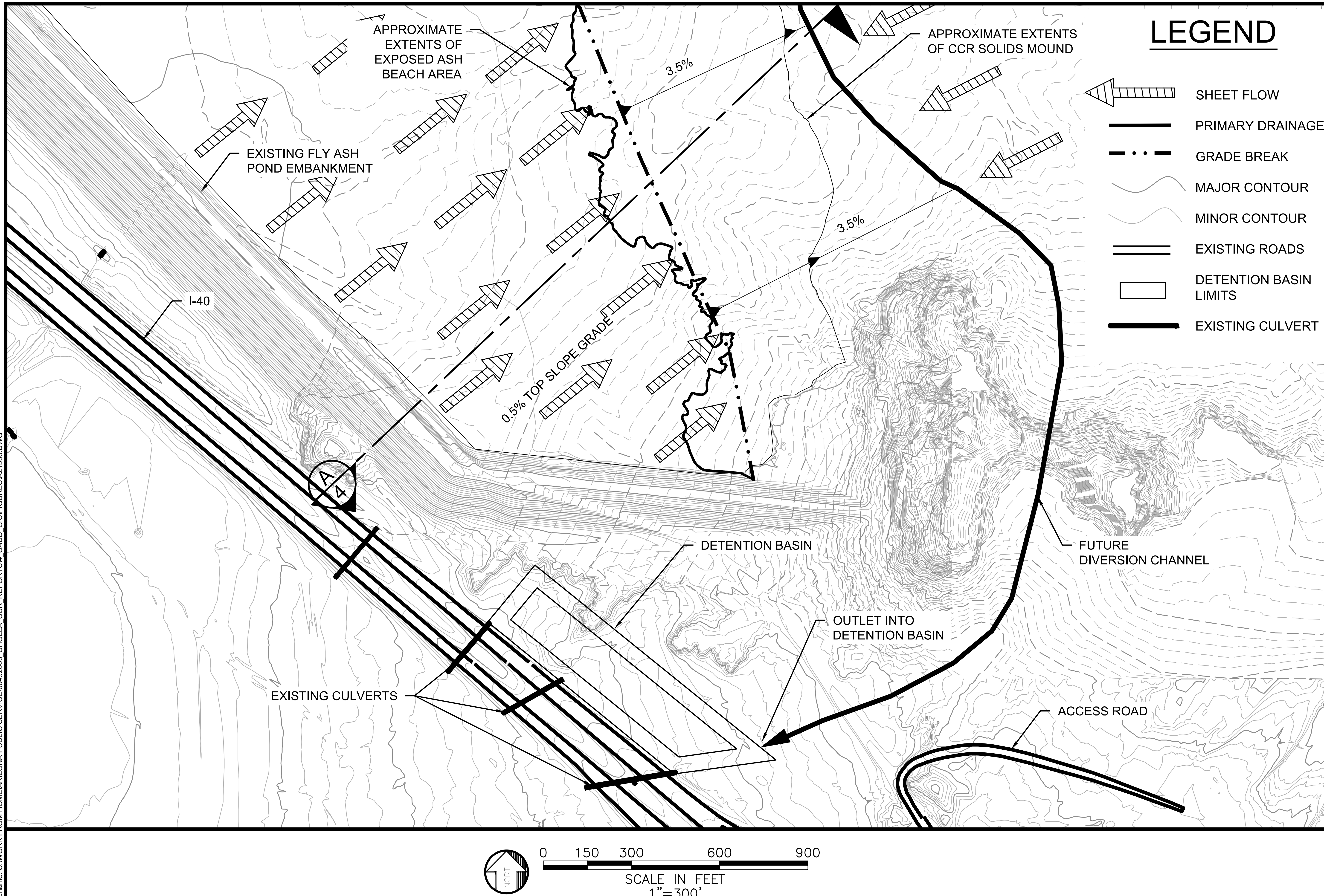
Project Management Initials: Designer: SDU Checked: JBH Approved: AWG ANSI B 11" x 17"



AECOM

Figure: 3

Cholla Fly Ash Pond Closure
Plan View

Cholla Power Plant
Arizona Public Service
Cholla Power Plant, Joseph City, AZ
605224778
Date: 2016-06-28
Revised: 2020-11-18

Project Management Initials: Designer: SDU Checked: JBH Approved: AWG ANSI B 11" x 17"

Last saved by: KRISTINE.PALMISANO(2020-11-20) Last Plotted: 2020-11-20
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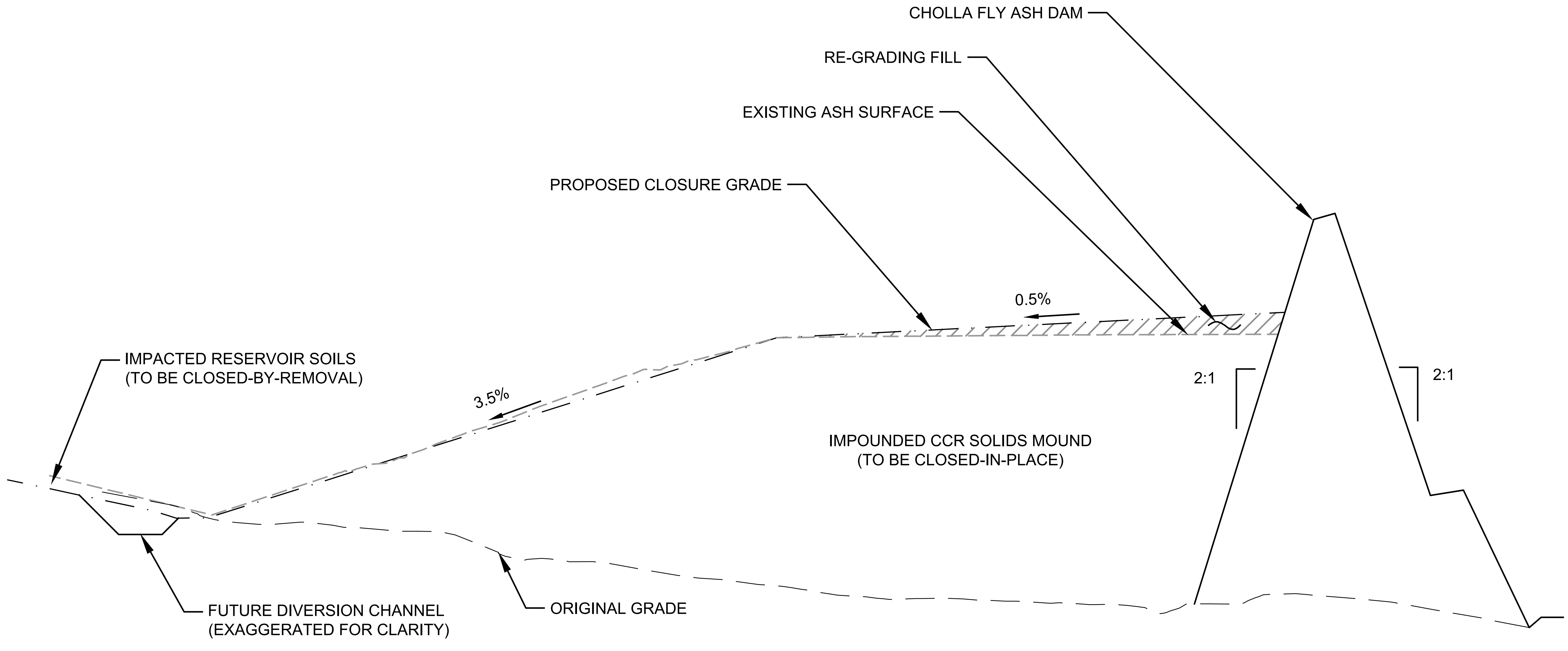


