



*Prepared for*

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**ASSESSMENT OF CORRECTIVE  
MEASURES  
PLANT WATSON FORMER CCR UNIT**

*Prepared by*

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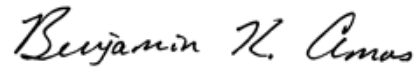
August 2020

## ASSESSMENT OF CORRECTIVE MEASURES

Plant Watson  
Former CCR Unit

August 2020

Prepared by:



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## LIST OF ACRONYMS

ACM	Assessment of Corrective Measures
ASD	Alternate Source Demonstration
CCR	coal combustion residuals
CFR	Code of Federal Regulations
cm/sec	centimeters per second
EPRI	Electric Power Research Institute
ft	feet
ft bgs	feet below ground surface
ft MSL	feet below mean sea level
GWPS	Groundwater Protection Standard
ISCO	In-situ chemical oxidation
ISCR	In-situ chemical reduction
LLDPE	linear low-density polyethylene
MDEQ	Mississippi Department of Environmental Quality
MNA	monitored natural attenuation
NELAP	National Environmental Laboratory Accreditation Program
NPDES	National Pollution Discharge Elimination System
O&M	operations and maintenance
P&T	pump and treat
PRB	permeable reactive barriers
SSL	statistically significant level
TDS	total dissolved solids
UIC	underground injection control
US EPA	United States Environmental Protection Agency
ZVI	zero-valent iron

## 1.0 INTRODUCTION

In accordance with the United States Environmental Protection Agency (US EPA) coal combustion residuals (CCR) rule [40 Code of Federal Regulations (CFR) Part 257, Subpart D] and the Agreed Order (number 7010 19, effective December 23, 2019) between the Mississippi Commission on Environmental Quality acting through the Mississippi Department of Environmental Quality (MDEQ) and Mississippi Power Company (Mississippi Power), Geosyntec Consultants, Inc. (Geosyntec) has prepared this *Assessment of Corrective Measures (ACM)* for Mississippi Power's Plant Jack Watson Electric Generating Plant former CCR Unit.

Pursuant to 40 CFR 257.96 and the Agreed Order, this ACM evaluates potential groundwater corrective measures to address statistically significant levels (SSLs) of arsenic, combined radium, lithium, and molybdenum identified in the *2020 Groundwater Monitoring Report* (Southern Company Services, 2020a). These are the constituents for groundwater corrective measures presented in this ACM. Although an SSL of barium was also identified at the former CCR Unit, an alternate source demonstration (ASD) was completed for barium (Geosyntec, 2020a); therefore, barium was not considered in this ACM. An ASD for combined radium has been initiated and is currently ongoing.

The ACM was initiated on March 15, 2020, within 90 days of identifying the SSLs on January 13, 2020. A 60-day extension until August 11, 2020 for completion of the ACM was documented on June 12, 2020. This ACM is the first step in identifying viable corrective measures to address SSLs in groundwater at the former CCR Unit. Based on the results of the ACM, further evaluation may be performed, additional studies completed that are specific to the former CCR Unit, and a remedy selected and implemented pursuant to 40 CFR 257.97 and 257.98.

Completing a final long-term corrective action frequently takes several years. Therefore, corrective measures presented herein can be applied as warranted based on former CCR Unit conditions during closure monitoring and while implementing a long-term corrective action strategy to meet remedial objectives at the former CCR Unit.

### 1.1 Purpose

The purpose of this ACM is to begin the process of selecting corrective measure(s) for groundwater at the former CCR Unit. This process is typically iterative and may be

composed of multiple steps to analyze the effectiveness of corrective measures to address the potential migration of CCR constituents in groundwater at the former CCR Unit.

Once potential corrective measures were identified, they were further evaluated using the criteria outlined in 40 CFR 257.96(c), which states that corrective measures assessment should include an analysis of the following:

- Performance;
- Reliability;
- Ease of implementation;
- Potential impacts;
- The time required to begin and complete the remedy; and
- Any institutional requirements that could affect implementation of the remedy.

These evaluation criteria, discussed in more detail in the following sections, were considered for each potential remedy.

### **1.1.1 Performance**

Factors taken into consideration when evaluating the performance of a remedy include the degree to which the remedy removes released Appendix IV constituents from the environment and the ability of the remedy to achieve groundwater protection standards (GWPS) at compliance boundaries.

### **1.1.2 Reliability**

Reliability includes the following: (i) the type and degree of long-term management (e.g., monitoring, operations, and maintenance) of a remedy; (ii) the reliability of the engineering and institutional controls to maintain the effectiveness of the remedy; (iii) the potential need for replacement; or (iv) any other operational reliability considerations that may arise for the remedy that will influence its use or effectiveness in meeting the corrective action objectives.

### **1.1.3 Ease of Implementation**

Ease of implementation includes the degree of difficulty associated with installing or constructing a remedy due to conditions at the former CCR Unit. This includes the following: (i) the need to obtain necessary approvals and/or permits from other agencies; (ii) the availability of necessary equipment or specialists to implement the remedy; and (iii) the available capacity and location of treatment, storage, or disposal services, if needed.

### **1.1.4 Potential Impacts of the Remedy**

Potential impacts of a remedy include the following: (i) the short-term risks that might be posed to the community or the environment during implementation of the remedy (e.g., due to excavation, transportation, disposal, or containment of CCR material); (ii) potential for exposure of humans and environmental receptors to remaining CCR material following implementation of the remedy; and (iii) cross-media impacts due to the remedy.

### **1.1.5 Time Required to Begin and Complete the Remedy**

The time required to begin and complete a remedy considers the amount of time needed to completely design and implement (i.e., begin) the remedy as well as the time it will take the implemented remedy to achieve applicable GWPS at compliance points.

### **1.1.6 Institutional Requirements**

Institutional requirements can vary from location to location and technology to technology. State, local, or location-specific requirements (e.g., permits), or other environmental or public health requirements that could substantially affect construction or implementation of the remedy are considered.

## **1.2 Plant Watson Location and Description**

Plant Watson is located in Harrison County, Mississippi near the City of Gulfport. Plant Watson is bordered by Interstate Highway 10 (I-10) to the north, Reichold Road and industrial land on the south, the tidally influenced Biloxi River on the east, and industrial land on the west (**Figure 1**). The physical address of the plant is 10406 Lorraine Road, Gulfport, Mississippi, 39503.

The former CCR Unit operated on 102-acres to support coal-fired electricity generation at Plant Watson until April 2015. Intake and discharge canals were installed to the north



and west of the former CCR Unit, respectively, and water from the intake canal was used to sluice CCR into the former CCR Unit during coal-fired operations. In 2015, Plant Watson converted to a natural gas fired electricity generation process and the former CCR Unit was subsequently closed in May 2018 as described in Section 1.3.

Construction and raising of a dike around the former CCR Unit occurred intermittently from 1955-1987. A subsurface cement-bentonite wall was installed around the perimeter of the former CCR Unit along/beneath the dike between 1994 and 2000. The primary purpose of the slurry wall was to enhance structural stability of the dike; however, it likely impedes horizontal groundwater flow from the former CCR Unit. The wall extends to subsurface depths of approximately 45 to 60 feet below ground surface (ft bgs).

