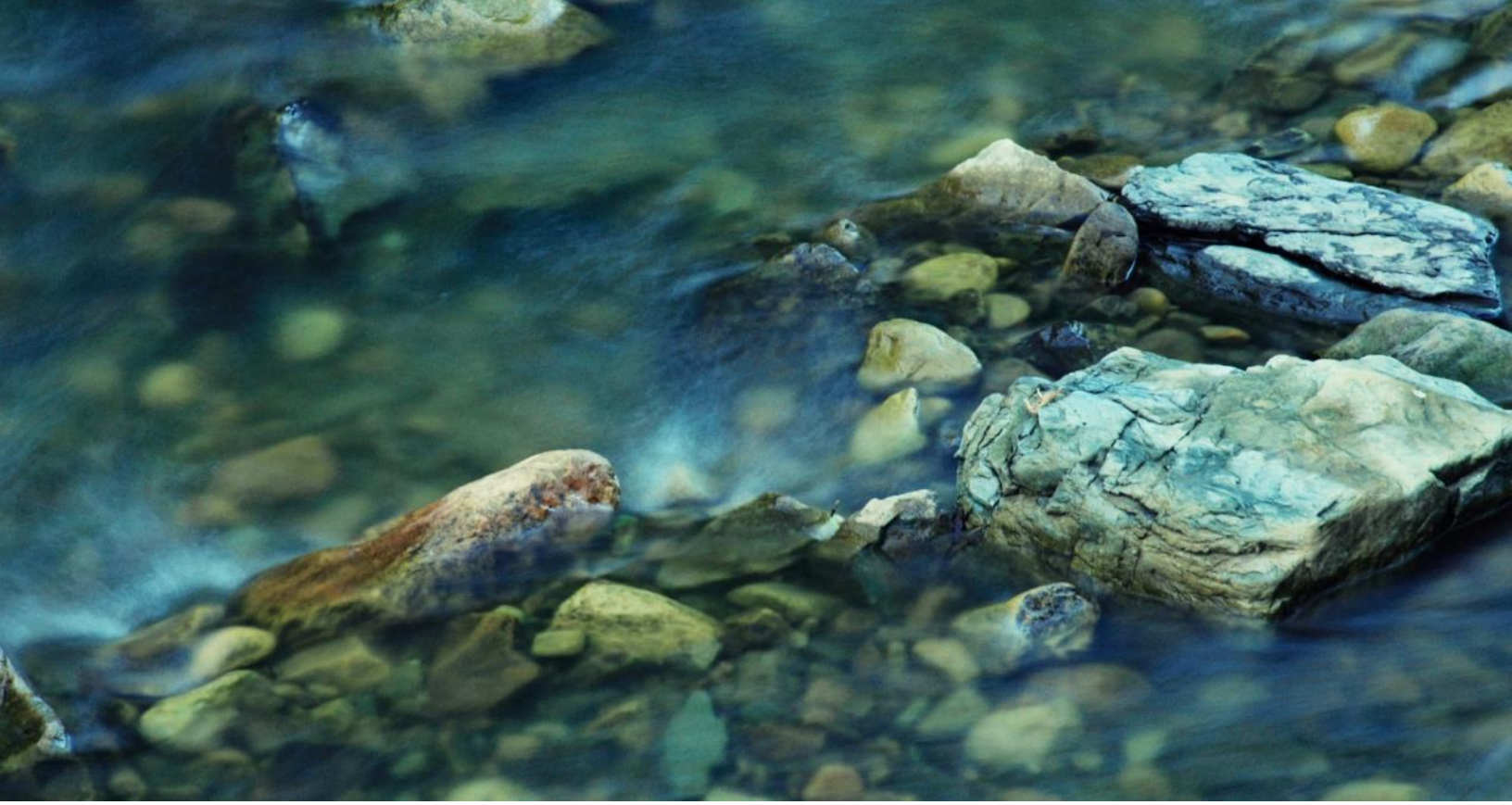


December 2020

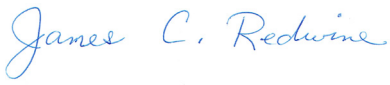
ANCHOR QEA

Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas

Prepared for Alabama Power Company

December 2020

Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



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ABBREVIATIONS

ACM	Assessment of Corrective Measures
ADEM	Alabama Department of Environmental Management
Alabama Power	Alabama Power Company
BALF	Bottom Ash Landfill
CCR	coal combustion residuals
CEC	cation exchange capacity
CFR	Code of Federal Regulations
COI	constituent of interest
CSM	conceptual site model
EPA	U.S. Environmental Protection Agency
MNA	monitored natural attenuation
Site	Plant Gorgas
SEM	scanning electron microscopy
SSE	selective sequential extraction
SSL	statistically significant level
USGS	U.S. Geological Survey
XRD	X-ray diffraction
XRF	X-ray fluorescence

1 Introduction

In accordance with the U.S. Environmental Protection Agency's (EPA's) coal combustion residuals (CCR) Rule 40 Code of Federal Regulations (CFR) § 257.97(a), the Alabama Department of Environmental Management's (ADEM's) Admin. Code r. 335-13-15-.06(8)(a), and Part C of Administrative Order No. 18-096-GW, this *Semi-Annual Remedy Selection and Design Progress Report* has been prepared for Plant Gorgas (Site). Specifically, this report has been prepared to describe the progress made in evaluating the selected remedy and alternative remedies and designing a remedy plan in the second semi-annual period of 2020.

In June 2019, Alabama Power Company (Alabama Power) completed an Assessment of Corrective Measures (ACM) (Anchor QEA 2019) to address the occurrence of arsenic, lithium, and molybdenum in groundwater at statistically significant levels (SSLs) at the Ash Pond and lithium at the Gypsum Pond. In February 2020, Alabama Power revised the ACM to address the occurrence of arsenic at the Bottom Ash Landfill (BALF), lithium at the CCR Landfill, and lithium at the Gypsum Landfill[1] (Anchor QEA 2020). In the ACM, the following remedies were considered feasible for corrective measures for groundwater:

- Monitored natural attenuation (MNA)
- Hydraulic containment (pump and treat)
- Geochemical manipulation via injections (i.e., enhanced natural attenuation)
- Permeation grouting

As required by the Administrative Order, MNA was proposed as the main groundwater corrective action remedy for the Site. Source control measures consisting of consolidation, dewatering, and capping of the Ash Pond, dewatering and removing gypsum/CCR from the Gypsum Pond and consolidating and capping the BALF were already planned as part of closure activities.

Additional assessment work has been completed in 2020 to evaluate and demonstrate MNA and geochemical manipulation as corrective measures at the Site. Groundwater samples and solids (precipitates) were collected from select wells, and groundwater sampling results were used to perform geochemical modeling, which predicted attenuating species under Site geochemical conditions. Well solids were analyzed to determine attenuating phases for the constituents of interest (COI; arsenic, lithium, and molybdenum) at the Site. Solids analysis also provides insight into the stability of the attenuating mechanisms. The well solids were analyzed as follows:

- Elemental analysis by X-ray fluorescence (XRF) to determine the chemical composition of the matrix (e.g., iron compounds, aluminosilicates, and carbonates) and presence of COI
- X-ray diffraction (XRD) to determine crystalline mineral phases

[1] Alternate Source Demonstrations for the CCR Landfill and Gypsum Landfill were submitted to ADEM in February 2019, and an alternate source demonstration for the BALF was submitted to ADEM in July 2019.

- Scanning electron microscopy (SEM) and associated elemental analysis to confirm mineral phases and attenuating mechanisms
- Selective sequential extraction (SSE) to determine the association of COI with attenuating phases and the relative binding strength of attenuated COI, and to provide a sense of permanence
- Cation exchange capacity (CEC) and exchangeable COI concentrations for samples that contain clay minerals

In addition, concentration versus time and concentration versus distance graphs were created to help determine if attenuation is occurring with time and/or distance from the ash pond.

Any data obtained during on-site investigations or to evaluate corrective action alternatives will be included in the subsequent *Semi-Annual Groundwater Monitoring and Corrective Action Reports*.

2 Summary of Work Completed

Site investigations and preliminary design work have continued at the Site to support remedy selection and design. As discussed in the ACM (Anchor QEA 2020), completing a final long-term corrective action plan is often a multi-year process. Additional assessment work has been completed since June 2020, and laboratory work has been performed to support MNA and in situ geochemical manipulation as discussed in the ACM. MNA and geochemical manipulation are both geochemically based, such that site-specific geochemical data and analyses can be applied to both technologies.

Laboratory analysis of groundwater and precipitates (attenuating solids) was conducted to support MNA and geochemical manipulation. The major rationale for these investigations includes the following:

- Identifying attenuating mechanisms
- Gaining an understanding of the stability of the attenuating mechanisms
- Identifying potential geochemical manipulation approaches for COIs based on Site geochemical conditions and attenuation processes already occurring naturally

In the previous reporting period (January through June 2020), the following field and laboratory investigations were performed:

- Evaluated groundwater analytical data (primarily graphing) to look for evidence of natural attenuation occurring in space and time.
- Collected groundwater samples from background and impacted wells and performed a complete chemical analysis on the samples to enable groundwater geochemical modeling and the development of a geochemical conceptual site model (CSM).
- Performed geochemical modeling using the U.S. Geological Survey (USGS) computer program PHREEQC with the WATEQ4F thermodynamic database.
- Collected precipitate samples from the bottom of monitoring wells.
- Analyzed precipitate samples by XRF and XRD.

The following investigations were begun in the previous reporting period but completed in the current reporting period:

- SEM to directly observe attenuating mineral phases
- SSE to determine association of COI with attenuating phases, determine relative strength of attenuation, and provide a sense of permanence
- CEC to assess ion exchange as an attenuation mechanism

The work performed since the completion of the June 2020 progress report includes the following:

- Installing and sampling delineation wells
- Completing SEM, SSE, and CEC testing on well solids samples

- Analyzing and synthesizing the laboratory data described above to develop a geochemical CSM and to evaluate MNA and geochemical manipulation
- Conceptualizing other corrective action options in the context of site-specific conditions, should MNA or geochemical manipulation not perform as expected

2.1 Preliminary Data Analysis

Results from existing groundwater data analysis, geochemical modeling, and well solids analyses provide evidence for attenuation mechanisms for arsenic, lithium, and molybdenum, as summarized in Table 1. The attenuating mechanisms identified include sorption on amorphous iron oxides (arsenic and molybdenum), precipitation of arsenate and molybdate phases (for arsenic and molybdenum, respectively), and cation exchange on clays (lithium).

2.1.1 Concentration Versus Time and Concentration Versus Distance Graphs

Existing groundwater data were used to generate concentration versus time and concentration versus distance graphs to determine if attenuation is occurring over space and/or time and to assess natural attenuation occurrence and rates. Arsenic, lithium, and molybdenum were plotted on the y-axis. For the concentration versus distance graphs, the distance between the pond boundary and the monitoring well was plotted on the x-axis. No trends are apparent for the concentration versus distance graphs, though this could change as more data become available with continued monitoring. For the concentration versus time plots, the time between sampling events (in days) was plotted on the x-axis. Figures 1 through 3 show that arsenic concentration in GS-AP-MW-12 and arsenic and lithium concentration in GS-AP-MW-18,[2] respectively, are decreasing with time, which provides evidence for natural attenuation. Similar evidence from other wells is expected after closure, as closure activities cut off the source of COI to groundwater.