Cholla Fly Ash Pond Closure
Section A

Cholla Power Plant
Arizona Public Service
Cholla Power Plant, Joseph City, AZ
605224778
Date: 2016-06-28
Revised: 2020-11-18

AECOM
Figure: 4

CHOLLA POWER PLANT
CLOSURE PLAN §257.102(b)
BOTTOM ASH POND
Amendment 2 (November 23, 2020)

Closure Plan Contents §257.102(b)(1)

The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section.

Prepared for Arizona Public Service by AECOM Technical Services, Inc. (AECOM)	
CLOSURE PLAN AMENDMENT HISTORY	
Initial	August 30, 2016
Amendment 1	October 2, 2020 - Updated regulatory framework information and dates
Amendment 2	November 23, 2020 – Deleted reference to closure of Sedimentation Pond being performed concurrently with closure of Bottom Ash Pond.
SITE INFORMATION	
Site Name / Address	Cholla Power Plant / 4801 I-40 Frontage Road, Joseph City, AZ 86032
Owner Name / Address	Arizona Public Service / 400 North 5^{th} Street, Phoenix, AZ 85004
CCR Unit	Bottom Ash Pond
Location	34° 57’ 18” N, 110° 17’ 19” W
Reason for Initiating Closure	Permanent cessation of a coal-fired boiler(s) by a date certain
Final Cover Type	Evapotranspiration Cover
Closure Method	Closure by leaving CCR in place
CLOSURE PLAN DESCRIPTION	
(b)(1)(i) – A narrative description of how the CCR unit will be closed in accordance with this section.	The Bottom Ash Pond (BAP) is an existing Coal Combustion Residual (CCR) impoundment constructed for the storage of bottom ash generated by the Cholla Power Plant. The BAP was placed into service after the Bottom Ash Dam was completed in 1978. The Bottom Ash Dam was built to impound the hydraulically deposited bottom ash. The BAP is regulated by the United

	States Environmental Protection Agency per 40 CFR parts 257 and 261. The BAP embankment dam is regulated by the Arizona Department of Water Resources (ADWR) Dam Safety Program (ADWR Dam #09.27). The BAP will be dewatered to facilitate construction of a final cover system for leaving the CCR in place. The final cover will be constructed over a graded and prepared CCR subgrade. The Bottom Ash Pond decant areas will be filled with hydraulically deposited bottom ash to provide grading from south or southwest to northeast. The bottom ash top slopes will be re-graded to provide the slope to promote storm water drainage off the closed pond. The storm water runoff will be discharged off the closed configuration of the BAP to a new detention basin. The detention basin will outfall to Tanner Wash. Closure operations will consist of: 1) Dewatering, 2) Re-grading CCR to create acceptable grades for closure, 3) Installing the final cover system, and 4) Constructing the perimeter drainage channels. In accordance with §257.102(b)(3), this Amendment 1 revises information in the initial written closure plan regarding dates and regulatory framework information. This amended written closure plan will be amended to provide additional details after the final engineering design for the grading and cover system is completed. The current version of the closure plan reflects the information and planning available at the time of issuance.

(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.	Not applicable. The Bottom Ash Pond will be closed by leaving CCR in place and designed in accordance with §257.102(d).
(b)(1)(iii) – If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section.	Applicable. The Bottom Ash Pond will be closed by leaving CCR in place and closure will be designed in accordance with §257.102(d). The area is in a semi-arid to arid climate with precipitation on the order of 6 inches per year and evaporation losses (pan evaporation rate) on the order of 50 inches per year. Therefore, this environment is appropriate for using a water-balance soil cover system that relies on the net water losing climate to reduce infiltration into the subgrade of the cover. The final cover system will be installed in direct contact with a sloped subgrade of CCR or other fill to achieve final subgrade elevations designed for positive storm water drainage. The alternative final cover ("evapotranspiration cap") system, designed in accordance with requirements of §257.102(d)(3)(ii), will consist of the following (from bottom to top): 1) a minimum of 18 inches of compacted earthen material with a discharge (flux) through the cover material equivalent to a cover system with a single geomembrane; 2) Six inches of soil capable of sustaining native plant growth and resisting erosion (erosion layer); and 3) Seeded with native vegetation. CCR material will be re-graded and earthen fill material placed, as required, to bring the grades to the design slopes. Earthen material for the infiltration layer will be placed, graded, and compacted to meet the specified thickness and