### **1.3 Pond Closure and Source Control**

Mississippi Power completed closure of the former CCR Unit in 2018 via closure in place and capping. A notification of intent to close the former CCR Unit was placed in the operating record on December 15, 2015 and posted to Plant Watson's CCR website within 30 days. The Closure Plan submitted to MDEQ as part of the closure permit application package described the closure activities and requirements in accordance with 40 CFR 257.102. The Closure Plan and notification of closure completion are posted on Plant Watson's publicly available website.

During closure, the former CCR Unit was dewatered sufficiently to remove free liquids. The CCR material remaining in the former CCR Unit was graded and a final cover system installed. The final cover system consists of a ClosureTurf<sup>®</sup> cover system by WatershedGeo<sup>™</sup> that utilizes a 50-mil linear low-density polyethylene (LLDPE) geomembrane overlain by an engineered synthetic turf. The final cover system was designed to limit infiltration of precipitation by providing sufficient grades and slopes to promote precipitation runoff to discharge points along the intake and discharge canals along the perimeter of the former CCR Unit. The permeability of the final cover system is less than the permeability of the natural subsoils beneath the surface impoundment and not greater than 1E-05 centimeters per second (cm/sec).

The closure of the former CCR Unit in the manner described above provides a source control measure that reduces the potential for migration of CCR constituents to groundwater. Corrective measures discussed in this ACM are being evaluated to address SSLs in groundwater at the compliance boundary.

## 2.0 GEOLOGY AND GROUNDWATER FLOW

The following section summarizes the geologic and hydrogeologic conditions at Plant Watson as described in the May 2020 *Aquifer Performance Test Work Plan* submitted to MDEQ as part of Mississippi's reporting requirements under the Agreed Order (Geosyntec, 2020b).

### 2.1 Geology

Based on previous geologic investigations, four distinct hydrogeologic units were observed to occur to depths of approximately 150 ft bgs beneath Plant Watson. A brief description of each unit (decreasing in depth) follows:

- Unit 1 is earthen fill material comprising the dike along the perimeter of the former CCR Unit and occurs to depths generally less than 20 ft bgs. Ash within the former CCR Unit is generally at the same elevation as Unit 1 and above Unit 2.
- Unit 2 is a sandy clay to clay aquitard underlying the former CCR Unit separating Unit 1 and Unit 3. The following details about Unit 2 are based on historical soil borings installed along the perimeter of the former CCR Unit (Southern Company Services, 1995): (i) the composition of Unit 2 is typical of the bay area marsh environment, (ii) Unit 2 appears to be continuous beneath the majority of the former CCR Unit, and (iii) the thickness of the Unit 2 aquitard varies from approximately 5 ft to 25 ft. Unit 2 has been shown to have a sufficiently low permeability ( $2.2\text{E}-07$  to  $8.0\text{E}-09$  cm/sec) that limits vertical migration of surface water or ponded water to Unit 3. Plant Watson's intake and discharge canals are incised through Unit 2 and intersect Unit 3.
- Unit 3 is a sand aquifer that consists primarily of fine- to medium-grained quartz sand and is the uppermost aquifer at Plant Watson for groundwater monitoring. Unit 3 extends to depths of 40 to 60 ft bgs (typical) or greater. Unit 3 is a confined or semiconfined aquifer. Geochemical evaluation of the Unit 3 aquifer indicates that groundwater in this unit is of similar quality as the surrounding surface water, with respect to major cations and anions.
- Unit 4 is a clay aquitard that occurs beneath the Unit 3 sand and extends across the region. The top of this aquitard occurs at depths of approximately 45 to 60 ft

bgs. Unit 4 consists of stiff to plastic, variably-colored clayey silt to sandy silty clay. One permeability test was completed on Unit 4 material and indicated Unit 4 has a permeability of approximately 1E-06 cm/sec.

## **2.2 Geochemistry and Groundwater Flow**

Previous geochemical investigations found that the composition of groundwater in Unit 3 had elevated total dissolved solids (TDS) concentrations in the same range as saline water. This conclusion is consistent with the setting of Plant Watson being adjacent to a tidally influenced brackish surface water environment. The TDS concentration gradually shifts towards fresh water (TDS <1,000 milligram per liter) within approximately 1,000 ft northwest of the intake canal underlying portions of Plant Watson. Additionally, Unit 3 geochemistry resembled surface water geochemistry at the intake and discharge canals (Southern Company Services, 1995). These results suggest that Unit 3 groundwater is influenced by surface water mixing. The Unit 3 sand aquifer is typically located at elevations between 0 and -42 ft below mean sea level (MSL). Groundwater recharge to Unit 3 is largely through infiltration of precipitation or lateral migration of surface water.

In 2016, a CCR groundwater monitoring well network was installed at Plant Watson to monitor groundwater in Unit 3 (**Figure 2**). Ten monitoring wells installed around the perimeter of the former CCR Unit serve as monitoring points. In January 2019, monitoring wells APMW-11 and APMW-12 were installed as upgradient background monitoring wells. Additional background wells were installed northeast of the former CCR Unit in 2020. In addition to background and downgradient monitoring wells, paired piezometers were installed inside the former CCR Unit footprint and screened in the ash and Unit 3, respectively (**Figure 3**). A summary of the monitoring well network is presented in **Table 1**.

**Figures 3 and 4** present potentiometric surface contour maps for Unit 3 from August 2019 and March 2020, respectively. The apparent groundwater flow direction in Unit 3 beneath the former CCR Unit is toward the intake and discharge canals to the north and west, respectively, and toward the marsh on the east side of the former CCR Unit.

**Figures 5 and 6** present potentiometric surface contour maps for the former CCR Unit porewater from August 2019 and March 2020, respectively. The potentiometric data generally indicate porewater head is greatest in the central, highest elevation, portion of the former CCR Unit diminishing toward the pond boundaries. **Figures 5 and 6** also show that the porewater piezometric surface within the former CCR Unit are distinctly greater

than those observed in the collocated underlying Unit 3 locations. This is likely because the Unit 2 aquitard impedes vertical groundwater flow from the former CCR Unit to Unit 3, resulting in the groundwater head differential between the former CCR Unit and Unit 3 (e.g., 7.55 ft between 7S-GS and 7D-GS in August 2019).

### 3.0 NATURE AND EXTENT OF APPENDIX IV CONSTITUENTS

The following sections describe monitoring-related field and assessment activities performed through July 2020 in support of (i) delineating the nature and extent of SSLs in groundwater and (ii) evaluating potential corrective measures to address them.

#### 3.1 SSLs for Appendix IV Constituents

Groundwater monitoring data collected during the semi-annual monitoring events completed in August 2019 and March 2020 were statistically analyzed pursuant to 40 CFR 257.93(f) and using methodology presented in *Statistical Analysis of Groundwater Data at RCRA Facilities Unified Guidance* (Unified Guidance) (US EPA, 2009). In accordance with CCR rule requirements, GWPS were established for statistical comparison to Appendix IV parameters (**Table 2**). Details regarding the statistical analyses are provided in the *2020 Annual Groundwater and Corrective Action Monitoring Report* (Southern Company Services, 2020b).