2.1.2 Laboratory Analyses

Well solids (precipitates) were previously collected and were analyzed as follows:

- XRF to determine the chemical composition of the matrix (e.g., iron compounds) and presence of COI
- XRD to determine mineral phases
- SEM to directly observe attenuating phases
- SSE to determine association of COI with attenuating phases, determine relative strength of attenuation, and provide a sense of permanence
- CEC to assess ion exchange as a mechanism for attenuation

[2] Arsenic is the only SSL in well GS-AP-MW-12; arsenic and lithium are the only SSLs in well GS-AP-MW-18.

All samples with sufficient volume were analyzed by XRF. A select number of samples were chosen to be analyzed by XRD to determine predominant mineralogy. Samples for XRD analysis were selected by looking at a variety of data, including, but not limited to, XRF data, field parameters, sample location, chemical analysis, and recovered sample mass.

In solid samples collected from 15 monitoring wells, the XRF chemical analysis of the well solids (Table 2) showed a relationship with at least one COI and elements associated with natural attenuation (iron, calcium, and/or manganese). The relationship of arsenic and iron, and molybdenum and iron are shown in Figures 4 and 5, respectively. Upgradient data (MW-8) and the lower COI to iron ratios were used to define geogenic (naturally occurring) arsenic and molybdenum. Arsenic (Figure 4) and molybdenum (Figure 5) values above the line represent arsenic and molybdenum enrichment in iron compounds, which demonstrates natural attenuation for these COI in downgradient wells.

XRD identified multiple attenuating species for the COI (Table 3), including ferrihydrite (an iron oxide), illite, montmorillonite and vermiculite (clay minerals), and zeolite (a clay-like mineral).

SEM and associated elemental mapping were conducted on select samples to confirm mineral phases and attenuating mechanisms. SEM results indicate the solids collected from GS-AP-MW-6D are predominantly silica (quartz) interspersed with very small aluminum-rich and iron-rich grains. Very little alteration, with very thin coatings of aluminum- and iron rich-material, was observed.

SEM results indicated the solids collected from MW-13 are fine-grained quartz and feldspar grains, often coated with aluminum-rich and iron-rich material. Coatings contained a significant fraction of platy, clay-like grains that may represent clay minerals formed in place. Analysis also showed that iron nodules were in two forms: 1) spherical assemblages of sulfide nanoparticles; and 2) irregular, often roughly cylindrical assemblages of oxide nanoparticles. The oxide nanoparticles themselves were often needle-like or formed by linear assemblages of nanospheres. Arsenic was not detected in the iron oxide nanoparticles. SEM images (Figures 6a through 6c) indicate framboidal pyrite (an iron sulfide mineral) is present. Spectral analysis confirmed the pyrite composition, which was sequestering up to 0.3 weight percent arsenic. This is thought to be pyrite formed in place but could possibly be detrital pyrite weathering from the rock. The framboids in MW-13 appear to include both iron oxide and sulfide clusters in the sample, and arsenic is detectable (0.1 to 0.3 weight percent) in the sulfides, suggesting that natural attenuation and enhanced attenuation via sulfide sequestration would be viable under site conditions.

Based on the results from the XRF and XRD analyses and available sample volumes, samples were selected for SSE. SSE targets a series of operationally defined mineral fractions. In SSE, samples are leached with increasingly aggressive solutions to determine the chemical associations and mechanisms of attenuation. Generally, COIs released in each successive step represent stronger

sequestration and greater stability than the previous step. The fractions, from most to least environmentally available, are as follows:

- F1 – Water soluble
- F2 – Exchangeable (e.g., clay minerals)
- F3 – Reducible (e.g., poorly crystalline metal oxides such as iron oxides)
- F4 – Oxidizable (e.g., crystalline oxide and crystalline sulfide minerals)
- F5 – Residual (e.g., silicate phases)

The F4 and F5 fractions represent relatively stable (permanent) attenuating mechanisms, provided Site geochemical conditions do not change drastically.

Figure 7 shows the results of SSE for two samples from the ash pond, and Figure 8 shows the results for two samples from the landfills. Interpretation by COI includes the following:

- Arsenic – Bound primarily in the F4 (oxidizable) and F5 (residual) fractions, though some samples also show an association with the F2 (exchangeable) fraction. Arsenic associated with the F4 (oxidizable) fraction is consistent with the identification of iron sulfide minerals (framboidal pyrite) from the other investigations.
- Molybdenum – For the ash pond area, molybdenum is bound primarily in the F3 (reducible, poorly crystalline metal oxides) and F5 fractions, though some molybdenum is associated with the F2 (exchangeable) fraction. For the gypsum pond and landfill areas, molybdenum is bound primarily in the F4 (oxidizable) and F5 (residual) fractions, though some molybdenum is also associated with the F1 (water soluble) and F2 (exchangeable, clay mineral) fractions.
- Lithium – Most of the lithium data are below detection limits, which provides little information. The SSE detection limits for lithium are somewhat elevated due to small sample masses. Of the detectable lithium, all is bound in the F5 (residual) fraction.

Select samples with suspected clay content were submitted for CEC testing. CEC was variable in the samples, ranging from 33 to 487 milliequivalents per kilogram (Table 4). Exchangeable lithium was detected in downgradient well solids, indicating attenuation of lithium by cation exchange on clay minerals.

2.2 Geochemical Modeling

Geochemical equilibrium modeling was performed to help determine what phases may be controlling the solubility, mobility, and attenuation of arsenic, lithium, and molybdenum as well as the behavior of other species (such as iron, manganese, and aluminum) that influence the behavior of arsenic, lithium, and molybdenum.

The Geochemist's Workbench software was used to construct Pourbaix (Eh-pH) diagrams for COI, iron, and manganese based on Site groundwater chemistry, to assess the geochemical stability of

phases potentially controlling COI concentrations under Site conditions (Figures 9 through 15). The blue shaded fields indicate conditions under which dissolved/mobile species are predicted to be more stable, while yellow fields indicate conditions where solid phases are stable. Eh-pH data from Site groundwater wells are also plotted to determine the most stable forms under Site conditions. The Pourbaix stability diagrams indicate the following:

- Iron concentrations appear to be controlled by amorphous iron oxides [$Fe(OH)_{3(a)}$] (Figures 9 and 10). Iron oxides are strong sorbents for many metals and metalloids including arsenic and molybdenum.
- Arsenic is predominantly in the +5 valence state, and concentrations may be controlled by a barium arsenate mineral phase (Figures 11 and 12).
- Lithium is often associated with manganese oxides. In Figures 13 and 14, this association is represented by the stability field of the mineral lithiophorite [$(Al,Li)MnO_2(OH)_2$]. The thermodynamic properties of lithiophorite and other lithium-bearing manganese oxides are not well known, and the stability field is approximate. Site groundwater conditions appear to be too reducing to stabilize lithium in manganese oxides.
- Molybdenum (Ash Pond) concentrations do not appear to be controlled by any molybdenum minerals under site conditions (Figure 15).

Geochemical speciation-solubility calculations were also performed using PHREEQC with the WATEQ4F thermodynamic database (augmented with data for lithiophorite and molybdenum species from the MINTEQ database), to evaluate charge balance, calculate aqueous speciation, and determine the saturation state of groundwater samples with respect to possible mineral phases. Saturation index calculations can be useful in inferring potential solid phases present in an aquifer and controls on water chemistry and reactivity of an aqueous solution toward specific mineral phases. Geochemical modeling results indicate that groundwater is close to equilibrium with amorphous iron oxide [$Fe(OH)_{3(a)}$] and supersaturated with more crystalline iron oxides (goethite, hematite, and magnetite). The iron carbonate siderite is also close to equilibrium in most groundwater samples. Barite (barium sulfate) is close to equilibrium in all samples, and a barium arsenate phase is also predicted to be supersaturated in groundwater from ash pond wells. The mineral phase lithiophorite [$(Al,Li)MnO_2(OH)_2$] is supersaturated in samples with detectable aluminum and manganese. Groundwater samples appear to be undersaturated with respect to molybdate mineral phases. For samples with detectable aluminum, one or more clay minerals, including kaolinite, illite, and montmorillonite, are predicted to be stable.

In summary, geochemical modeling evaluations indicate the following:

- Arsenic concentrations are likely controlled by adsorption on iron oxides and possibly a barium arsenate phase.

- Lithium concentrations are likely controlled by cation exchange on manganese oxides and/or clay minerals.
- Molybdenum concentrations are likely controlled by adsorption on iron oxides.

These mineral associations are well documented in the scientific literature as attenuation mechanisms for arsenic, lithium, and molybdenum.

2.3 Geochemical Conceptual Site Model

The laboratory investigations described previously were integrated with geochemical modeling results to develop an initial geochemical CSM, including probable attenuating mechanisms for arsenic, lithium, and molybdenum, and the relative permanence of those mechanisms. The initial CSM for the Site is as follows:

- Multiple lines of evidence for arsenic, lithium, and molybdenum attenuation
- Suboxic, neutral to acidic groundwater conditions
- Redox buffered by iron oxide +/- carbonate equilibria
- Arsenic attenuation by sorption to iron oxides, incorporation in pyrite, and possibly precipitation of barium arsenate
- Lithium attenuation by cation exchange on clay minerals and/or incorporation in manganese oxides (e.g., lithiophorite)
- Molybdenum attenuation by adsorption to iron oxides

As supported by SSE results and the scientific literature, incorporation of arsenic into iron minerals, arsenic into barium arsenate, and lithium into manganese oxides are relatively stable attenuation mechanisms.

3 Planned Activities and Anticipated Schedule

The following conceptual-level feasibility study activities are planned for the next reporting period (January to June 2021) to evaluate MNA, geochemical manipulation, and possibly other corrective action technologies:

- Continue to compare site-specific corrective actions to the evaluation criteria in the CCR Rule, with emphasis on deficiencies that could eliminate a corrective action from further consideration
- Continue to determine how corrective actions could be integrated with pond closure, such as dewatering and associated water treatment systems
- Develop plans for additional Site investigations and associated laboratory work to determine MNA capacity, rates, and stability; and plans for laboratory treatability and/or field pilot tests to determine the effectiveness of geochemical manipulation as needed

Section 2 describes substantial evidence for the occurrence of natural attenuation at the Site. The EPA's four phases (or tiers) of MNA (EPA 2015) are as follows:

- Phase 1 – Demonstrate area of impacts (plume) is stable or shrinking
- Phase 2 – Determine mechanisms and rates of attenuation
- Phase 3 – Determine system capacity and stability
- Phase 4 – Design performance monitoring program and identify alternative remedies

The MNA work performed at the Site to date primarily supports Phase 2 (specifically mechanisms) of attenuation, though some information has been collected that supports all four phases. To advance MNA at the Site, additional work needs to be performed with respect to rate, aquifer capacity, and stability (permanence) of MNA.

Though substantial evidence for natural attenuation exists for the Site, natural attenuation is expected to increase as source control measures are implemented (i.e., dewatering, consolidation, and capping). MNA will almost certainly be one component, if not the only component, of corrective action. MNA could be implemented immediately upon pond closure.

The longer-term schedule for developing a corrective action system at the Site is as follows:

- Collect additional soil and/or rock samples and perform associated laboratory work to determine MNA capacity, rates, and stability (first and second quarters 2021)
- Perform laboratory treatability studies and implement field pilot tests as needed (second and third quarters 2021)
- Prepare a Remedy Selection Report (fourth quarter 2021)
- Develop a Corrective Action Groundwater Monitoring Program (fourth quarter 2021)

During the next reporting period, other potential remedies identified in the ACM will continue to be evaluated with respect to technical feasibility, ability to attain target standards, and ease of implementation. Based on the site-specific evaluation, additional studies may be implemented.