	permeability. The final cover surface will be seeded and vegetated. Figures 1 through 3 show the general grading concept for the closure of the BAP. The final cover will have minimum as-constructed top slopes of 0.5 to 1.0 percent. The proposed grading will allow water to flow from the top slope into a drainage collection channel that will collect and convey the runoff directly to a newly constructed detention/retention basin that will outfall to Tanner Wash. The outside slopes of the existing dam will not be re-graded as there is already erosion protection in place and previous geotechnical analyses have shown the existing slopes to be stable.
(b)(1)(iii) – How the final cover system will achieve the performance standards in §257.102(d). **Five Performance Standards:**	
1. (d)(1)(i) – Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere.	The infiltration (flux) through the final cover will be demonstrated to be equivalent to or less than flux through the unlined native soil comprising the bottom of the BAP. The demonstration of the alternative final cover system will be completed during final engineering design for the grading and cover system and issued in an amended closure plan.
2. (d)(1)(ii) – Preclude the probability of future impoundment of water, sediment, or slurry.	The final cover will have a minimum as-constructed top slope of 0.5 to 1.0 percent to preclude the probability of ponding. The overall drainage pattern of the final cover will slope toward the northeast corner of the BAP to coordinate drainage with the adjacent Bottom Ash Monofill. The design for the final cover system will consider the magnitude of the expected settlement of the wastes and the potential and locations of possible differential settlement. The post-closure plan includes maintenance measures to correct local grading deficiencies.

3. (d)(1)(iii) – Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.	The downstream slopes of the embankment dam will remain at 2H:1V and not be re-graded for the final closed configuration of the BAP. The final engineering design for the grading and cover system will include geotechnical analyses to demonstrate that the final outer slopes and cover will satisfy the stability requirements to prevent sloughing or mass movement.
4. (d)(1)(iv) – Minimize the need for further maintenance of the CCR unit.	The final cover will be seeded with native vegetation to minimize erosion maintenance. Drainage channels will have appropriate erosion protection measures to minimize erosion maintenance.
5. (d)(1)(v) – Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.	Closure is expected to occur in coordination with the schedule for cessation of coal-fired electricity generation at the Cholla Power Plant. Coal-fired electricity generation is scheduled to cease in 2025. APS is seeking a time extension to initiate closure in accordance with the separate "Site-specific alternative deadlines to initiate closure of CCR surface impoundments" provisions of §257.103(f)(2). The BAP is scheduled to close no later than October 17, 2028. The BAP closure will include sufficient dewatering and ash material stabilization for construction of the final grading and cover. These activities will be performed concurrently with the cessation of coal-fired electricity generation at the Cholla Power Plant in 2025 and the closure of the Fly Ash Pond and Bottom Ash Monofill. Dewatering and stabilization may take approximately 1 to 2 years and construction of the grading and final cover with appurtenant drainage features may take an additional 1 to 2 years.
(d)(2)(i) – Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.	The existing CCR will be dewatered to remove incidental free liquids and to provide a stable base for the construction of the final cover system. The form and extent of required dewatering has not yet been identified.

(d)(2)(ii) – Remaining wastes must be stabilized sufficiently to support the final cover system.	The existing CCR will be dewatered and re-graded to provide a stable base for the construction of the final cover. The materials within the BAP are generally bottom ash and therefore assumed to provide a stable liner subgrade surface with limited compactive effort.
(d)(3) – A final cover system must be installed to minimize infiltration and erosion, and at minimum, meets the requirements of (d)(3)(i) of this section, or the requirements of the alternative final cover system specified in paragraph (d)(3)(ii) of this section. (d)(3)(i) – The design of the final cover system must be included in the written closure plan.	The alternative final cover system will meet the requirements of §257.102(d)(3)(ii). The requirements of §257.102(d)(3)(ii) will be achieved using the clayey and silty soils present at the site to construct an infiltration layer that promotes runoff and evapotranspiration. The infiltration layer will be a minimum of 18 inches thick and will be constructed to reduce infiltration or flux into the BAP. On-site soils or an off-site aggregate source will be used to provide an erosion layer to protect the infiltration layer. The engineering design for the final cover system will be issued in an amended closure plan when the final cover system is completed.
EITHER (d)(3)(i)(A) – The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less. (d)(3)(i)(B) – The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer than contains a minimum of 18 inches of earthen material. OR (d)(3)(ii)(A) – The design of the final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (d)(3)(i)(A) and (B).	The alternative final cover system will meet the requirements of §257.102(d)(3)(ii). The permeability of the final cover will be demonstrated prior to closure.

EITHER (d)(3)(i)(C) – The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth. OR (d)(3)(ii)(B) – The design of the final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified in paragraph (d)(3)(i)(C) of this section.	The final cover will include either: a) a minimum of 6 inches of a soil erosion layer that is capable of sustaining native plant growth (erosion layer) that will be seeded and vegetated to meet the requirements of §257.102(d)(3)(i)(C); or b) a minimum of 6 inches of rock armor erosion protection to meet the requirements of §257.102(d)(3)(ii)(B).
(d)(3)(i)(D), (d)(3)(ii)(C) – The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.	The engineering design for the final cover system will consider the magnitude of the expected settlement of the wastes and the potential and locations of possible differential settlement. The relatively freely draining properties of bottom ash minimize the likelihood of delayed drainage or consolidation of wastes. The majority of settlement is likely to be immediate and not evident as additional waste is placed. The final cover will have as-constructed slopes graded to drain to accommodate potential future differential settlement and subsidence. The final cover will incorporate an 18-inch thick, loosely-compacted evapotranspiration layer that will behave in a flexible manner so as to minimize the risk of disrupting the continuity of the cap due to settlement.
INVENTORY AND AREA ESTIMATES	
(b)(1)(iv) – An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.	3,710,000 cubic yards
(b)(1)(v) – An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life.	80 acres