Statistical analyses of the August 2019 and March 2020 analytical data identified the following SSLs:

- Arsenic: APMW-3, APMW-4, APMW-5, APMW-6R, APMW-8, and APMW-10;
- Barium: APMW-2;
- Combined Radium 226+228: APMW-1R, APMW-2, APMW-3, APMW-7, and APMW-9
- Lithium: APMW-3, APMW-4, APMW-5, APMW-6R, and APMW-8; and,
- Molybdenum: APMW-6R and APMW-8.

As discussed in Section 1, this ACM evaluates potential groundwater corrective measures to address SSLs of arsenic, combined radium, lithium, and molybdenum. Although an SSL of barium was identified at the former CCR Unit, a barium ASD was completed (Geosyntec, 2020a); therefore, barium was not considered in this ACM. An ASD for combined radium has been initiated and is currently ongoing.

### 3.2 Delineation Activities

Mississippi Power submitted a *Semi-Annual Progress Report* (Geosyntec, 2020c) to MDEQ, which detailed investigation activities completed through July 2020 to (i) evaluate the nature and extent of the identified SSLs and (ii) support remedy evaluation. These ongoing activities are briefly summarized herein.

Seven vertical delineation monitoring wells (APMW-2D, APMW-3D, APMW-4D, APMW-5D, APMW-6D, APMW-8D, and APMW-10D) were installed adjacent to existing CCR monitoring wells (**Figure 7**). Monitoring well installation was completed via sonic drilling between April 28, 2020 and May 16, 2020 by Cascade Environmental, a licensed driller in the State of Mississippi, with Geosyntec providing direction on well placement. The seven vertical delineation monitoring wells were installed to assess the vertical extent of groundwater SSLs observed in Unit 3 by targeting the interbedded sands of Unit 4.

The nature and extent investigation also included a horizontal delineation assessment. A synoptic surface water sampling event, including existing and new surface water sample locations (**Figure 8**), was conducted on July 1, 2020 and surface water samples were analyzed for the following total and dissolved (i.e., field filtered with a 0.45 micron in-line filter) analytes: Appendix III and Appendix IV CCR constituents, hardness, total alkalinity, carbonate alkalinity, and bicarbonate alkalinity. Surface water samples were sent to TestAmerica, a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory, under chain of custody protocols.

Evaluation of vertical and horizontal delineation data is currently in progress. The analytical sampling results from the delineation locations will be reported in the *2020 Comprehensive Groundwater Investigation* to be submitted to MDEQ in December 2020. Although delineation of the nature and extent of SSLs is ongoing at Plant Watson, adequate data are available to assess potential corrective measures.

## **4.0 GROUNDWATER CORRECTIVE MEASURE ALTERNATIVES**

### **4.1 Objectives of the Corrective Measures**

In evaluating the effectiveness of potential corrective measures using the criteria listed in 40 CFR 257.96(c), including performance, reliability, ease of implementation, potential impacts, remedy duration, and institutional and public health requirements, the following criteria listed in 40 CFR 257.97(b) must be met by the corrective measure when selected:

- Protect human health and the environment;
- Attain applicable GWPS as specified pursuant to 40 CFR 257.95(h);
- Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents to the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards for management of wastes as specified in 40 CFR 257.98(d).

Corrective measures selected for evaluation for potential use at the former CCR Unit are anticipated to satisfy the above criteria.

### **4.2 Summary of Potential Corrective Measures**

The following presents a summary of potential corrective measures evaluated as part of this ACM. Based on specific information and knowledge of corrective alternatives and conditions at the former CCR Unit, the following remedies – or combination of remedies are being evaluated using the criteria specified in 40 CFR 257.96(c):

- In-Situ Injections;
- Pump and Treat (P&T; Hydraulic Containment and Dewatering);
- Monitored Natural Attenuation (MNA);

- Permeable Reactive Barrier (PRB);
- Phytoremediation; and
- Subsurface Vertical Barrier Walls.

#### 4.2.1 In-Situ Injections

Subsurface in-situ injections of reagents are a remediation technology for inorganic constituents. In-situ injections for inorganic constituents may be applied in three modes that influence solubility, mobility, and/or toxicity of inorganic constituents: (i) oxidation-reduction potential (redox) manipulation; (ii) adsorption to iron oxyhydroxides, other metal oxyhydroxides, or various sulfate compounds under oxidizing groundwater conditions; and (iii) adsorption to, or coprecipitation with, iron or other metal sulfides under reducing conditions. This technology requires understanding of the subsurface transport and (geo)chemical characteristics and a thorough understanding of the reaction kinetics to ensure appropriate reagent dosing is applied to the subsurface. Often this technology is field evaluated in a relatively small area (i.e., a pilot test) to bolster the understanding of these factors prior to remedial selection, design, and/or implementation.

Arsenic, molybdenum, and combined radium can be precipitated and/or immobilized under different combinations of pH and redox conditions. A variety of pH and/or redox-altering technologies are available which can incorporate biological processes, chemical oxidants and reductants, and/or mechanical processes such as air sparging. These processes can be used to decrease the mobility of these constituents.

For example, insoluble (or sparingly soluble) arsenic-containing minerals such as arsenopyrite ( $\text{FeAsS}$ ), realgar ( $\text{AsS}$ ), or orpiment ( $\text{As}_2\text{S}_3$ ) can be formed under sulfate-reducing, anaerobic conditions by indigenous microbial populations (Onstott et al., 2011). These conditions can be induced by injecting electron donors such as emulsified vegetable oil, lactate, or ethanol into arsenic-impacted groundwater together with a sufficient supply of iron and sulfate. Furthermore, arsenic can be sorbed to iron and manganese oxides under aerobic conditions.

To understand the biogeochemical processes that would effectively immobilize arsenic, molybdenum, and combined radium in groundwater, bench-scale treatability studies and/or field-scale pilot tests specific to the conditions at the former CCR Unit are needed to evaluate amendment effectiveness to promote appropriate conditions for the



precipitation and/or sorption of these inorganics without mobilizing other naturally-occurring constituents. Once precipitated, these minerals are often stable even if geochemical conditions revert to a different redox environment.

Air sparging can be used to provide oxygen to the subsurface in an attempt to precipitate (or make more “sorpative”) compounds that are generally more soluble and mobile under reducing conditions. This can also promote the formation of iron or manganese (oxy-) hydroxides for subsequent sorption of arsenic (and potentially, molybdenum and combined radium) onto these mineral phases. If sufficient iron is present in groundwater, the use of air sparging alone may be considered to precipitate iron (oxy-) hydroxides for sorption.

Furthermore, in-situ chemical oxidation (ISCO) or in-situ chemical reduction (ISCR) can be used to chemically alter the redox environment in the subsurface to affect the mobility and/or bioavailability of certain inorganic compounds, including arsenic.

Although not currently a proven in-situ technology, radium readily coprecipitates with barium in the presence of sulfate. Therefore, manipulation of the subsurface geochemical conditions combined with appropriate supplements may prove effective for the remediation of combined radium in groundwater.

The key process limiting in-situ remedial implementation and effectiveness is the delivery of amendments within the area of interest. Mixing and contact with the target constituents are necessary and can be difficult to achieve in heterogeneous materials and/or fine-grained materials. Additionally, in-situ remedial approaches are unlikely to be successful for lithium, which is a highly conservative species that does not readily adsorb or precipitate across a wide range of pH and redox conditions.