The schedule of activities above is considered typical and will be affected by the pond closure activities and schedule. For example, some of the activities could be performed sooner, to enable integration of corrective action with pond closure. Similarly, pond closure activities might delay implementation of some of the items above.

Pursuant to 40 CFR 257.97(a) and ADEM Admin. Code r. 335-13-15-.06(8)(a), semi-annual status progress reports will continue to be finalized in June and December until a final remedy plan is developed. Upon developing a final remedy plan, the Remedy Selection Report will be prepared describing the remedy plan and how it demonstrably meets the requirements of § 257.97 and r. 335-13-15-.06(8). Details regarding adaptive management triggers and criteria will be included in the Corrective Action Groundwater Monitoring Program.

Alabama Power will continue groundwater monitoring at the Site and submit the next *Semi-Annual Remedy Selection and Design Progress Report* by June 12, 2021.

4 References

Anchor QEA (Anchor QEA, LLC), 2019. *Assessment of Corrective Measures.* Plant Gorgas. Prepared for Alabama Power Company. June 2019.

Anchor QEA, 2020. *Assessment of Corrective Measures.* Plant Gorgas. Prepared for Alabama Power Company. February 2020.

EPA (U.S. Environmental Protection Agency), 2015. *Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites*. Office of Solid Waste and Emergency Response Directive 9283.1-36. August 2015.

Tables

Table 1
Lines of Evidence for Attenuation Mechanisms

Mechanism	Geochemical Modeling	XRF	XRD	SSE	CEC
Sorption on amorphous iron oxides (arsenic, molybdenum)	X	X	X	X	
Precipitation of arsenate and molybdate phases	X				
Cation exchange on clays (lithium)			X		X

Notes:

CEC: cation exchange capacity

SSE: selective sequential extraction

XRD: X-ray diffraction

XRF: X-ray fluorescence

Table 2
Bulk Chemistry of Well Solids Samples by XRF

Unit	Well ID	Arsenic	Molybdenum	Iron	Manganese	Aluminum	Calcium	Magnesium	Potassium	Silicon	Phosphorus	Sulfur
Ash Pond	GS-AP-MW-8	133	1	3,690	ND	3,030	1,190	ND	393	26,700	8,420	295
	GS-AP-MW-6D	23	15	351	ND	22,000	1,750	ND	194	221,000	4,460	2,570
	GS-AP-MW-7	11	2	212	ND	4,570	8,630	ND	79	231,000	3,080	996
	GS-AP-MW-12	10	10	219	ND	5,220	214,000	12,900	128	95,500	1,860	584
	GS-AP-MW-18	27	25	438	ND	26,100	65,200	10,100	326	150,000	3,430	4,000
Gypsum Pond	GS-GSA-MW-3	30	6	417	ND	34,400	3,940	ND	388	139,000	3,620	3,750
	GS-GSA-MW-4	31	12	362	ND	28,200	1,810	ND	347	148,000	3,270	2,200
Landfills	MW-1	15	25	298	3,640	12,500	954	ND	194	192,000	3,120	611
	MW-2	7	10	263	ND	12,800	1,340	ND	161	216,000	6,790	880
	MW-3	15	11	255	ND	19,600	1,070	ND	209	178,000	3,360	4,170
	MW-4	16	11	425	ND	27,200	1,420	5,440	354	159,000	3,230	445
	MW-13	19	13	317	ND	20,800	1,150	ND	249	180,000	3,140	5,620
	MW-14	19	17	292	ND	20,600	1,260	ND	240	166,000	2,990	7,550
	MW-6	27	17	353	ND	22,100	1,690	ND	297	221,000	3,960	2,430
	MW-12	69	60	347	ND	17,300	1,460	ND	231	201,000	3,280	2,030

Notes:
Direct analysis of lithium is not possible with portable XRF due to X-ray physics limitations.
Units are in milligrams per kilogram.
ND: below limit of detection
XRF: X-ray fluorescence

Table 3

Minerals Identified in Well Solids Samples by XRD[1]

Unit	Well ID	Quartz	Albite	Orthoclase	Kaolinite	Muscovite-Illite	Montmorillonite	Vermiculite	Zeolite	Calcite	Ferrihydrite	Iron Phosphate
Ash Pond	GS-AP-MW-8	--	--	--	--	--	--	--	--	--	27	73
	GS-AP-MW-6D	99.6	--	--	--	--	0.1	--	0.3	--	--	--
	GS-AP-MW-7	98.8	--	--	--	--	0.1	--	0.1	0.9	--	--
Gypsum Pond	GS-GSA-MW-4	36.8	--	--	--	61.0	--	0.2	2.0	--	--	--
Landfills	MW-2	33	5.0	--	16	45.3	--	0.8	--	--	--	--
	MW-3	27.2	--	--	19.7	52.9	--	0.2	--	--	--	--
	MW-4	42.6	3.9	--	4.7	48.6	--	0.2	--	--	--	--
	MW-13	46.3	--	--	16.5	37.0	--	0.2	--	--	--	--
	MW-12	57.8	--	--	13.9	28.3	--	--	--	--	--	--

Notes:

1: Estimated concentration (weight %) reported where available

--: not detected

XRD: X-ray diffraction

Table 4
Cation Exchange Capacity of Well Solids Samples

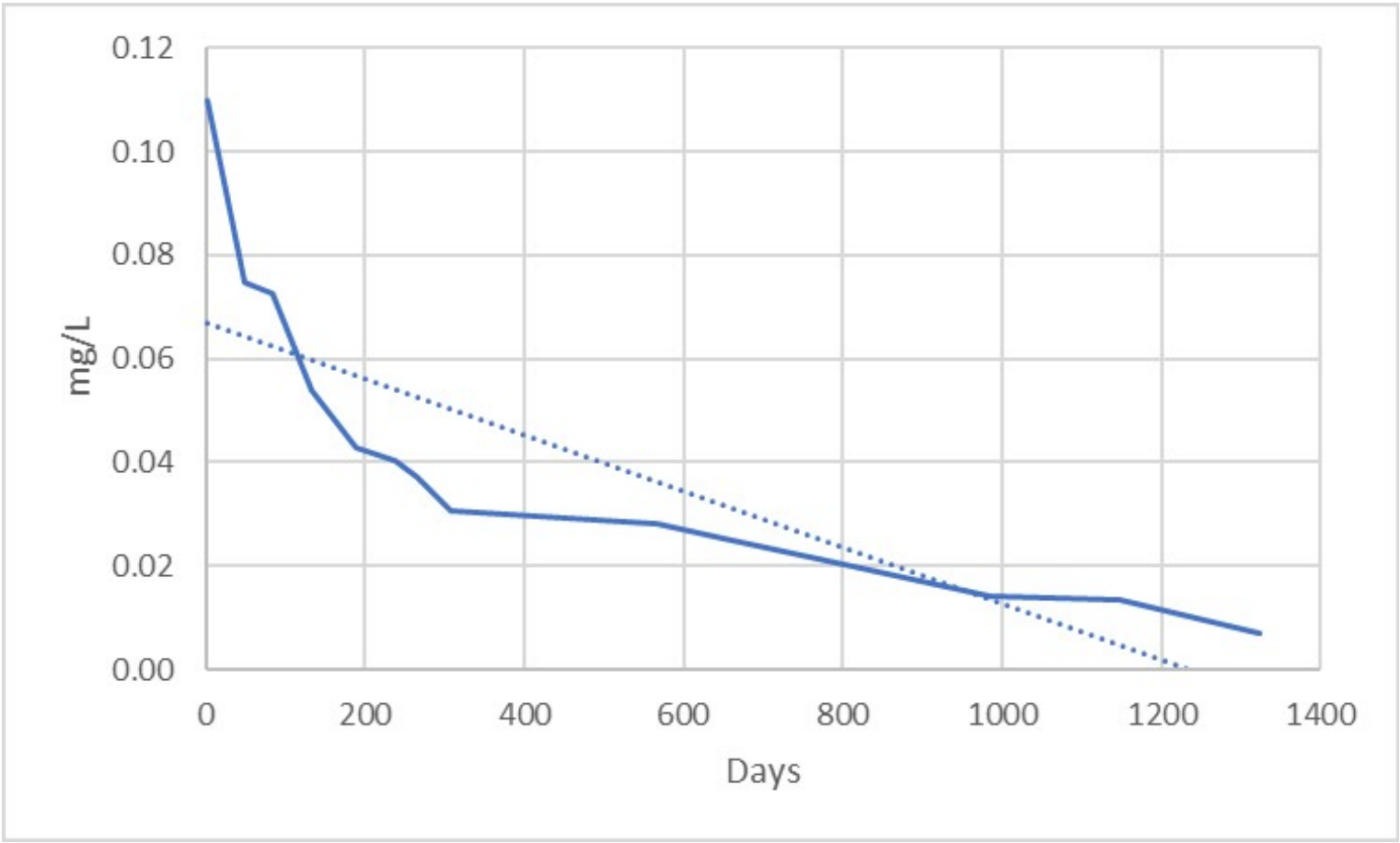
Unit	Well ID	Calcium	Magnesium	Potassium	Sodium	Lithium	Boron	Sum
Ash Pond	GS-AP-MW-6D	21	7.2	2.6	2.7	0.098	0.18	33
	GS-AP-MW-7	230	5.4	1.2	2.1	0.094	0.19	239
Gypsum Pond	GS-GSA-MW-3	310	150	8.4	19	0.21	0.34	487
Landfills	MW-13	120	150	7.4	3.9	<0.1	<0.08	282

Notes:

Concentrations are in milliequivalents per kilogram.