CLOSURE SCHEDULE	
(b)(1)(vi) – A schedule for completing all activities necessary to satisfy the closure criteria in this 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/milestones that will be taken to close the CCR unit, and the estimated timeframes to complete each step or phase of CCR unit closure. If closure timeframe is anticipated to exceed the timeframes specified in paragraph §257.102(f)(1) of this section, the written closure plan must include the site-specific information, factors and considerations that would support any time extension sought under paragraph §257.102(f)(2).	
APS is seeking a time extension to initiate closure in accordance with the separate "Site-specific alternative deadlines to initiate closure of CCR surface impoundments" provisions of §257.103(f)(2). The milestones and the associated timeframes are initial estimates. Some of the activities associated with the milestones will overlap. Amendments to the milestones and timeframes will be made as more information becomes available.	
Initial Written Closure Plan Completed	August 2016
Closure Plan Amendment 1	October 2020
Closure Plan Amendment 2	November 2020
Permits and Approvals from Agencies	October 2024 (estimated)
Date of Final Receipt of CCR	April 2025
Closure Activities Initiated	April 2023
Complete Dewatering	December 2026 (estimated)
Complete CCR Stabilization	December 2026 (estimated)
Installation of Final Cover	Prior to October 17, 2028
Estimated Completion of Closure Activities	Prior to October 17, 2028

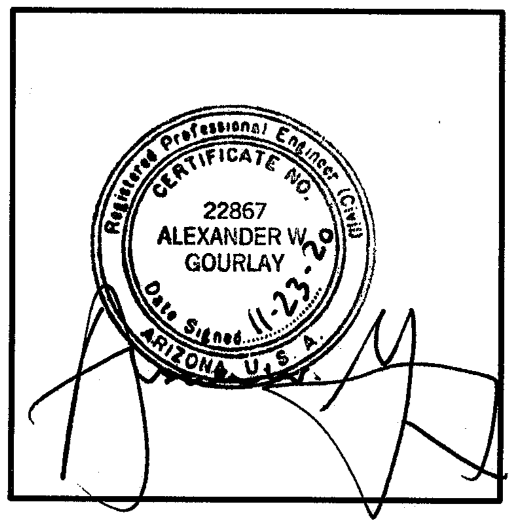
Certification Statement 40 CFR § 257.102(b)(4) – Amended Written Closure Plan for a CCR Surface Impoundment

CCR Unit: Arizona Public Service; Cholla Power Plant; Bottom Ash Pond

I, Alexander W. Gourlay, being a Registered Professional Engineer in good standing in the State of Arizona, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in the amended written closure plan dated November 23, 2020 meets the requirements of 40 CFR § 257.102.

Alexander W. Gourlay, P.E.
Printed Name

November 23, 2020
Date



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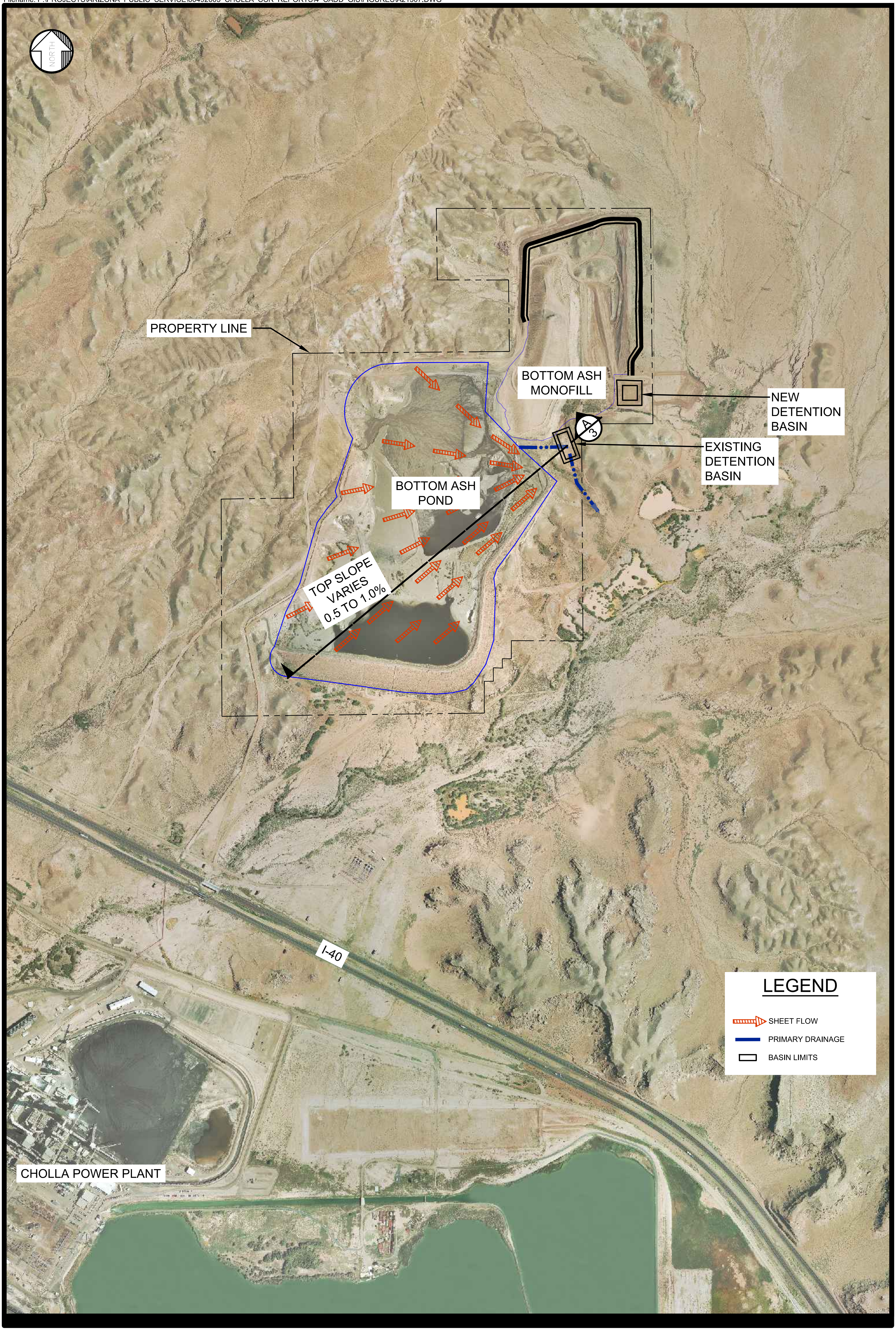
Project Management Initials: Designer: SDU Checked: JBH Approved: AWG ANSI B 11" x 17"