While the effectiveness of molybdenum attenuation using in-situ redox manipulations may be limited, to some extent, due to slow reaction kinetics, the attenuation of arsenic is expected to occur under both aerobic (via sorption to iron or manganese oxides) and anaerobic conditions (via formation of sulfide minerals). While in-situ injections are likely not an effective remedial technology for lithium, it may be considered a potentially viable corrective measure to address arsenic, combined radium, and molybdenum in groundwater at the former CCR Unit, especially in smaller, more localized areas. In-situ injection would likely need to be combined with an alternative technology to address lithium to provide a complete remedy for the former CCR Unit. This technology will be retained for further evaluation.

#### **4.2.2 Pump and Treat (Hydraulic Containment and Dewatering)**

Generally, P&T refers to the use of groundwater extraction to artificially induce a hydraulic gradient for capture or control of the migration of impacted groundwater. It is often considered to be a viable remedial technology at many sites (US EPA, 1996). This approach uses extraction wells or trenches to capture groundwater, which may subsequently require above-ground treatment and permitted discharge to a receiving water body or sewer system, reinjection into the aquifer, or reuse at the generating station. Groundwater P&T is often relatively slow and costly as a means to restore groundwater quality over a long-term period. However, P&T can be effective as a stand-alone remedy, a temporary (interim) measure, or in combination with another measure to provide hydraulic containment to limit constituent migration toward a potential receptor. At the former CCR Unit, P&T could be performed in Unit 3 and/or associated with dewatering of ash to limit migration of constituents from ash porewater to Unit 3.

Groundwater extraction for hydraulic control can often effectively address the variety of inorganic constituents encountered at CCR sites, including arsenic, combined radium, lithium, and molybdenum. Extraction technologies are more efficient for conservative species, such as lithium, which are not readily attenuated by other mechanisms (e.g., precipitation, adsorption). Extraction technologies also have the ability to overcome the limitations of in-situ injection-based technologies (i.e., subsurface mixing and contact with affected materials, access to impacted groundwater in lower permeability geologic formations). Space constraints are mainly limited to the above-ground conveyance and treatment component of a P&T system since extraction wells can generally be installed into relatively tight spaces at the edge of waste or other points of compliance.

Extracted groundwater may need to be treated prior to discharge (depending on discharge permit requirements) but does have the potential to be used for reuse (as process water), irrigation (e.g., of a cover system or other vegetated areas at Plant Watson), or dust suppression purposes. Therefore, P&T is a potentially viable corrective measure for arsenic, combined radium, lithium, and molybdenum in groundwater at the former CCR Unit and will be retained for further evaluation.

#### **4.2.3 Monitored Natural Attenuation**

US EPA defines MNA as the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by

other more active methods. The natural attenuation processes that are at work in such a remediation approach include a variety of physical, chemical, and/or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of constituents in soil or groundwater. These in-situ processes include the following: dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, precipitation, transformation, or destruction of inorganic constituents (US EPA, 2015).

Attenuation mechanisms for inorganic constituents, such as arsenic, combined radium, lithium, and molybdenum are either physical (e.g., dilution, dispersion, flushing, and related processes) or chemical (e.g., sorption or oxidation reduction reactions). Select chemical processes can be facilitated by (bio)geochemical reactions. Per US EPA (2015), *“MNA may, under certain conditions (e.g., through sorption or oxidation-reduction reactions), effectively reduce the dissolved concentrations and/or toxic forms of inorganic contaminants in groundwater and soil. Both metals and non-metals (including radionuclides) may be attenuated by sorption reactions such as precipitation, adsorption on the surfaces of soil minerals, absorption into the matrix of soil minerals, or partitioning into organic matter. Oxidation-reduction (redox) reactions can transform the valence states of some inorganic contaminants to less soluble and thus less mobile forms (e.g., hexavalent uranium to tetravalent uranium) and/or to less toxic forms (e.g., hexavalent chromium to trivalent chromium).”* Arsenic, combined radium, and molybdenum undergo sorption to iron and manganese oxides. Also, redox reactions, via abiotic or biotic processes, can transform arsenic into sparingly soluble sulfide minerals.

Lithium exhibits more conservative behavior, as it is generally non-reactive and tends to move readily with groundwater flow. Thus, the predominant attenuation mechanisms for lithium are likely to be dispersion or dilution from mixing with groundwater. MNA for conservative species such as lithium is most appropriate at sites with active source control, such as the existing final cover system on the former CCR Unit.

The US EPA uses four phases to establish whether MNA can be successfully implemented for inorganics at a given site. The phases (or steps) include:

1. Demonstration that SSLs in groundwater are delineated and stable.
2. Evaluation of the mechanisms and rates of attenuation.

3. Assessment if the capacity of the aquifer is sufficient to attenuate the mass of constituents in groundwater and that the immobilized constituents are stable and will not remobilize.
4. Design of a performance monitoring program based on the mechanisms of attenuation and including a decision framework for consideration of a contingent remedy tailored to site-specific conditions should MNA not perform adequately.

A successful MNA approach requires a good understanding of hydrogeologic conditions and may require additional information and monitoring over an extended period of time. MNA is a relatively slow remedy to obtain site closure when used in isolation; as such, MNA is frequently used in combination with other remedies, including source control. Based on MNA case histories for inorganic constituents, MNA timeframes range from a few years to a few decades (EPRI, 2015).

MNA is a potentially viable corrective measure for arsenic, combined radium, lithium, and molybdenum in groundwater at the former CCR Unit and will be retained for further evaluation.

#### **4.2.4 Permeable Reactive Barriers**

PRBs typically involve the installation of a permeable subsurface wall constructed with reactive media for the removal of constituents as groundwater passes through. PRBs can be installed in downgradient locations using conventional excavation methods or one-pass trenching method. Excavated trenches are back-filled with reactive media to create a barrier that treats dissolved constituents as they passively flow through the PRB with the groundwater (e.g., ITRC, 2011). These systems can either be constructed as continuous “walls” or as “funnel-and-gate” systems where (impermeable) slurry walls create a “funnel” that directs groundwater to permeable “treatment gates” filled with reactive materials. Since the costs for reactive materials (e.g., zero-valent iron [ZVI] or similar) are generally higher than bentonite-based slurry wall construction, the funnel-and-gate configurations with a smaller treatment area help lower construction and maintenance costs. PRBs are typically keyed into an underlying low-permeability unit such as a clay layer.

PRBs can present a viable alternative for in-situ treatment of arsenic, combined radium, and molybdenum. The technology typically includes reactive media such as ZVI, biologically active media (to induce oxidizing or reducing conditions), or clays, apatite,

zeolites, and/or peat moss (to promote ionic exchange and/or sorption). While uncommon, addition of a sulfate source to a PRB may be an effective technology for remediation of combined radium. PRBs have proven to be effective in passively treating several inorganic constituents found at CCR sites, including arsenic, selenium, and chromium (e.g., ITRC, 2011). The use of PRBs for molybdenum has been tested, but additional site-specific testing is needed to confirm the applicability of this technology to remove molybdenum from groundwater since it has shown early breakthrough with ZVI-type media (e.g., Morrison et al., 2006) and careful testing is required to select the appropriate treatment media. PRBs are unlikely to be a viable alternative for in-situ treatment of lithium due to its limited reactivity and highly conservative nature.