<: Indicates the compound was analyzed for but not detected

Figures



Note:
mg/L: milligrams per liter

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Figure 1
Arsenic Concentration Versus Time in GS-AP-MW-12
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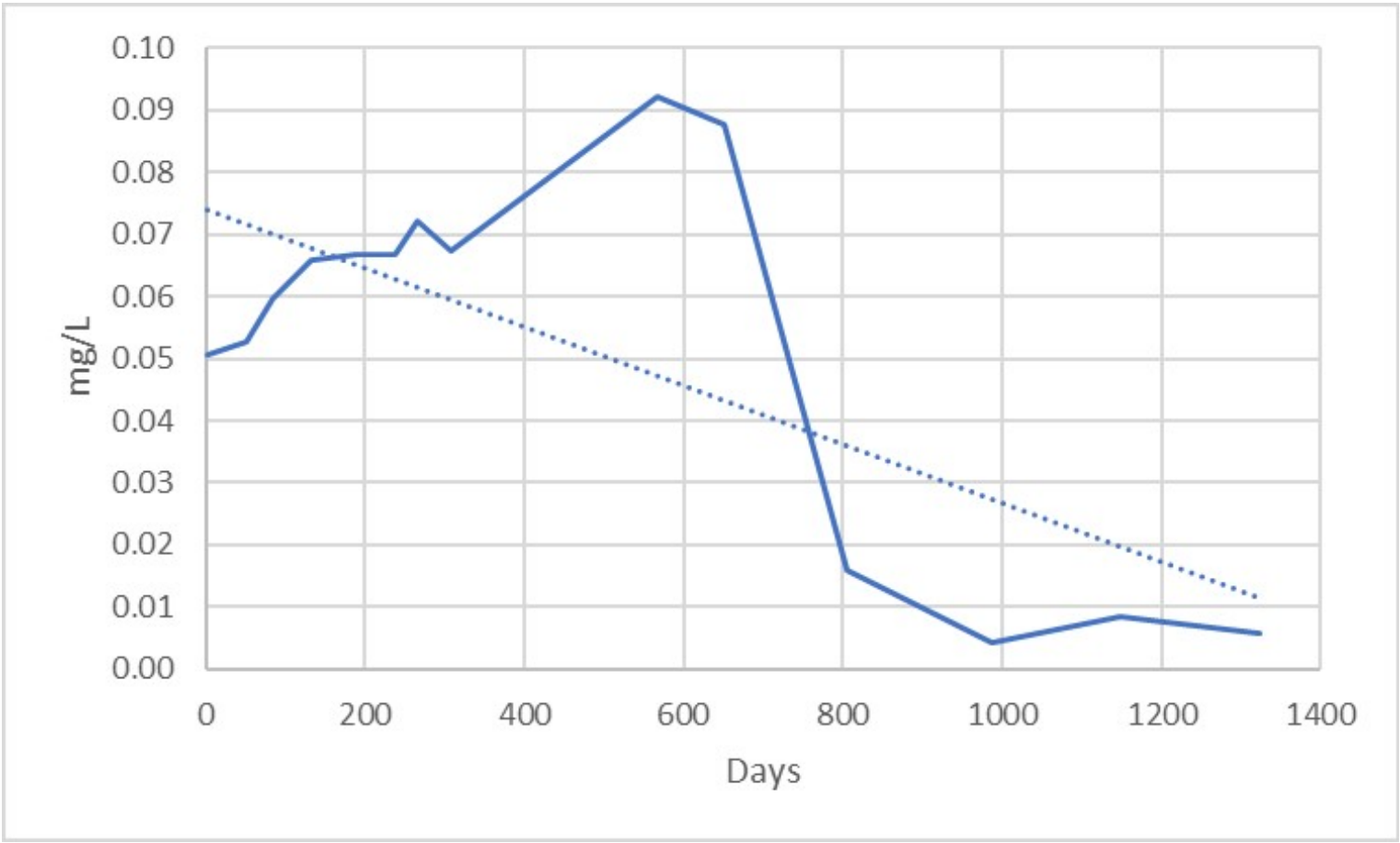

Note:
mg/L: milligrams per liter

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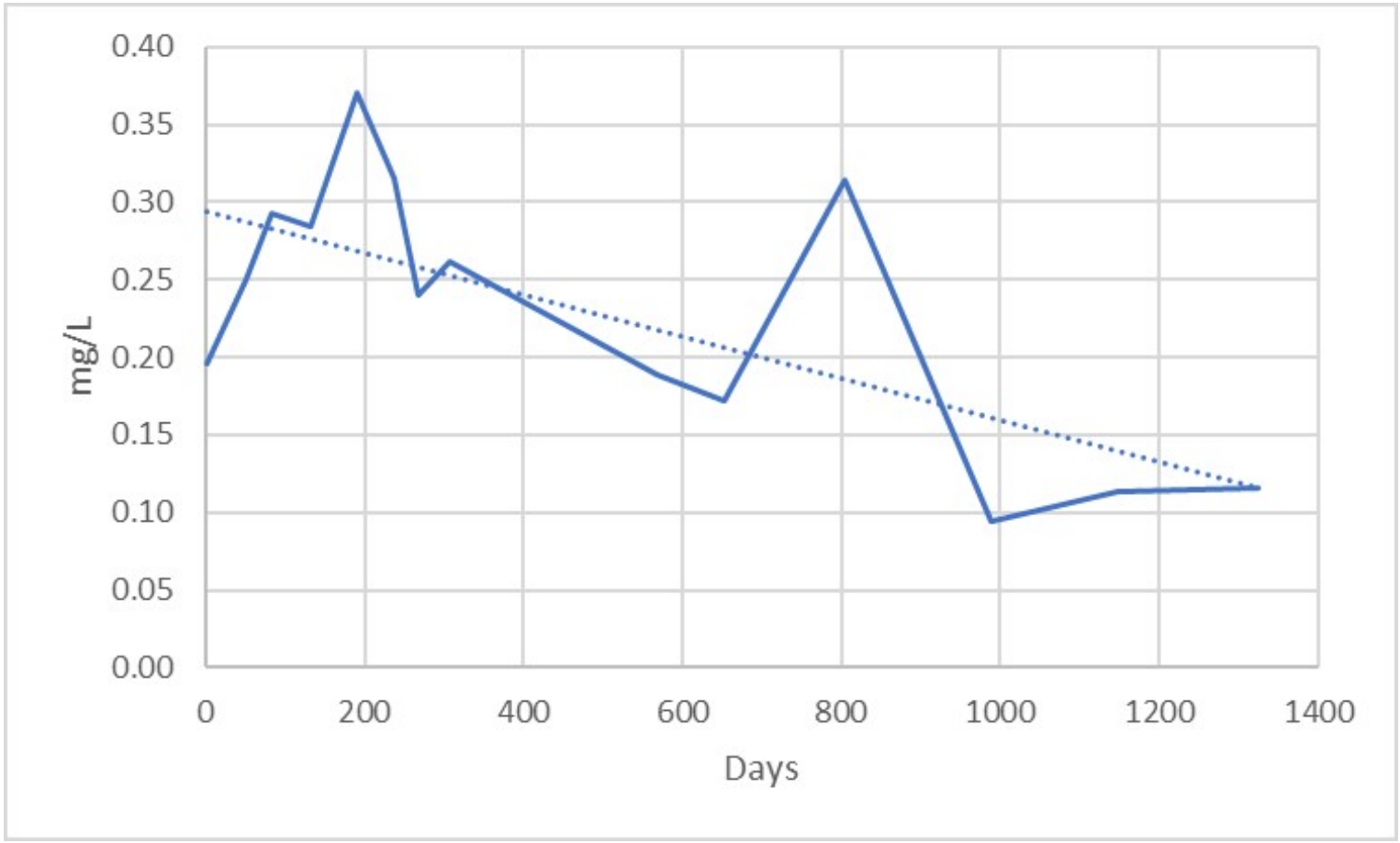
Figure 2
Arsenic Concentration Versus Time in GS-AP-MW-18
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
mg/L: milligrams per liter

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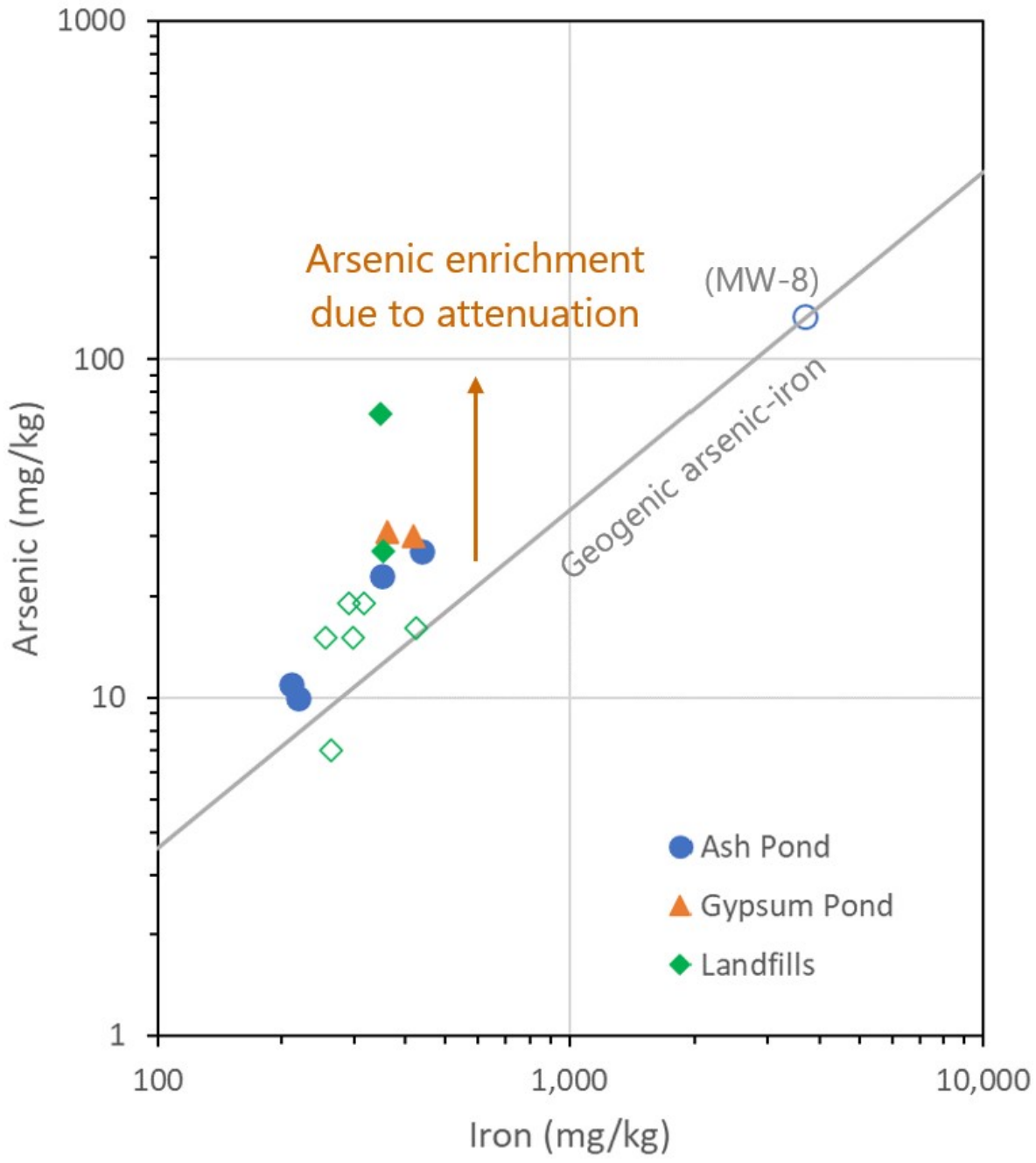
Figure 3
Lithium Concentration Versus Time in GS-AP-MW-18
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Notes:
Open markers indicate upgradient wells.
mg/kg: milligrams per kilogram