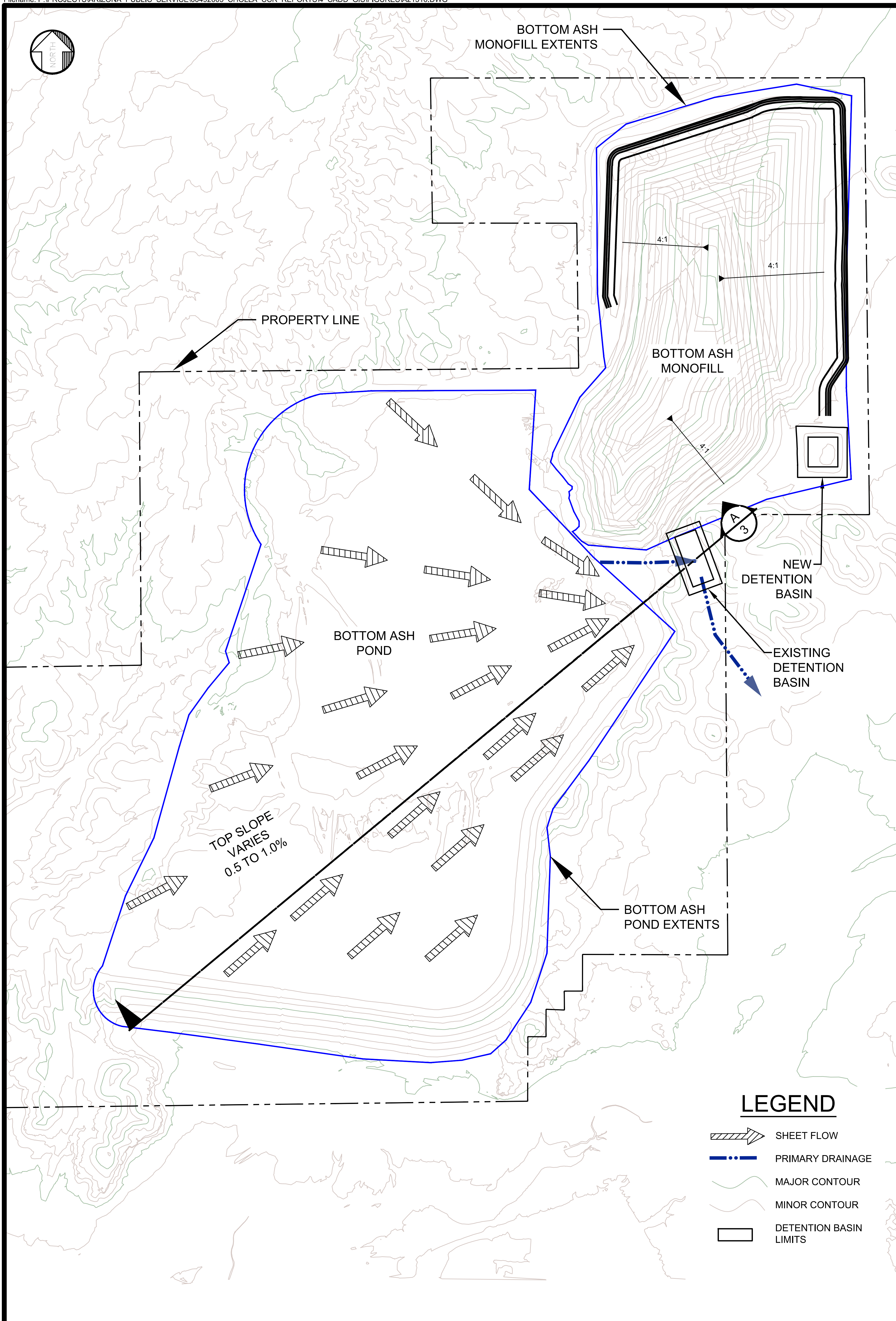


Cholla Power Plant
Arizona Public Service
Cholla Power Plant, Joseph City, AZ
60492605 Date: 2016-08-23

Cholla Power Plant
Bottom Ash Pond Closure

AECOM

Figure: 1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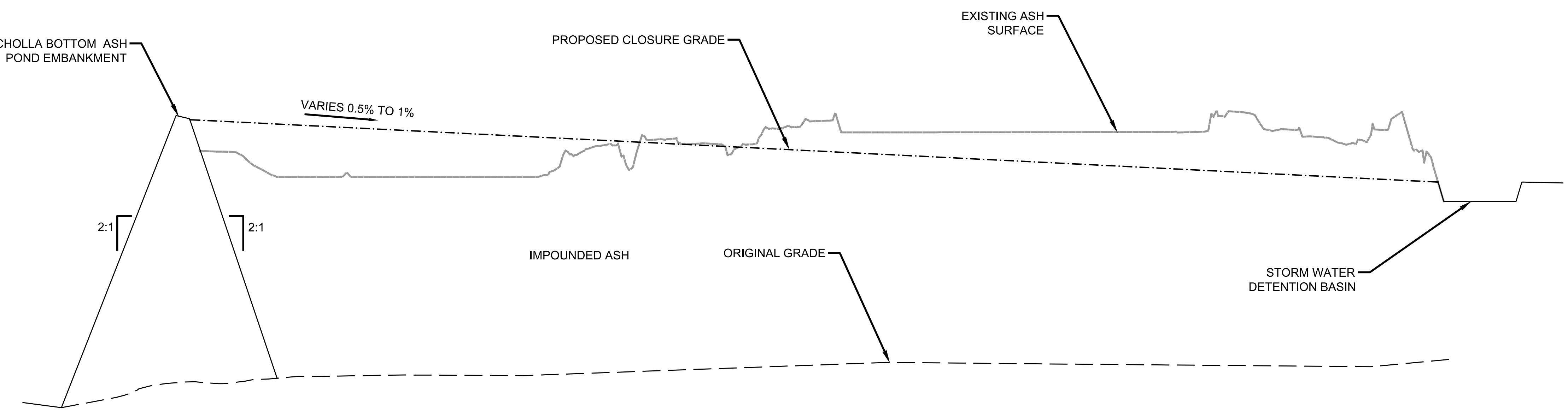
BOTTOM ASH
MONOFILL EXTENTS
PROPERTY LINE
4:1
4:1
BOTTOM ASH
MONOFILL
4:1
A
3
NEW
DETENTION
BASIN
BOTTOM ASH
POND
EXISTING
DETENTION
BASIN
TOP SLOPE
VARIES
0.5 TO 1.0%
BOTTOM ASH
POND EXTENTS
LEGEND
SHEET FLOW
PRIMARY DRAINAGE
MAJOR CONTOUR
MINOR CONTOUR
DETENTION BASIN
LIMITS