The installation depths of a PRB are generally limited to about 90 ft bgs. The installation of a PRB generally requires more space than extraction wells for a P&T system, but a PRB does not require above-ground treatment components and therefore, the overall treatment footprint is likely to be smaller compared to a P&T system. Given the proximity of the adjacent canals to the unit, space constraints may be an issue for installation of a PRB.

Additional subsurface investigations, reactive media testing, and compatibility testing of groundwater with the components of a PRB are needed to evaluate the feasibility of installing a PRB at the former CCR Unit. Pending these evaluations, the technology is currently considered to be a potentially viable corrective measure to address arsenic, molybdenum, and potentially combined radium in groundwater at the former CCR Unit and will be retained for further evaluation. This technology would likely need to be combined with an alternative technology to address lithium to provide a complete remedy for the former CCR Unit.

#### **4.2.5 Phytoremediation**

Phytotechnologies encompass a number of plant-based technologies and applications, including any plantings that enhance the environmental goals for a given site. Phytotechnologies include a variety of applications ranging from constructed wetlands to alternative landfill covers, from tree plantations for hydraulic control to the use of plants for slope stabilization, from planted (riparian) buffers for nutrient management and sediment control to the classical applications of constituent uptake and degradation (Goldmund and Gestler, 2019).

In the latter example, phytoremediation is the use of plants to degrade, immobilize, and/or contain constituents in soil, groundwater, surface water, and sediments. Phytoremediation has emerged as a viable alternative to more active and costly environmental cleanup technologies, especially for large areas with relatively low levels of constituents in shallow soils or groundwater.

In general, the main mechanisms involved in the application of phytoremediation for inorganic constituents include:

- Phytosequestration, which is the ability of plants to sequester constituents in the rhizosphere (an area a few millimeters away from a root surface). This is a containment mechanism.
- Phytohydraulics is the ability of plants to capture and evaporate water. This is hydraulic control of a groundwater plume through plant root uptake and is considered a containment mechanism.
- Phytoextraction is the process of constituent uptake into the plant. This is remediation by removal.

Typically, a combination of these mechanisms acts in concert to achieve successful applications of phytoremediation for inorganic constituents.

The effectiveness of groundwater remediation using traditional phytoremediation approaches may be limited by compacted soil conditions that impede root penetration, or target groundwater that is too deep for root access. Given that groundwater wells at the former CCR Unit that exhibited SSLs for arsenic, combined radium, lithium, and molybdenum are screened at depths up to 60 ft bgs, traditional plantings for phytoremediation are not expected to be successful. However, more recently, an engineered approach to phytoremediation, the *TreeWell*<sup>®</sup> system (which is a proprietary system developed by Applied Natural Sciences), has been shown to overcome these constraints by utilizing a specialized lined planting unit constructed with optimum planting media designed to promote downward root growth, encourage constituent treatment, and focus groundwater extraction from a targeted depth interval (e.g., Gatliff et al., 2016).

By installing a cased “well” for tree planting using large diameter auger technology, extraction of deeper groundwater zones (i.e., in excess of 50 ft bgs) can be achieved since

the surface of the “well” is sealed and only groundwater from a targeted zone is allowed into the cased-off borehole. This type of system mirrors a traditional mechanical extraction system using the trees as pumps. The *TreeWell*<sup>®</sup> system can be used for both hydraulic control of groundwater and for treatment of constituents via degradation (for organic constituents) or immobilization/containment mechanisms (for organic and inorganic constituents). With respect to the specific conditions at the former CCR Unit, the system would be applied for hydraulic control, but arsenic, combined radium, lithium, and molybdenum are expected to be either immobilized within the root zone or incidentally taken up into the tree biomass.

The advantage of an engineered phytoremediation system includes no above-ground water management needs and limited long-term operation and maintenance (O&M) requirements following the establishment of the system. Such systems have been observed to meet design hydraulic control parameters typically within three years of installation. The layout for a phytoremediation remediation system is generally based on groundwater flow modeling.

With the exception of the *TreeWell*<sup>®</sup> technology, phytoremediation technologies are not feasible at the former CCR unit due to the depth of SSLs. Although the *TreeWell*<sup>®</sup> technology can access SSLs at depth, the groundwater extraction rate needed to limit SSL migration exceeds the capacity of the *TreeWell*<sup>®</sup> technology due to the limited physical space for installation of a phytoremediation system between the former CCR Unit and the adjacent surface water bodies. Thus, while phytoremediation is technically feasible as a remedial technology for arsenic, combined radium, lithium, and molybdenum, it will not be retained for further evaluation.

#### **4.2.6 Subsurface Vertical Barrier Walls**

Subsurface vertical barrier walls have been used for seep control and groundwater cutoff at impoundments and waste disposal units for more than three decades. In general, barrier walls are designed to provide containment; localized treatment achieved through the sorption or chemical precipitation reactions from construction of the walls are incidental to the design objective.

This approach involves placing a barrier to groundwater flow in the subsurface, frequently around the source area (or the downgradient limits of the source area), to prevent future migration of dissolved constituents in groundwater from beneath the source to downgradient areas. Barrier walls are typically keyed into a lower confining

unit. Barrier walls can also be used in downgradient applications to limit discharge to a surface water or to reduce aquifer recharge from adjacent surface water features when groundwater extraction wells are placed near a surface water feature. A variety of barrier materials can be used, including cement and/or bentonite slurries or various mixtures of soil with cement or bentonite, geomembrane composite materials, or driven materials such as steel or vinyl sheet pile.

Given that a slurry wall has already been installed around the former CCR Unit (see Section 1.2), the installation of a sheet pile wall is likely the most viable alternative to consider as a corrective measure. In general, the applicability of sheet pile walls is limited by the depth of installation, which is approximately 60-65 ft bgs with a single sheet. Total maximum depth (with spliced sheets in ideal geologic conditions) is 75-100 ft bgs. However, location-specific geologic and technology-specific considerations may limit this depth to shallower installations.

Groundwater extraction is typically required upgradient of the barrier wall to maintain an inward hydraulic gradient and avoid groundwater mounding behind the barrier. The extracted groundwater would likely require treatment in an above-ground treatment system.

Additional subsurface investigations may be needed to further evaluate the feasibility as well as the placement of an additional barrier wall at the former CCR Unit. This technology is considered a potentially viable corrective measure to address arsenic, combined radium, lithium, and molybdenum at the former CCR Unit and will be retained for further evaluation. However, it is more likely to be a component of another application rather than a stand-alone corrective measure.

### **4.3 Potential Remedy Evaluation**

The following remedies are considered potentially viable for corrective measures for groundwater at the former CCR Unit:

- In-Situ Injections;
- P&T (Hydraulic Containment and Dewatering);
- MNA;
- PRB; and



- Subsurface Vertical Barrier Walls.

Although these technologies are potentially feasible remedies, further data collection and evaluation are required to: (i) verify the feasibility of each; and (ii) provide sufficient information to design a corrective action system that meets the criteria specified in 40 CFR 257.97(b). **Table 3** provides a summary of these technologies compared to the evaluation criteria discussed in Section 1 as applied to location-specific conditions. **Table 4** summarizes the advantages and disadvantages of each technology that should be considered.