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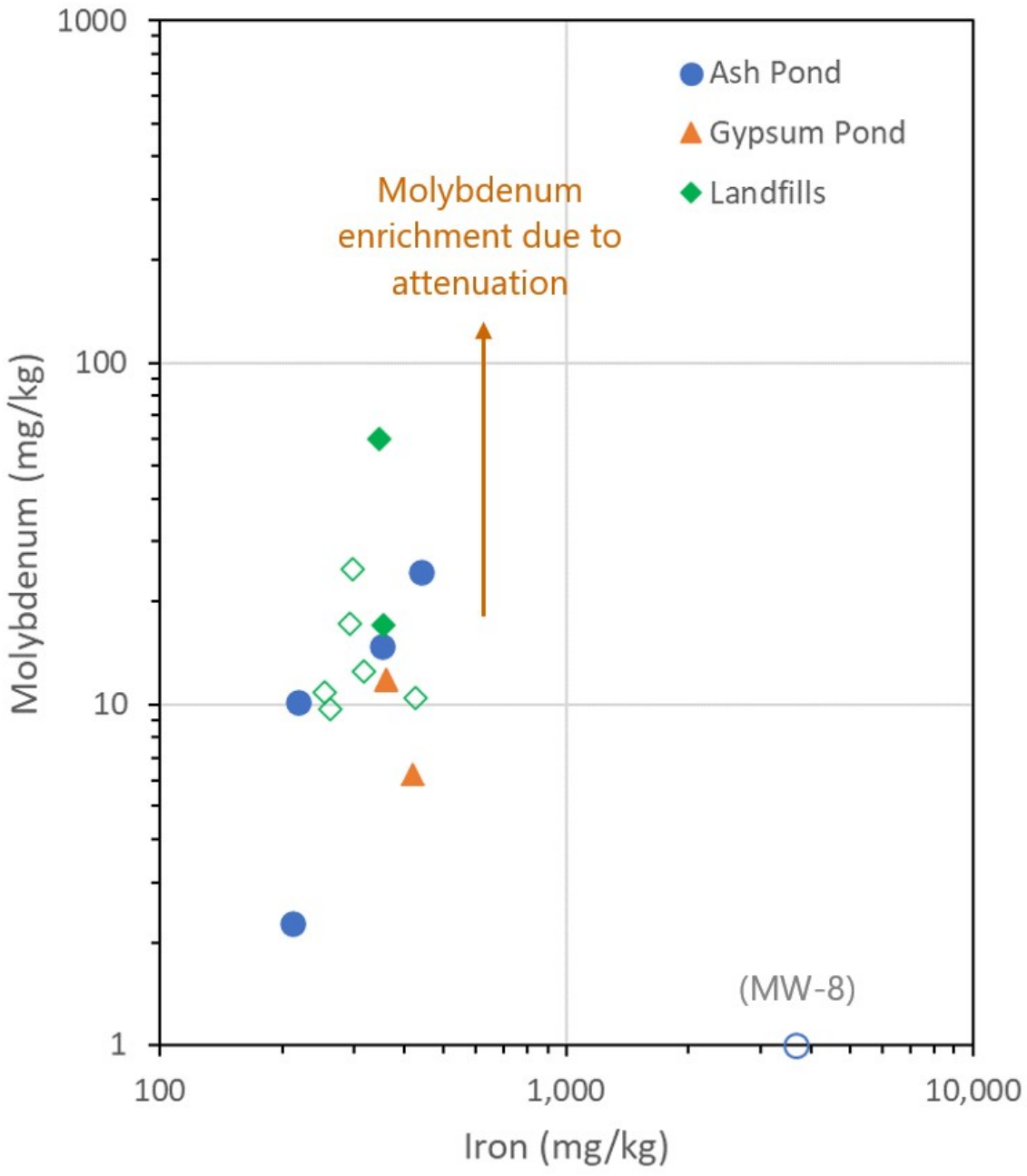
Figure 4
Bulk Chemistry Relationship Between Arsenic and Iron
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Notes:
Open markers indicate upgradient wells.
mg/kg: milligrams per kilograms

Filepath: \\Athena\Mobile\Projects\Southern Company\Alabama Power ACMs - PRIVILEGED & CONFIDENTIAL\Progress Reports\3 - Dec 2020\Gorgas\Figures\Figure 5_Gorgas Mo Bulk Solids.docx

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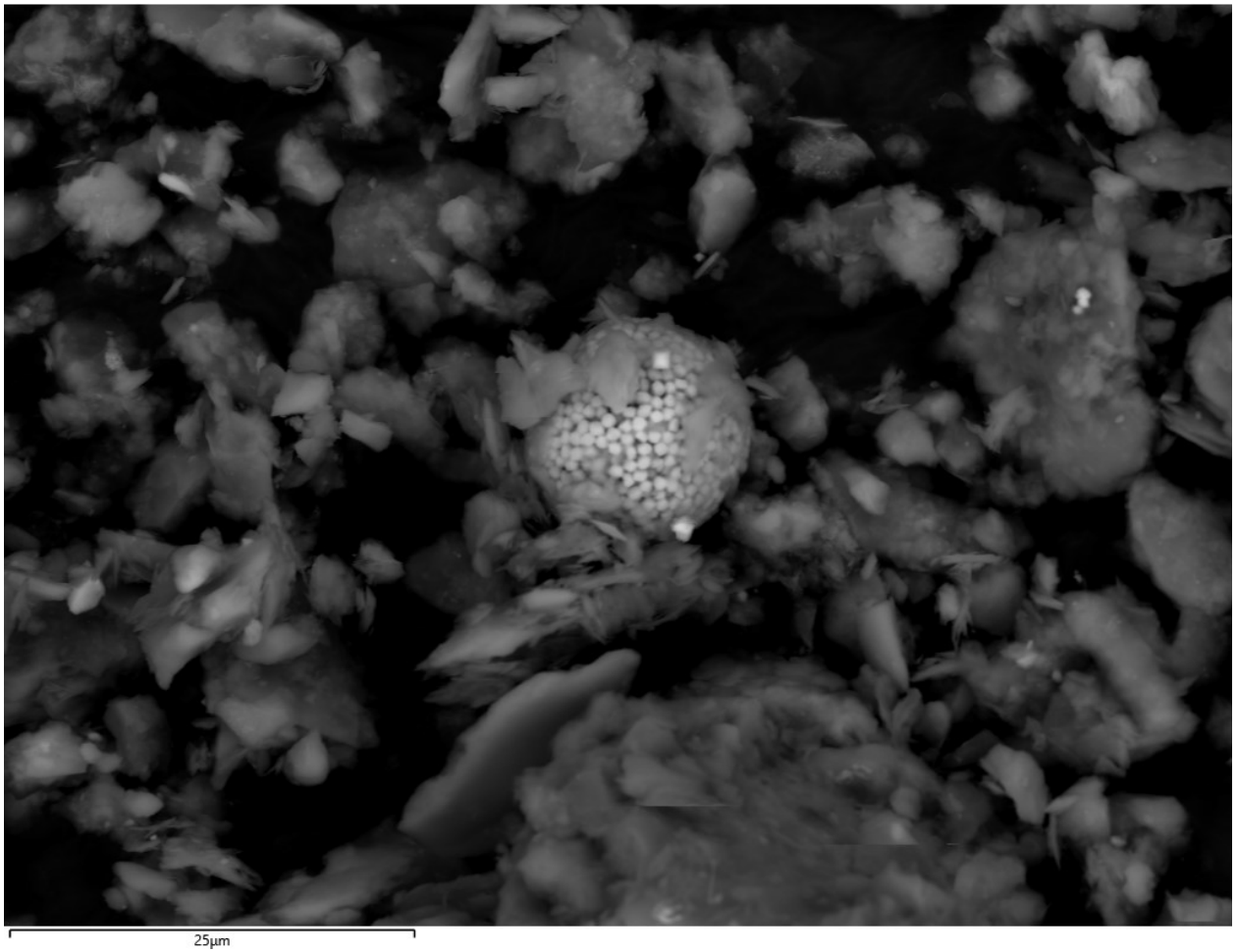
Figure 5
Bulk Chemistry Relationship Between Molybdenum and Iron
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
µm: micron

Filepath: \\Athena\Mobile\Projects\Southern Company\Alabama Power ACMs - PRIVILEGED & CONFIDENTIAL\Progress Reports\3 - Dec 2020\Gorgas\Figures\Figure 6a_SEM (MW-13 area 1).docx

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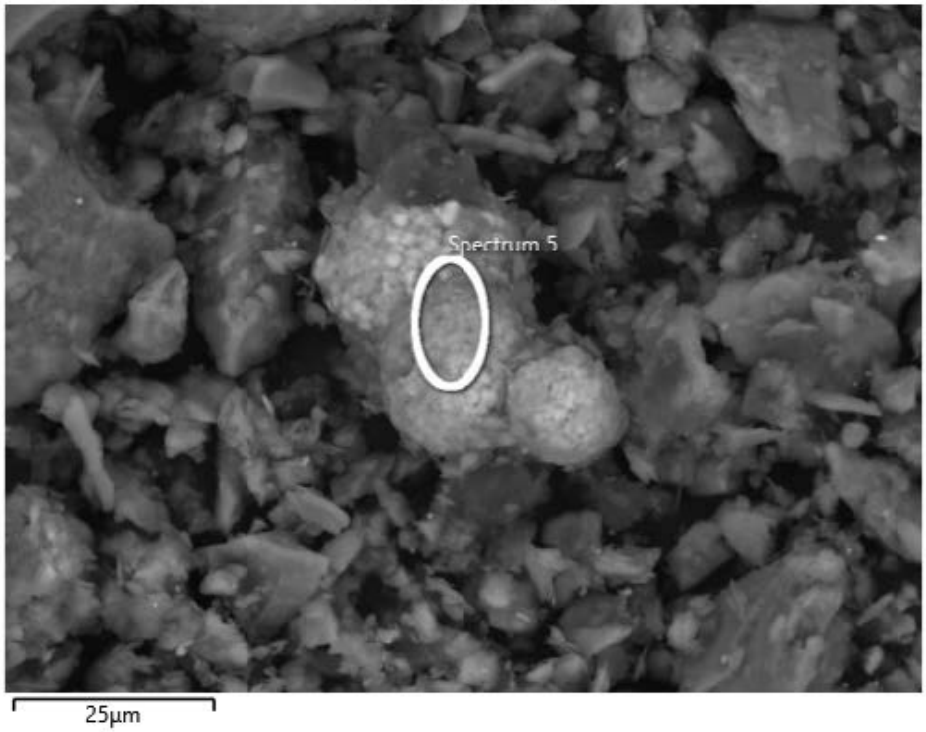
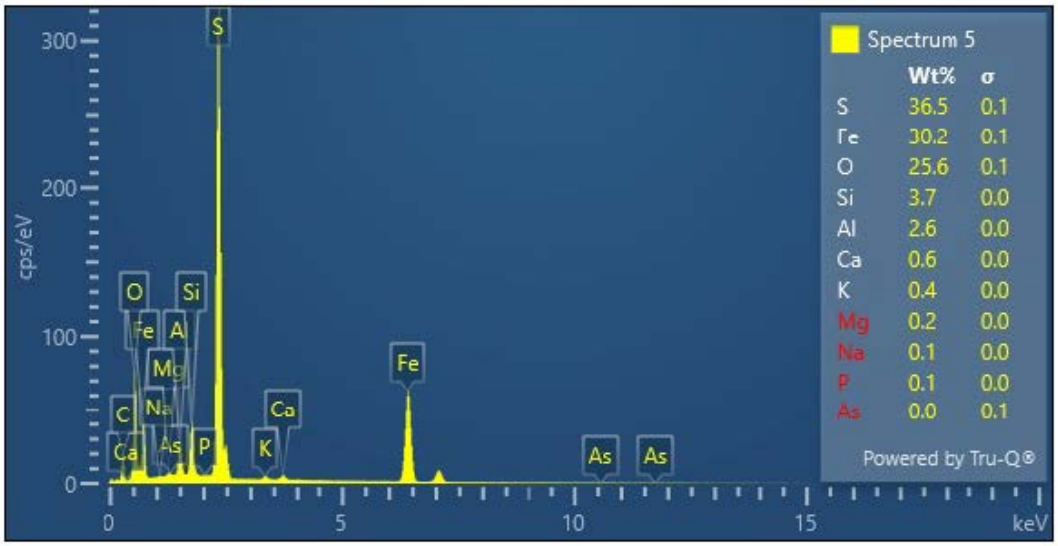
Figure 6a
SEM Results for MW-13 (Area 1)
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas





Notes:
µm: micron
cps/eV: counts per second per electron-volt

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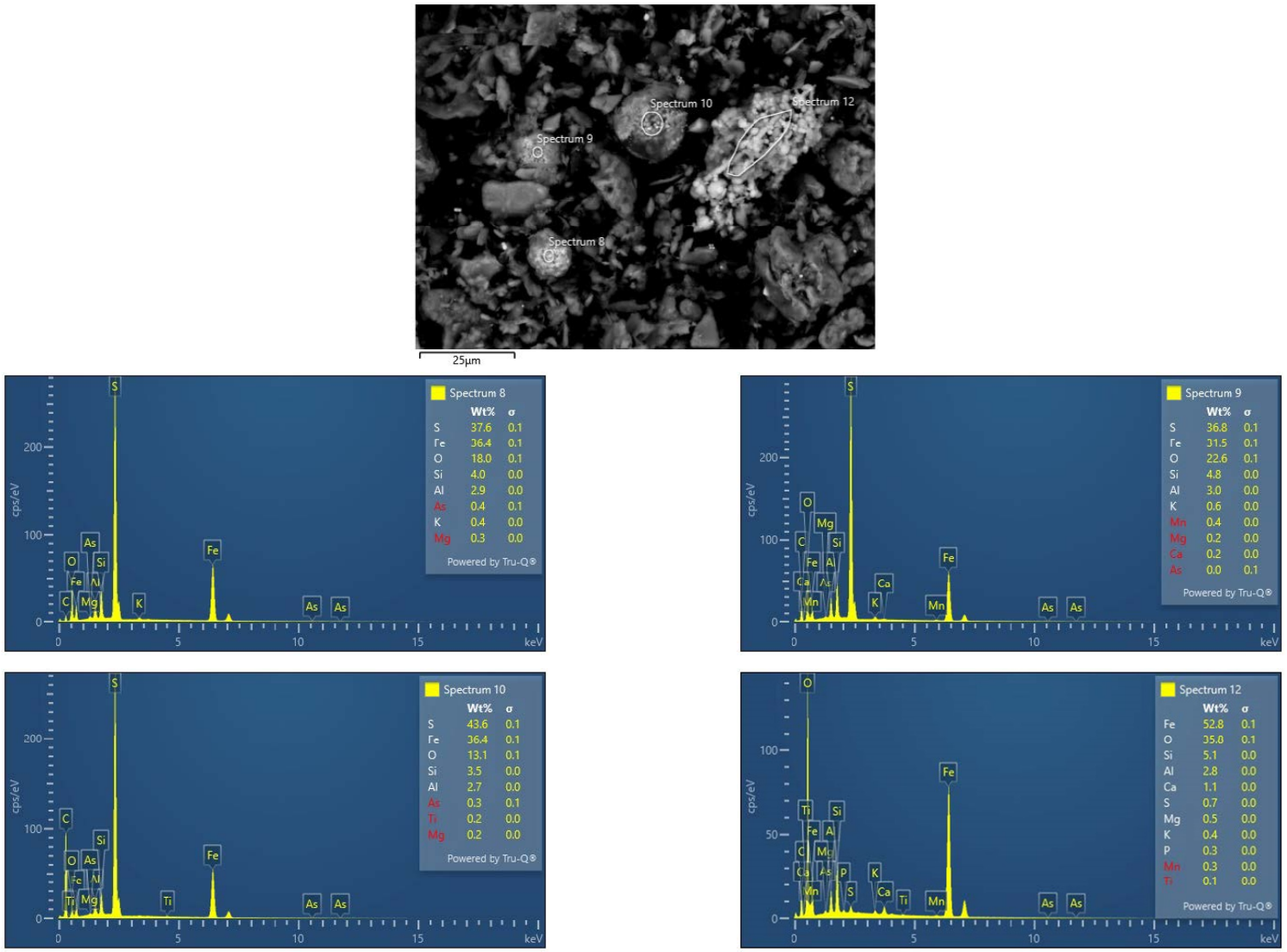
Figure 6b
SEM Results and Associated Spectrum for MW-13 (Area 2)
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Notes:
µm: micron
cps/eV: counts per second per electron-volt

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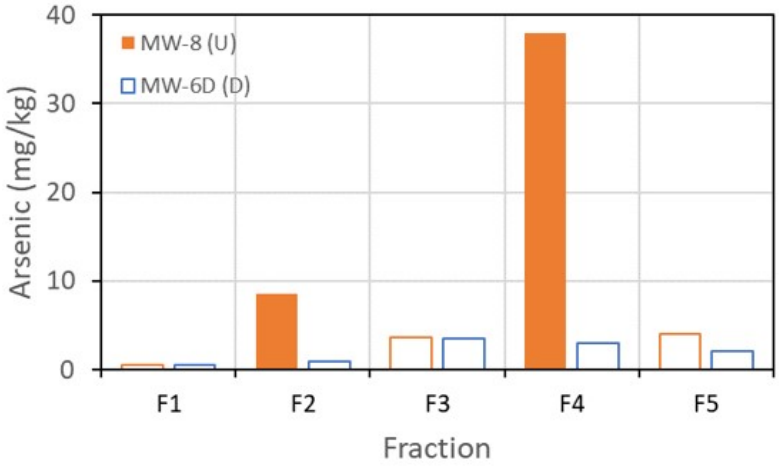
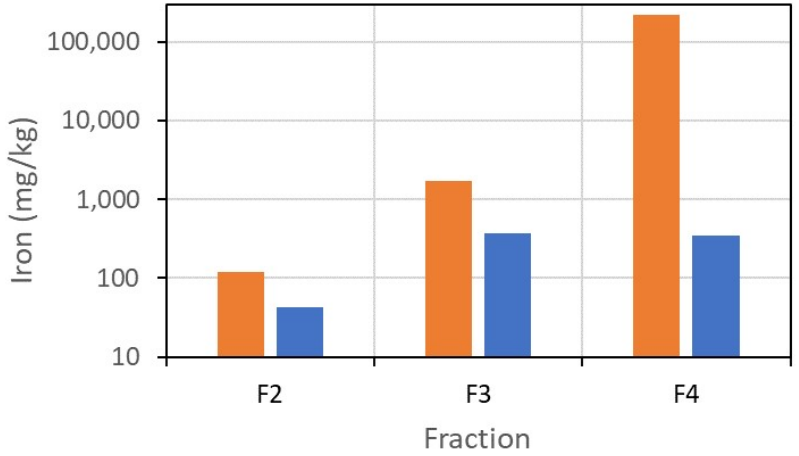
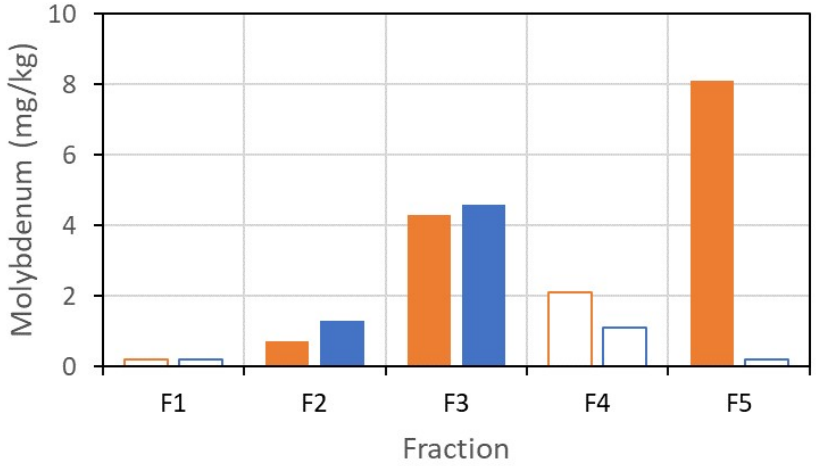
Figure 6c
SEM Results and Associated Spectra for MW-13 (Area 3)
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas







Notes:
Non-detect results shown as unfilled bars plotted at detection limit.
mg/kg: milligrams per kilogram
F1 – Water soluble
F2 – Exchangeable (e.g., clay minerals)
F3 – Reducible (e.g., poorly crystalline metal oxides such as iron oxides)
F4 – Oxidizable (e.g., crystalline oxide and crystalline sulfide minerals)
F5 – Residual (e.g., silicate phases)

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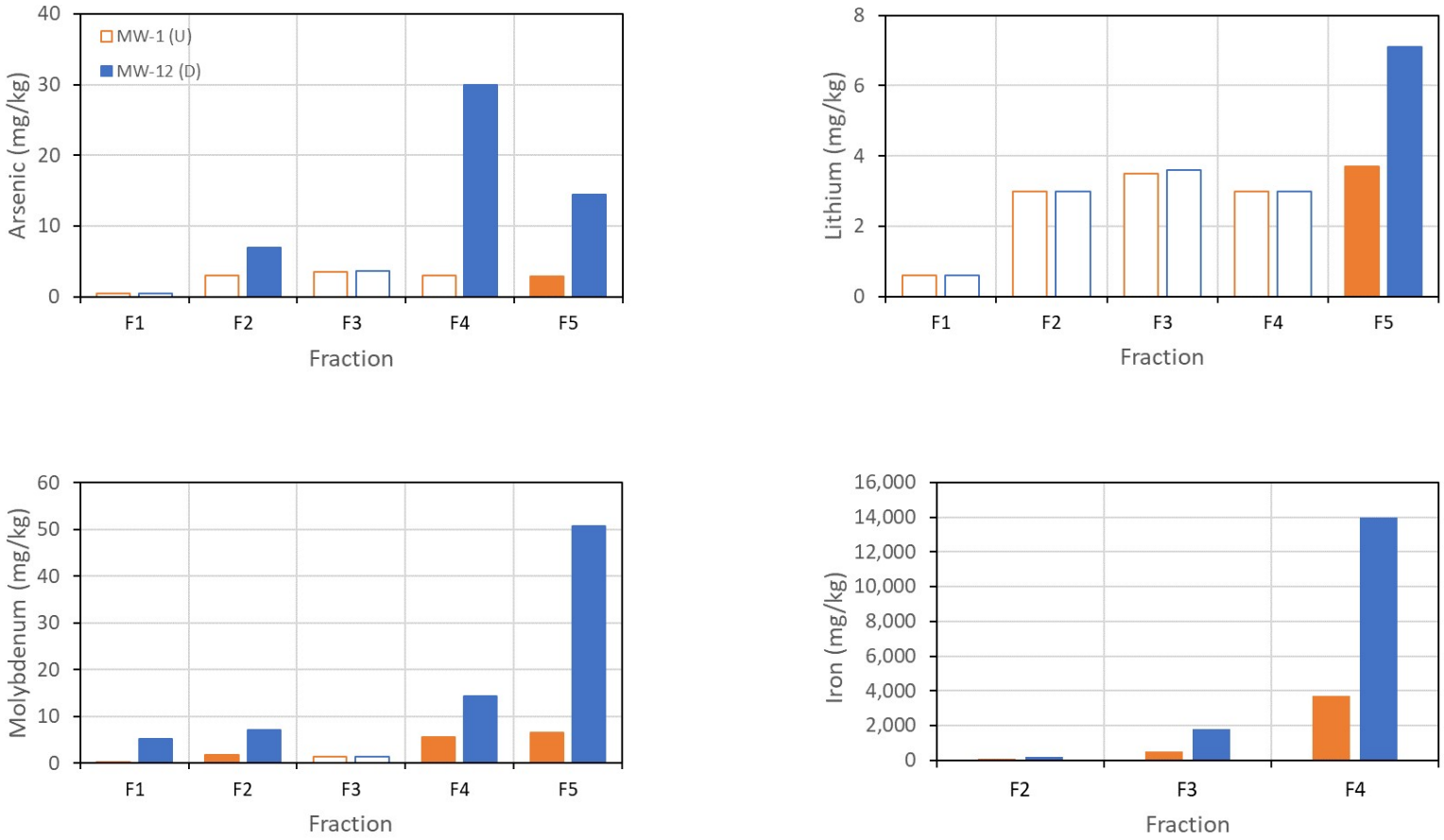
Figure 7
SSE Results for Well Solids – Ash Pond
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Notes:
Non-detect results shown as unfilled bars plotted at detection limit.
mg/kg: milligrams per kilogram
F1 – Water soluble
F2 – Exchangeable (e.g., clay minerals)
F3 – Reducible (e.g., poorly crystalline metal oxides such as iron oxides)
F4 – Oxidizable (e.g., crystalline oxide and crystalline sulfide minerals)
F5 – Residual (e.g., silicate phases)