Cholla Power Plant
Bottom Ash Pond Closure
Profile

Cholla Power Plant
Arizona Public Service
Cholla Power Plant, Joseph City, AZ
60492605 Date: 2016-07-05

AECOM
Figure: 3

ATTACHMENT D(2)

CHOLLA POWER PLANT
CLOSURE SCHEDULE NARRATIVE
40 CFR 257.103(f)(2)(v)(D)

Arizona Public Service Company (APS) has been planning for the closure of the Fly Ash Pond (FAP) and Bottom Ash Pond (BAP) for some time. Figures D-1 (FAP Closure Activities) and D-2 (BAP Closure Activities) present Gantt charts depicting the tasks that must be completed as part of pond closure with the corresponding planned schedule for those tasks. This narrative supplements the Closure Plans presented as Attachment D(1) and presents supporting detail regarding the tasks and schedule identified in each Gantt chart.

1. Closure of the Fly Ash Pond

1.1 Pre-Construction

1.1.1 Minimize Discharge to the FAP

Continue implementing measures that limit discharges to the FAP; this activity has been ongoing since early 2016 and has included sale of fly ash to a local cement manufacturer, shut down of Unit 2, diversion of water from seepage collection systems to general water (this flow previously discharged into the FAP), and various plant operational modifications. This activity will continue thru plant shut down.

1.1.2 Stockpile Closed Ash Pond 1 CCR Material for Bridge Lift

Move approximately 600,000 cubic yards (cy) of ash from closed Ash Pond 1 to a stockpile area located within the Fly Ash Pond footprint and store for utilization as bridge lift material for closure activities. This activity should require approximately 15 months depending upon contractor productivity. Work began during Third Quarter 2020.

1.1.3 Stockpile Bottom Ash for Bridge Lift

Relocate approximately 600,000 cy of bottom ash from the Bottom Ash Monofill (BAM) to a stockpile area located within the FAP footprint and store for utilization as bridge lift material for closure activities. This work can start approximately one year prior to cessation of discharge of CCR material.

1.1.4 Land Acquisition for Closure (e.g. Diversion Channels)

No later than 3 years prior to starting closure activities, acquire land adjacent to the FAP for soil borrow areas and construction of diversion channels.

1.1.5 Run-On Diversions and Coffer (Push Up) Dams

Upstream in the drainage channels, build small retention coffer dams to capture precipitation run on. This work should start up to two years prior to cessation of discharge of CCR material.

1.1.6 Excavate Abutment Diversion Channels and Stockpile Select Soil

Start the excavation of abutment diversion channels approximately one year prior to the cessation of discharge of CCR material (as early as Second Quarter 2024).

1.2 Engineering

1.2.1 Design Engineering

Start design engineering activities in 2023; these activities will include approximately 21 months of design engineering work. The objective of these activities is to produce design drawings and specifications that will be used to procure a contractor for FAP closure activities.

1.2.2 Geotechnical and Borrow Investigations

Start the geotechnical soils evaluation after acquisition of lands adjacent to abutments. Identify usable soils for borrow materials. If possible, build roads onto the FAP beach for access of light-weight geotechnical test equipment.

1.2.3 Bridge Lift Test Fill

Start construction test fills over the CCR material exposed in the pond next to the dam embankment. Test fills to measure internal water pressures generated by bridge lift loading. Estimate techniques and materials needed to construct full-scale soil fill cap.

1.3 Permits

1.3.1 Arizona Department of Water Resources (ADWR) Dam Modifications

Anticipate that the permitting process with the ADWR Dam Safety Bureau to modify a jurisdictional high hazard dam will require nine months. Consult early with ADWR to identify if additional time is needed.

1.3.2 Arizona Department of Environmental Quality (ADEQ) or US Environmental Protection Agency (EPA) CCR Rule Closure Plan Approval

Anticipate up to six months will be required to achieve approval of proposed Closure Plan from ADEQ or US EPA if ADEQ does not have primacy.

1.4 Procurement

1.4.1 Preliminary Construction Contracts

Anticipation of six months duration for procurement of the primary construction contract (includes bid event and award of contract).

1.5 Final Boiler Closures

1.5.1 Plant Final Boiler Closures

Cease generation using coal no later than April 2025.

1.6 Construction

1.6.1 Gravity Drain Down CCR Pile

Allow up to 18 months to gravity drain the delta of CCR material adjacent to the dam. This activity may include pushing out of bridge lift material to help squeeze pore water from the CCR material. This task can begin following cessation of discharge of CCR material to the FAP.

1.6.2 Complete Diversion Channel Rock Excavations

Complete diversion channels; rock excavations started in pre-construction. Continue to segregate the selected materials for construction borrow material (activities started Second Quarter 2025).

1.6.3 Fill Remaining Water Ponds with Rockfill from Diversion Channel Cuts

Backfill remaining free water at the toe of CCR with rock fill material to entrap remaining free water this activity should coincide with the excavation of the diversion channels. Utilize rock from diversion excavation.