#### 4.3.1 In-Situ Injections

In-situ injections can be used in isolation but are also compatible with the other groundwater corrective actions that are potentially viable for the former CCR Unit. For example, in-situ injections can be implemented in smaller, isolated areas, where performance can be readily monitored and additional treatment applied, if needed, and MNA, P&T, or another technology can be used broadly downgradient of the former CCR Unit.

Performance: The performance of in-situ injections is considered moderate due to the limited application history for combined radium and unlikely treatment of lithium via redox manipulation approaches under either aerobic or anaerobic conditions. Thus, the performance of this measure can only be evaluated for arsenic and molybdenum. The technology would likely need to be combined with an alternative technology to attenuate lithium and potentially combined radium. The effective immobilization of arsenic has been shown under aerobic and anaerobic conditions; however, both aerobic and anaerobic approaches would require additional data and testing. The effectiveness of molybdenum attenuation using in-situ redox manipulations may be limited, to some extent, due to slow reaction kinetics. Molybdenum attenuation under both aerobic and anaerobic conditions needs further evaluation but is expected to occur. Molybdenum is more strongly sorbed to aluminum oxides than other metal oxides, and it is generally less sorptive and more mobile compared to arsenic.

Reliability: Reliability for arsenic and molybdenum attenuation via in-situ injections is considered medium because (i) amendment distribution is dependent on the permeability and heterogeneity of the subsurface, and (ii) the amount and distribution of secondary iron or manganese (oxy-) hydroxides (for aerobic approach) or soluble iron or manganese and sulfur (for anaerobic approach). This would be considered a reliable technology if

injected materials can be distributed throughout the impacted aquifer. Bench-scale treatability studies and/or field-scale pilot testing programs are needed to understand the biogeochemical processes that would effectively treat arsenic, combined radium, and molybdenum in groundwater. The testing programs should evaluate if coupled technologies (e.g., the additional remedy selected for lithium) would affect the reliability of in-situ injections. Once precipitated, arsenic and molybdenum are often stable even if geochemical conditions revert to a different redox environment. Potential rebound under variable redox conditions should be evaluated during the testing program referenced above.

Ease of Implementation: The ease of implementation is easy to moderate. The installation of an injection well network or other injection infrastructure would be required. Alternative installation approaches may be considered, such as along the downgradient edge of impacted groundwater, which would function similar to a PRB application. The injection wells and/or the aquifer matrix (especially if low permeability) have a potential for clogging. Evaluation of the amendment distribution during injections (i.e., radius of influence) is needed to support full-scale design.

Potential Impacts: Minimal impacts are expected if remedy works as designed, based on a thorough pre-design investigation, geochemical modeling, and bench/pilot study results. Redox-altering processes have the potential to mobilize naturally-occurring constituents as an unintended consequence if not properly evaluated and implemented. Consideration of groundwater flow to nearby sensitive environments may be needed.

Duration: A thorough pre-design investigation, geochemical modeling, and/or bench-scale treatability study and/or field-scale pilot testing may take up to 24 months to obtain design parameters prior to design and construction of the corrective measure. Once designed, installation of the injection network can be accomplished relatively quickly (i.e., 1 to 2 months; potentially longer depending on the scale of the remedy). Once installed, the time for an injection event and distribution of the injected materials throughout the treatment area can be variable. Following injections, the time required to achieve GWPS for arsenic, combined radium, and lithium within the treatment area may take up to 5 to 10 years but depends on the attenuation process kinetics of each targeted constituent as well as amendment longevity. Additional injection events may be needed to maintain redox conditions and/or address additional flux of impacted groundwater into the treatment area. The time for lithium concentrations to decline will be dependent on the additional technology selected to address those impacts.

Institutional Requirements: Deed restrictions may be necessary until in-situ treatment has achieved GWPS. An underground injection control (UIC) permit would be required to implement this corrective measure. No other institutional requirements are expected at this time.

#### **4.3.2 Pump and Treat**

P&T can be used as a stand-alone remedy, although it is generally compatible with the other groundwater corrective actions that are potentially viable for the former CCR Unit, such as MNA.

Performance: P&T is an effective, demonstrated technology for hydraulic control and/or dewatering. Evaluation of the corrective measure is contingent on completing additional assessment activities that are ongoing (i.e., delineation, combined radium ASD, aquifer pump test data analysis, flow modeling, and capture zone analysis). These steps are needed to refine the constituent distribution in the subsurface to target specific zones for pumping for improved mass recovery efficiency/effectiveness and to further evaluate the potential remedy performance. The design of the P&T system requires groundwater modeling for the well network and potentially, design of an above-ground treatment system.

Reliability: P&T is medium to highly reliable for hydraulic containment and/or dewatering. Reliability may also depend on the operation and performance of an ex-situ treatment system, if needed. System downtime for maintenance may impact reliability.

Ease of Implementation: The ease of implementation is moderate. P&T is a proven, long-standing approach that requires installation of extraction wells/trenches, which is fairly straightforward. A variety of approaches exist for ex-situ treatment of arsenic and molybdenum; treatment of lithium can be challenging as it is not readily adsorbed or precipitated from solution. O&M requirements are expected to include upkeep of infrastructure components (pumps, pipes, tanks, instrumentation and controls, above-ground treatment system) and handling of treatment residuals.

Potential Impacts: Groundwater extraction may unintentionally alter the geochemistry within the hydraulic capture zone. Consideration of groundwater withdrawal from nearby sensitive environments may be needed, depending on the groundwater extraction volume required to maintain hydraulic containment.

Duration: A thorough pre-design investigation, flow modeling, and bench-scale treatability studies and/or field-scale pilot testing (i.e., for design of the ex-situ treatment system) would be required. These activities may take up to 24 months prior to design, permitting, and construction of the corrective measure. Once designed, installation of extraction wells and/or trenches can be accomplished relatively quickly. The initiation of the approach would be contingent on the start-up of the ex-situ treatment infrastructure. Hydraulic containment can be achieved relatively quickly after startup of the extraction system, but uncertainty exists with respect to the time to achieve GWPS without additional data collection to better understand mobility and attenuation mechanisms for arsenic, combined radium, molybdenum, and lithium.

Institutional Requirements: A permit may be required to withdraw water (e.g., water or consumptive use permit). Depending on the effluent management strategy, modifications to the existing National Pollutant Discharge Elimination System (NPDES) permit may be required for surface water discharge. Alternatively, a new UIC permit may be needed if groundwater reinjection is chosen. In addition, deed restrictions may be necessary until groundwater concentrations are below GWPS.

#### **4.3.3 Monitored Natural Attenuation**

MNA can be used as a stand-alone remedy, although it is often used in combination with other remedial technologies, including source control. MNA can serve as a polishing step when coupled with other technologies (US EPA, 2015).

Performance: Physical and chemical mechanisms for natural attenuation of arsenic, combined radium, molybdenum, and lithium, including dilution, dispersion, sorption, and oxidation-reduction reactions, are anticipated to be effective at achieving GWPS within a reasonable timeframe. The performance depends on oxidation-reduction conditions, aquifer reactivity, and aquifer attenuation capacity, which each require additional investigation to support evaluation of MNA as a corrective measure. Delineation data needs to be reviewed to evaluate whether attenuation processes are already occurring at the former CCR Unit. MNA typically requires effective source control (e.g., capping) to achieve target concentrations within a reasonable time frame. As a source control measure has already been installed at the former CCR Unit, MNA performance is considered medium to high in the absence of additional data regarding the attenuation mechanisms applicable at the former CCR Unit.