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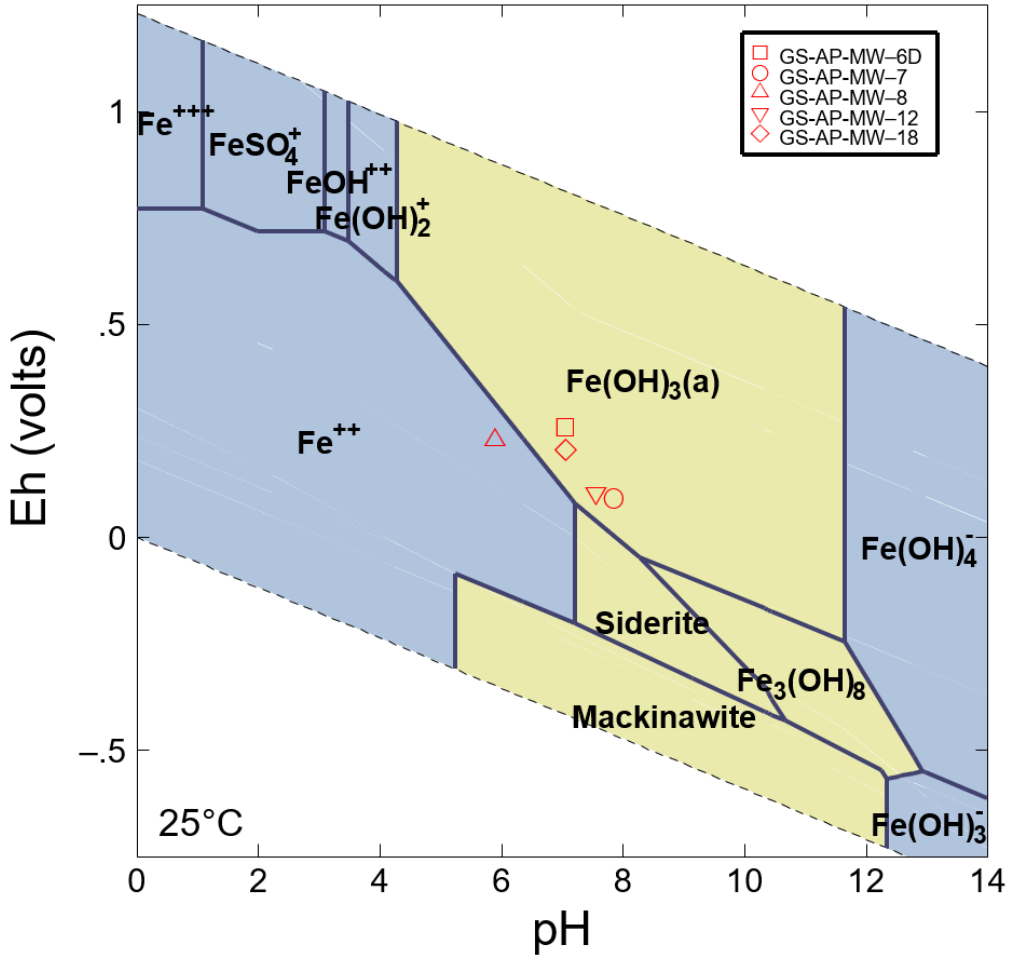
Figure 8
SSE Results for Well Solids – Gypsum Pond and Landfills
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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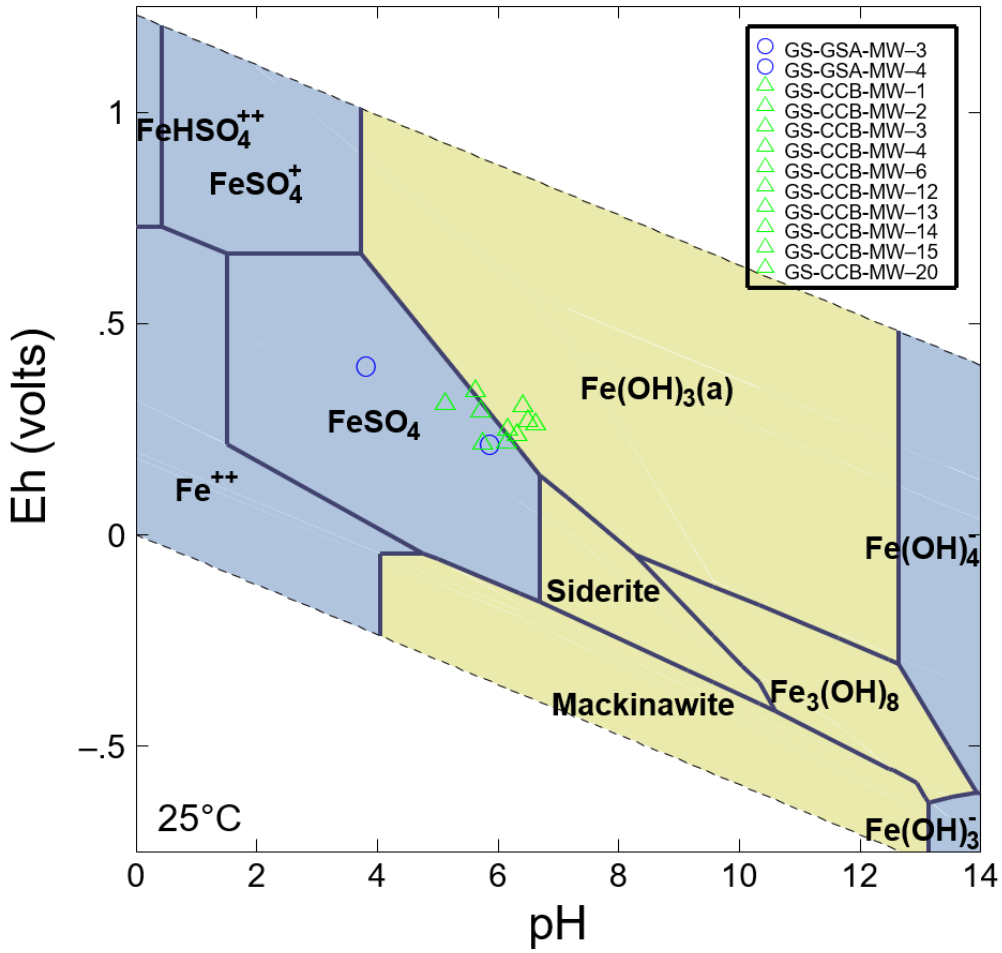
Figure 9
Eh-pH Stability Diagram for Dissolved and Solid Iron Phases – Ash Pond
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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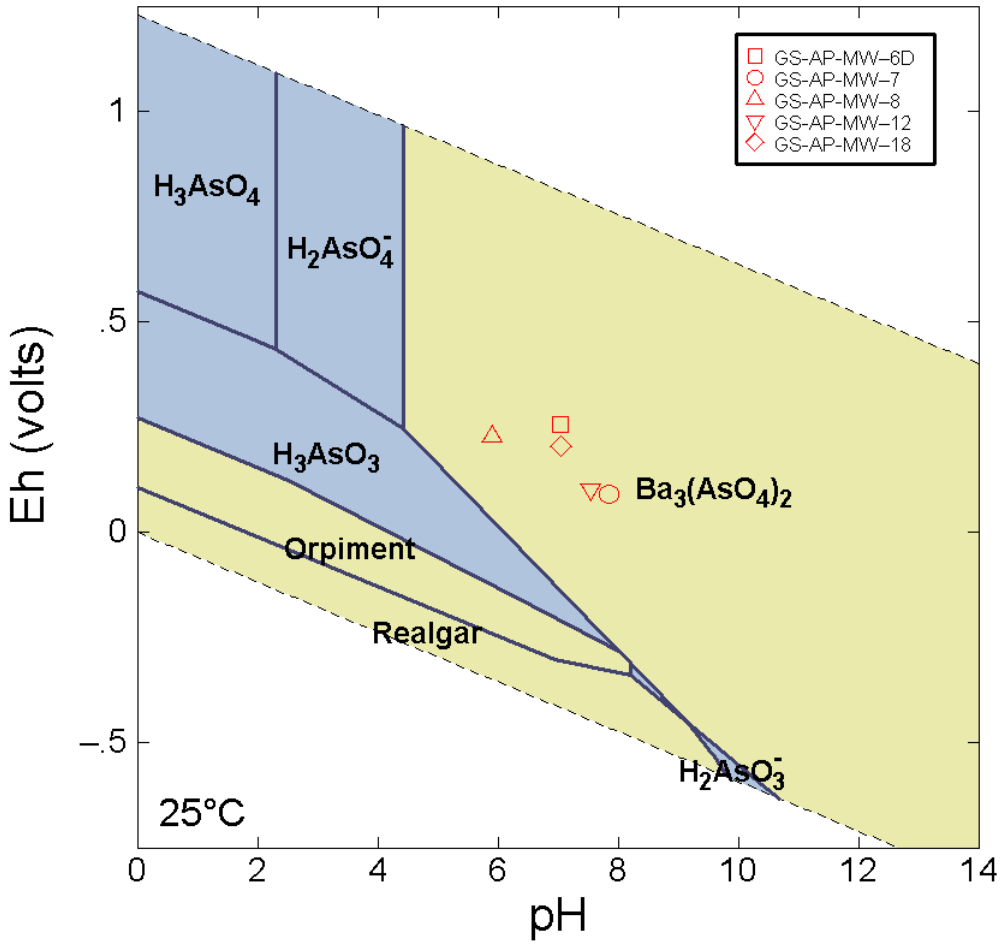
Figure 10
Eh-pH Stability Diagram for Dissolved and Solid Iron Phases – Gypsum Pond and Landfills
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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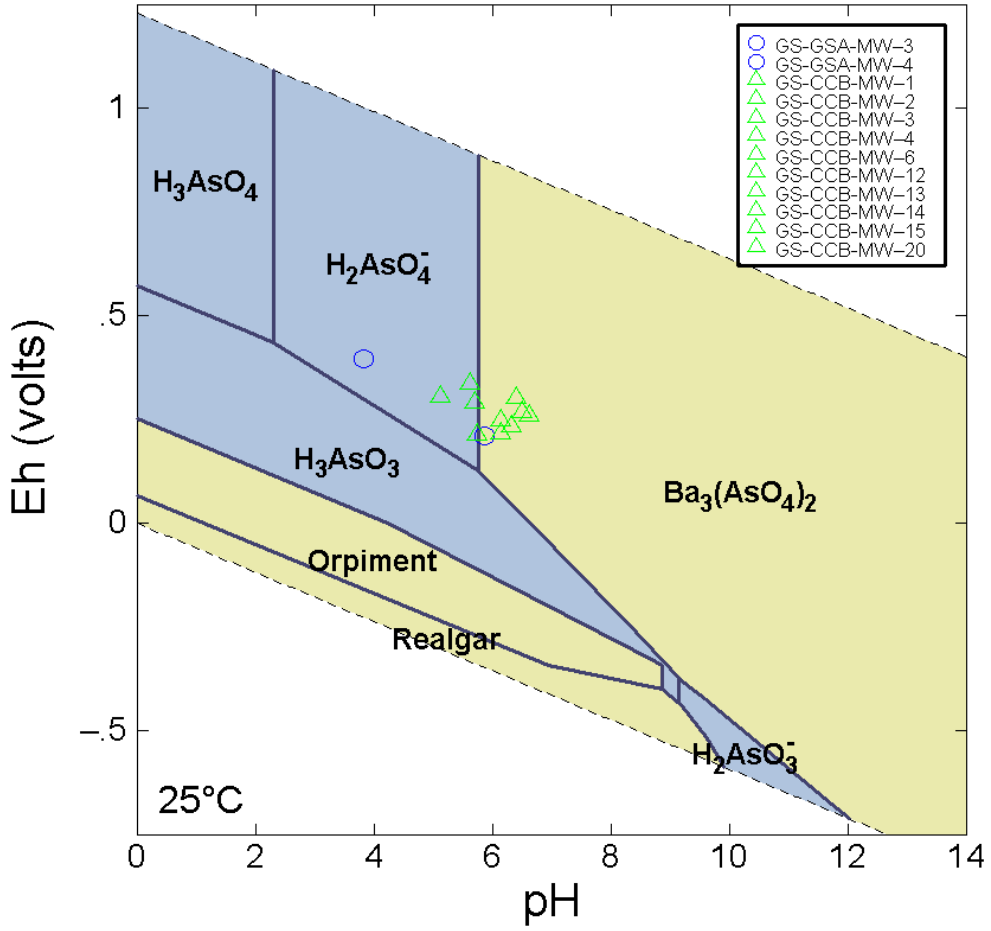
Figure 11
Eh-pH Stability Diagram for Dissolved and Solid Arsenic Phases – Ash Pond
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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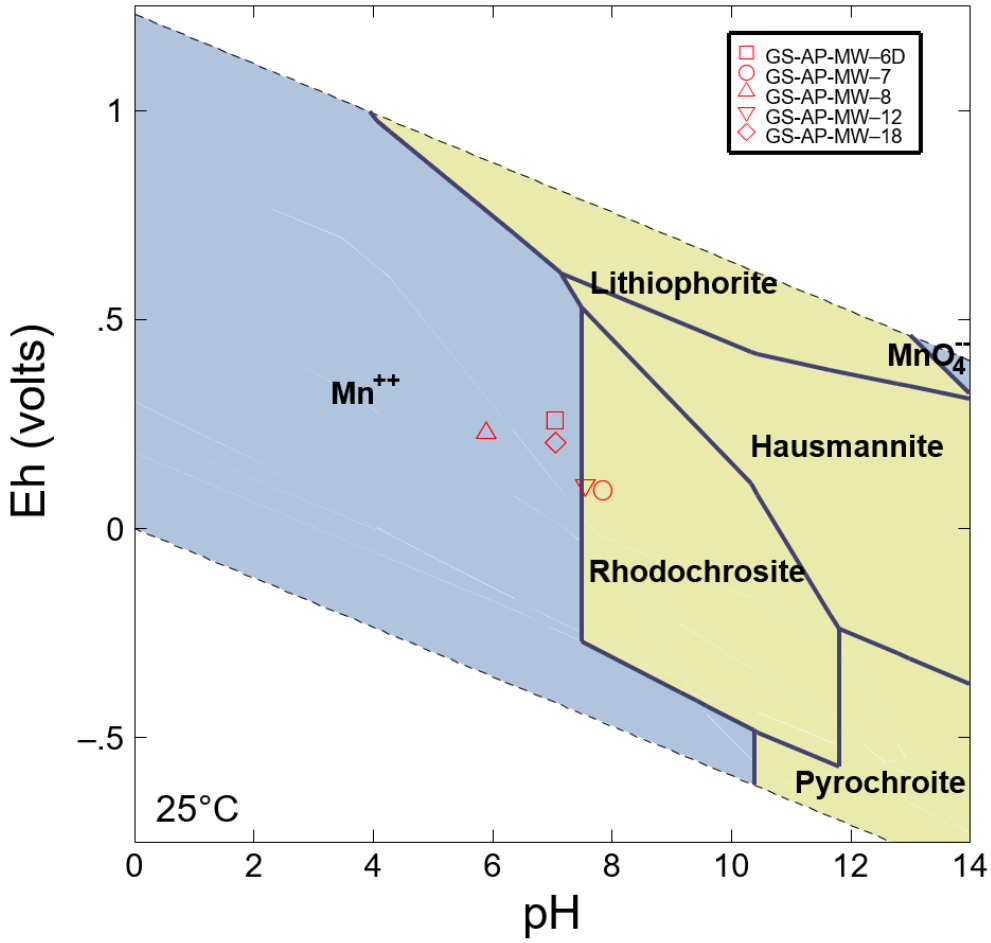