1.6.4 Build Rockfill Toe Buttress to Stabilize Upstream Toe of CCR Pile

Build the toe buttress with larger rock to stabilize the CCR material. This activity will coincide with the rockfill to trap the remaining free water. Can start Fourth Quarter of 2025.

1.6.5 Excavate Upstream Diversion Channels and Coffer Dams

Finish excavating upstream diversions to connect with the diversion channels around the abutments. Work starts Third Quarter of 2025 and requires 21 months.

1.6.6 Build Stormwater Detention Basins and Outlet Works

Construct stormwater detention basins which will outfall into culverts that convey water under Interstate 40.

1.6.7 Build the South and North Half Bridge Lifts and Construct Evapotranspiration (ET) Cap

Construct the bridge lifts and place the ET cap material over the supporting bridge lift material as area comes available. These construction activities will be split along the north and south halves of the pond, advancing the cap materials from southwest to northeast to squeeze pore water out of the CCR pile. ET cap placement will follow the bridge lift construction activities as areas become available. Work starts Second Quarter 2026.

1.6.8 Vegetate ET Cap

Seed the ET cap as sections are completed. Finish September or October 2028.

2. Closure of the Bottom Ash Pond

<u>2.1 Pre-Construction</u>

2.1.1 Land Acquisition for Closure (e.g. Diversion Channels)

No later than 3 years prior to starting closure activities, acquire land adjacent to the BAP for soil borrow areas and construction of diversion channels.

2.1.2 Stop Mining of Bottom Ash from BAP (to Bottom Ash Monofill)

Suspend removal of bottom ash from the BAP with placement of the ash in the BAM so that the material can be used in closure activities.

2.1.3 Allow Sluice of Bottom Ash into Decant Area to fill with BA

Allow ash from the plant to fill in the decant west and east cells in the BAP.

2.2 Engineering

2.2.1 Design Engineering

Design engineering activities starting in 2023 approximately 21 months of design engineering work.

2.2.2 Geotechnical and Borrow Investigations

Start the geotechnical soils evaluation after acquisition of lands adjacent to abutments. Identify usable soils for borrow materials. Build roads onto bottom ash beach areas to access light-weight geotechnical test equipment.

2.3 Permits

2.3.1 ADWR Dam Modifications

Anticipate that the permitting process with the ADWR Dam Safety Bureau to modify a jurisdictional high hazard dam will require nine months. Consult early with ADWR to identify if additional time is needed.

2.3.2 ADEQ or US EPA CCR Rule Closure Plan Approval

Anticipate up to six months will be required to achieve approval of proposed Closure Plan from ADEQ or US EPA if ADEQ does not have primacy.

2.4 Procurement

2.4.1 Preliminary Construction Contracts

Anticipation of six months duration for procurement of the primary construction contract (includes bid event and award of contract).

2.5 Final Boiler Closures

2.5.1 Plant Final Boiler Closures

Cease generation using coal no later than April 2025.

2.6 Construction Activities

2.6.1 Transfer Remaining Decant Water to General Sump for Use during Decommissioning

Siphon or pump extensively sending all free water possible to the plant for use in decommissioning activates.

2.6.2 Gravity Drain-Down CCR Pile

Allow up to 18 months to gravity drain the delta of CCR material. Activities may include the pushing out of bridge lift material to help squeeze pore water from the CCR material. Starts with the cessation of discharge of CCR material.

2.6.3 Grade Pond Using Drained Bottom Ash

Grade cut and fill utilizing drained bottom ash material to achieve the final surface configuration. This activity should start as soon as possible with the gravity drain down of the bottom ash material.

2.6.4 Excavate Upstream Diversion Channels and Retention Pond

Excavate upstream diversion channels to connect with the diversion channels around the abutments. Work will start First Quarter of 2026 and continue for 15 months.

2.6.5 Build ET Cap Using Stockpiled Soil from Diversion Channel Cuts

ET cap placement will follow the grade cut and fill construction activities as areas become available. Activities will start in Third Quarter of 2027.

2.6.6 Vegetate ET Cap

Seed the ET cap as sections are completed. Finish September or October 2028.

Figure D-1

Planned Schedule for FAP Closure Activities

Last Updated: 10.09.2020

NOTES:
1. Does not describe any removal of free water to Evaporation Pond or unlined basins
2. Does not describe any measures for enhancing drain down or pore pressure relief within CCR pile.
3. For cap construction, a south/north distinction has been made to allow an extra year for drain down of the more fine-grained northern half.

TASK	START	END	Duration
Pre-Construction			
Minimize discharge to FAP	20Q1	25Q2	63 months
Stockpile 600,000 cy existing fly ash for bridge lift	20Q3	21Q4	15 months
Stockpile 600,000 cy of BAM BA for bridge lift	24Q1	25Q1	12 months
Land acquisition for closure (e.g. diversion channels)	22Q1	23Q2	15 months
Run-on diversions and coffer (push up) dams	23Q2	24Q1	12 months
Excavate abutment diversion channel, stockpile select soils	24Q2	25Q2	12 months
Engineering			
Design Engineering (SG2)	23Q1	24Q4	21 months
Geotechnical and Borrow Investigations	23Q2	23Q4	6 months
Bridge Lift test fill	24Q2	24Q4	6 months
Permits			
ADWR Dam Modifications	23Q4	24Q3	9 months
ADEQ/USEPA CCR Closure Plan Approval	24Q2	24Q4	6 months
Procurement			
Primary construction contract(s)	24Q2	24Q4	6 months
Final Boiler Closures			
Plant Final Boiler Closures	25Q2	25Q2	0 months
Construction			
Gravity drain-down CCR pile	25Q2	26Q4	18 months
Complete diversion channel rock excavations	25Q2	26Q4	18 months
Fill remaining water ponds with rockfill from diversion channel cuts	25Q2	25Q4	6 months
Build rockfill toe buttress to stabilize upstream toe of CCR pile	25Q4	26Q2	6 months
Excavate upstream diversion channels and coffer dams	25Q3	27Q2	21 months
Build stormwater detention basins and outlet works to LCR	27Q2	28Q2	12 months
Build south half of bridge lift using stockpiled fly ash	26Q2	27Q1	9 months
Build south half of ET Cap using stockpiled soil from diversion cuts	27Q2	27Q4	6 months
Build north half of bridge lift using stockpiled fly ash	27Q1	27Q4	9 months
Build north half of ET Cap using stockpiled soil from diversion channel cuts	28Q1	28Q3	6 months
Vegetate ET cap	28Q3	28Q4	3 months