Reliability: The reliability of MNA is moderate to high as long as aquifer attenuation capacity is present and aquifer conditions that results in attenuation remain favorable and/or are being enhanced. Monitoring well rehabilitation, replacement, or repair may be needed long-term.

Ease of Implementation: Implementation of MNA at the former CCR Unit is relatively easy with respect to infrastructure since the well network for MNA is already in place, although additional wells may need to be installed to monitor progress in select areas. Additional data are needed to show that the existing aquifer attenuation capacity is sufficient to meet to achieve GWPS within a reasonable timeframe.

Potential Impacts: Potential impacts of the remedy will be negligible because MNA relies on natural processes active in the aquifer matrix without significant disturbing the surface or subsurface.

Duration: Implementation of the MNA remedy would require time for additional data collection and documentation, even though an existing monitoring network is already in place. The additional data collection activities may take up to two years to complete. The additional data would be needed for statistical analysis and to evaluate if additional monitoring wells need to be installed to supplement the existing monitoring network.

MNA is a relatively slow remedy to obtain site closure when used in isolation; additional evaluation would be required to estimate the duration. Based on MNA case histories for inorganic constituents, MNA timeframes range from a few years to a few decades (EPRI, 2015). However, the timeframe at the former CCR Unit may be less because of the source control measure (i.e., capping).

Institutional Requirements: Deed restrictions may be necessary until natural attenuation processes have achieved GWPS. No other institutional requirements that may limit application of MNA are expected at this time.

#### **4.3.4 Permeable Reactive Barriers**

PRBs can serve as stand-alone technologies but are also compatible with the other groundwater corrective actions that are potentially viable for the former CCR Unit. For example, since PRBs are unlikely to effectively address lithium in groundwater, another correction action, such as MNA, could be used in conjunction with PRB to achieve GWPSs.

Performance: The performance of a PRB is anticipated to be moderate. PRBs have been shown to effectively address arsenic in groundwater, but additional testing is required for combined radium and molybdenum to select the appropriate reactive media(s). PRBs are unlikely to effectively address lithium in groundwater as it is not readily attenuated via typical PRB processes. The approach is expected to achieve GWPS for arsenic, combined radium, and molybdenum as impacted groundwater passes through the reactive barrier. A thicker wall might be needed to treat multiple inorganic constituents relative to treating only for one constituent (e.g., arsenic). Finally, delineation data and existing slurry wall construction details will need to be reviewed for effective placement of a PRB.

Reliability: PRBs are a reliable groundwater corrective measure technology for select constituents (e.g., arsenic), but loss of reactivity over time may require re-installation depending on the duration of the remedy. Additional data collection, including conducting a laboratory treatability test and/or field pilot study, is needed to better characterize current attenuation mechanisms and/or select the appropriate reactive media mix for a PRB wall. The potential interaction of an alternative selected remedy for lithium should be considered with respect to PRB reliability.

Ease of Implementation: Implementation of a PRB is considered moderate to difficult. Trenching would be required to install a mix of reactive materials in the subsurface. Continuous trenching may be the most feasible construction method but space for installation may be limited. Installation methods and materials are readily available. Once installed, treatment will be passive and O&M requirements are minimal if replacement of the PRB is not necessary.

Potential Impacts: Minimal impacts are expected following the construction of the remedy. However, ZVI and other PRB constituents have the potential to alter geochemical conditions (create anaerobic conditions) downgradient of the PRB wall that may mobilize redox-sensitive naturally-occurring constituents. These conditions need to be carefully evaluated and monitored. Consideration of groundwater flow to nearby sensitive environments may be needed. Short-term impacts during the construction of the remedy can be mitigated through appropriate planning and health and safety measures.

Duration: Installation of a PRB can be accomplished relatively quickly (6 to 12 months), depending on the final location and configuration. However, bench-scale treatability studies and/or compatibility testing would be required to obtain design parameters prior to design and construction of the remedy. These processes may take up to 24 months. Once installed, the time to achieve GWPS downgradient of the PRB is anticipated to be

relatively quick. The PRB will need to be monitored and potentially replaced to maintain reactive conditions and/or address additional flux of impacted groundwater into the PRB. The time for lithium concentrations to decline will be dependent on the additional technology selected to address those impacts.

Institutional Requirements: Deed restrictions may be necessary until groundwater concentrations are below GWPS. No other institutional requirements that may limit installation of a PRB are expected at this time.

#### **4.3.5 Subsurface Barrier Walls**

Performance: Barrier walls are a proven technology for seepage control and/or groundwater cutoff at impoundments. Sheet pile walls are limited by the depth of installation, which is approximately 60 to 65 ft bgs with a single sheet. However, geologic and technology considerations specific to the former CCR Unit may limit this depth to shallower installations. Within the context of the former CCR Unit, a barrier wall might be used in conjunction with a “funnel and gate” system for a PRB rather than a stand-alone technology. As such, groundwater with arsenic, combined radium, and molybdenum above GWPS could either be directed to “treatment gates” for passive treatment (in a PRB) or migration of impacted groundwater could be minimized via barrier wall installation. Additional subsurface investigations and compatibility testing with groundwater from the former CCR Unit will be needed.

Reliability: Subsurface barrier walls are reliable as a barrier to groundwater flow. O&M requirements can range significantly, depending on if groundwater extraction and subsequent treatment from inside the wall is required.

Ease of Implementation: The implementation is considered moderate to difficult due to the depth of wall installation, which should be keyed into a low permeability layer. Installation methods and materials are readily available. Once installed, above-ground infrastructure may be required to treat groundwater if extraction is necessary.

Potential Impacts: Minimal impacts are expected following the construction of the remedy. Short-term impacts during remedy construction can be mitigated through appropriate planning and health and safety measures. Changes to groundwater flow patterns due to installation of the barrier wall are expected, which can affect other aspects of groundwater corrective action. Groundwater extraction may unintentionally alter the

geochemistry within the wall that may result in the mobilization of other constituents that require treatment.

Duration: Design phase and additional compatibility testing may be required, which may take up to 24 months. Installation of a barrier wall can be accomplished relatively quickly (i.e., 6 to 12 months), depending on the final location and configuration. Once installed, preventing migration of constituents in groundwater is anticipated to be similar to the companion technology (e.g., PRBs or P&T). Since this approach does not treat the downgradient area of impacted groundwater but prevents migration from a source area, it will likely have to be maintained long-term and coupled with other approaches (e.g., MNA).

Institutional Requirements: Deed restrictions may be necessary until groundwater concentrations are below GWPS. No other institutional requirements that may limit application of this technology are expected at this time.



## **5.0 REMEDY SELECTION PROCESS**

The purpose of this ACM is to begin the process of selecting corrective measure(s) for groundwater using the criteria outlined in 40 CFR 257.96 and the Agreed Order. The remedy process implemented at the former CCR Unit will be composed of four elements:

1. Source control;
2. Groundwater remedy;
3. Corrective action groundwater monitoring program; and
4. Adaptive management.

The following describes these components of the remedy process and a conceptual schedule for implementation.