Figure 12
Eh-pH Stability Diagram for Dissolved and Solid Arsenic Phases – Gypsum Pond and Landfills
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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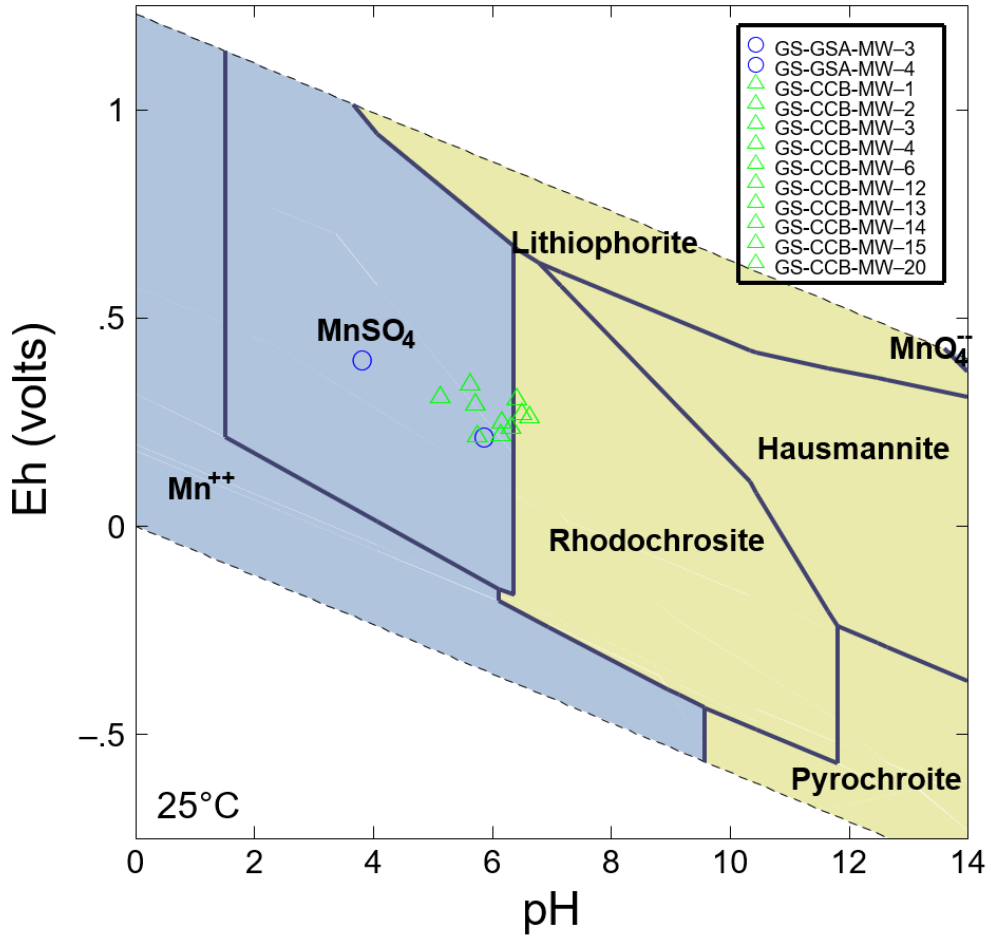
Figure 13
Eh-pH Stability Diagram for Dissolved and Solid Manganese Phases – Ash Pond
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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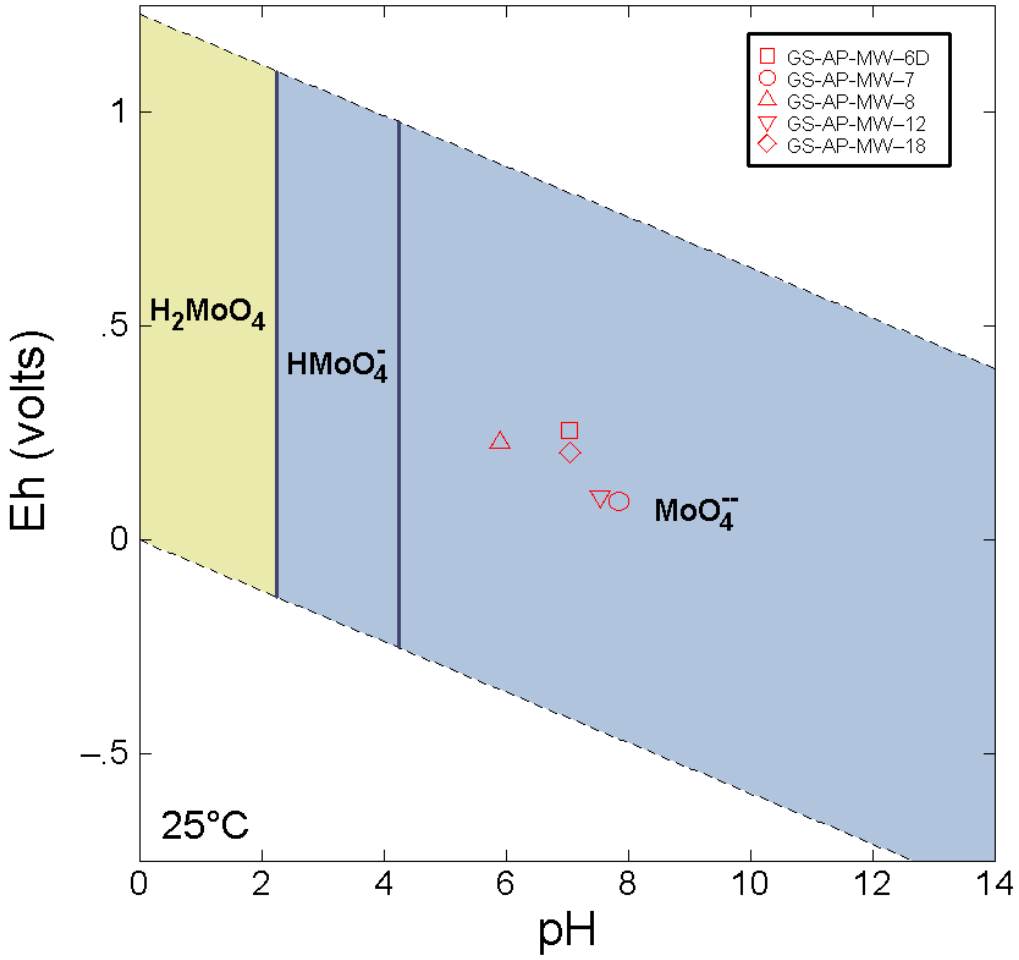
Figure 14
Eh-pH Stability Diagram for Dissolved and Solid Manganese Phases – Gypsum Pond and Landfills
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas



Note:
Blue fields indicate dissolved/mobile species. Yellow fields indicate solid/attenuated species.

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Figure 15
Eh-pH Stability Diagram for Dissolved and Solid Molybdenum Phases – Ash Pond
Semi-Annual Remedy Selection and Design Progress Report
Plant Gorgas