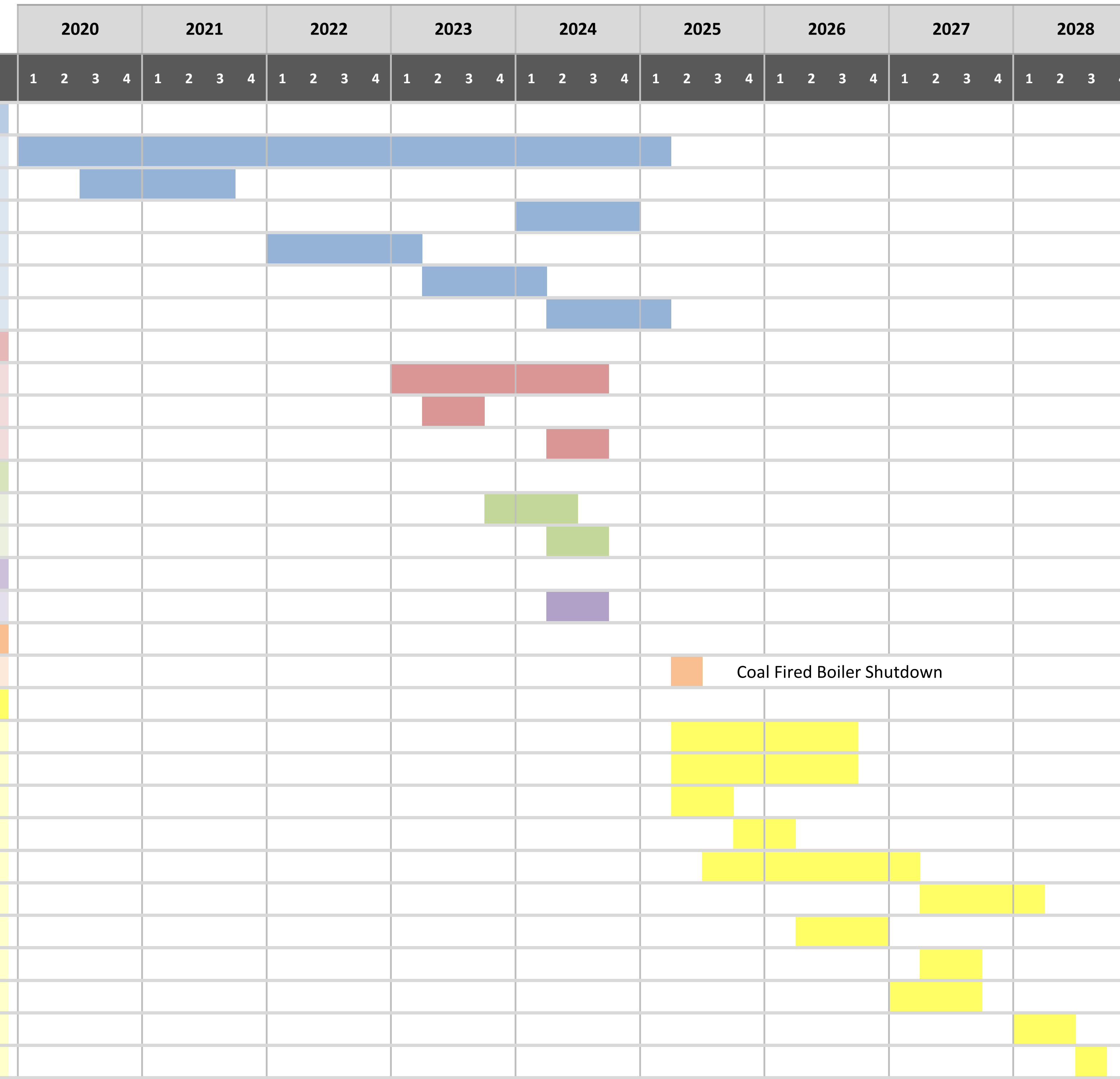


Figure D-2

Planned Schedule for BAP Closure Activities

Last Updated: 04.16.2020

NOTES:
1. Does not describe any removal of free water to Evaporation Pond or unlined basins.
2. Does not describe any measures for enhancing drain down or pore pressure relief within CCR pile.

TASK	START	END	Duration
Pre-Construction			
Land acquisition for closure (e.g. diversion channels)	21Q1	23Q2	27 months
Stop mining of bottom ash from BAP (to Bottom Ash Monofill)	23Q1	25Q2	27 months
Allow sluice of bottom ash into decant area to fill with BA	23Q1	25Q2	27 months
Engineering			
Design engineering (SG2)	23Q1	24Q4	21 months
Geotechnical and borrow investigations	23Q2	24Q1	9 months
Permits			
ADWR dam modifications	23Q4	24Q3	9 months
ADEQ/USEPA CCR closure plan approval	24Q2	24Q4	6 months
Procurement			
Primary construction contract(s)	24Q2	24Q4	6 months
Final Boiler Closures			
Plant final boiler closures	25Q2	25Q2	0 months
Construction			
Transfer remaining decant water to general sump for use during decommissioning	25Q2	26Q4	18 months
Gravity drain-down CCR pile	25Q2	26Q4	18 months
Grade pond using drained bottom ash	26Q4	27Q3	9 months
Excavate upstream diversion channels and retention pond	26Q1	27Q2	15 months
Build ET Cap using stockpiled soil from diversion channel cuts	27Q3	28Q1	6 months
Vegetate ET cap	28Q1	28Q2	3 months