### **5.1 Source Control**

Source control at Plant Watson is considered complete as Mississippi Power closed the inactive Unit at Plant Watson in 2018 via closure in place and capping. The current conceptual model may need to be refined and/or updated as more data are collected and analyzed.

### **5.2 Groundwater Remedy**

A groundwater remedy process that incorporates one or more remedies described in this ACM will be implemented at the former CCR Unit. The remedy process will be designed to meet the performance standards described in 40 CFR 257.98(c). Since the groundwater remedy may incorporate multiple approaches, additional data and analysis will be required to (i) perform a thorough location-specific evaluation regarding the feasibility of each potential remedy and (ii) to design or configure a groundwater corrective action plan.

The following summarizes typical additional data needed to evaluate and select a remedy:

- Geochemical studies of groundwater and aquifer media;
- Geochemical, groundwater flow, or fate and transport modeling;

- Material compatibility tests;
- Laboratory treatability studies on groundwater, aquifer media, reactive media, and potential treatment solutions for injection; and/or
- Field pilot studies based on results of laboratory treatability studies.

Some of the data needed to evaluate potential remedies may be collected concurrently with routine groundwater monitoring events or during supplementary sampling events, if required. Additional data collection or feasibility evaluations may require 18 to 30 months to complete.

### **5.3 Corrective Action Groundwater Monitoring Program**

Concurrent with design of a groundwater remedy, a corrective action groundwater monitoring program will be developed in accordance with 40 CFR 257.98(a)(1). The design of the monitoring program will consider the following: (i) meeting the assessment monitoring requirements of the CCR rules; (ii) documenting the effectiveness of the corrective action remedy; and (iii) demonstrating compliance with the GWPS established for the former CCR Unit. In addition, the groundwater monitoring program will include adaptive monitoring thresholds that will be used to evaluate if changes to the remedy system should be considered based on changing conditions.

### **5.4 Adaptive Management**

Mississippi Power will utilize adaptive management for Plant Watson during implementation of the remedial strategy to address changes in former CCR Unit conditions (e.g., successful reduction of constituent concentrations or changing trends) as may occur. Under an adaptive management strategy:

- A corrective measure will be installed or implemented to address current conditions;
- The performance of the corrective measure will be monitored, evaluated, and reported at least semi-annually;
- The conceptual model will be updated as more data are collected; and

- Adjustments and augmentations will be made to the corrective measure(s), as needed, to assure that performance criteria and remedial goals are met.

## **5.5 Schedule, Reporting, and Next Steps**

Data collection to delineate the nature and extent of SSLs is ongoing. Mississippi Power is preparing semi-annual progress reports to document groundwater conditions at Plant Watson, results associated with additional data collection and the progress in selecting and designing the remedy in accordance with the Agreed Order and 40 CFR 257.97(a). In addition, an ASD for combined radium has been initiated and is currently ongoing.

**Table 5** provides a generalized conceptual schedule for evaluating additional information and selecting a remedy. At least 30 days prior to the selection of remedy or remedies, a public meeting to discuss the results of the corrective measures assessment will be held pursuant to 40 CFR 257.96(e). The final remedy selection report will be developed as outlined in 40 CFR 257.97(a). Once the remedy has been selected, the implementation of the remedy will be initiated in accordance with 40 CFR 257.98.

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# TABLES

**Table 1.**  
**Monitoring Well Network Summary**  
**Plant Watson, Gulfport, Mississippi**

Well Name	Installation Date	Purpose	Northing	Easting	Ground Elevation	Top of Casing Elevation (ft NAVD88)	Top of Screen Elevation (ft NAVD88)	Bottom of Screen Elevation (ft NAVD88)	Top of Screen Depth (ft bgs)	Bottom of Screen Depth (ft bgs)
APMW-1	7/12/2016	Water Level	339968.4	924453.57	22.48	24.86	-1.52	-11.92	24.00	34.40
APMW-1R	1/24/2019	Downgradient	339938.3	924486.3	22.50	25.16	-8.34	-13.34	30.84	35.84
		(APMW-1 Replacement)								
APMW-2	7/18/2016	Downgradient	339436.26	925145.2	19.95	22.58	-9.05	-19.65	29.00	39.60
APMW-3	7/18/2016	Downgradient	338466.67	926382.75	5.60	8.40	-17.40	-28.00	23.00	33.60
APMW-4	7/19/2016	Downgradient	338360.09	926947.41	10.76	13.39	-13.24	-23.84	24.00	34.60
APMW-5	7/19/2016	Downgradient	339095.64	926946.56	6.01	8.68	-17.99	-28.59	24.00	34.60
APMW-6	7/20/2016	Not Applicable	340025.9	926838.72	7.00	8.91	-16.00	-26.00	23.00	33.00
APMW-6R	1/29/2019	Downgradient	340071.3	926854.6	5.50	8.11	-44.09	-54.09	49.59	59.59
		(APMW-6 Replacement)								
APMW-7	7/20/2016	Downgradient	340970.41	927159.53	10.50	13.00	-14.50	-24.30	25.00	34.80
APMW-8	7/21/2016	Downgradient	341076.09	926536.95	18.08	21.00	-11.60	-21.60	29.68	39.68
APMW-9	7/21/2016	Downgradient	341069.72	925210.34	19.83	22.41	-9.17	-19.77	29.00	39.60
APMW-10	7/22/2016	Downgradient	341075.2	924053.45	18.20	21.11	-1.80	-11.40	20.00	29.60
APMW-11	1/24/2019	Upgradient	342047.37	922071.42	19.60	22.45	-18.59	-28.44	38.19	48.04
APMW-12	1/28/2019	Upgradient	341563.98	922052.04	17.10	20.06	-22.44	-32.98	39.54	50.08
APMW-13	6/18/2020	Upgradient	342483.05	926186.44	1.77	4.49	-14.23	-19.23	16.00	21.00
APMW-14	6/16/2020	Upgradient	342570.07	926269.01	2.04	4.12	-13.96	-18.96	16.00	21.00
APMW-15	6/17/2020	Upgradient	342649.05	927097.17	2.17	4.25	-17.83	-22.83	20.00	25.00
APMW-16	6/17/2020	Upgradient	342564.75	927191.96	1.88	4.14	-17.12	-22.12	19.00	24.00
1S-GS	2017	Interior Piezometer	340851.67	924722.82	25.00	28.01	14.01	4.01	10.99	20.99
2S-GS	2017	Interior Piezometer	340861.81	926350.29	24.70	27.91	13.51	3.51	11.19	21.19
3S-GS	3/20/2017	Interior Piezometer	340372.07	926713	23.06	26.53	12.63	2.63	10.43	20.43
4A-GS	4/30/2018	Interior Piezometer	338618.42	926907.87	13.51	18.14	7.84	-2.16	5.67	15.67
4B-GS	4/30/2018	Interior Piezometer	338455.92	926725.21	12.78	18.05	7.75	-2.25	5.03	15.03
5S-GS	3/20/2017	Interior Piezometer	340050.5	924758.87	26.73	29.73	16.53	6.53	10.20	20.20
6S-GS	7/19/2019	Interior Piezometer	339546.29	926110.62	35.40	38.75	12.90	2.90	22.50	32.50
7S-GS	7/18/2019	Interior Piezometer	340149.68	925708.82	45.40	48.72	20.90	10.90	24.50	34.50
4 in PVC	8/7/2015	Interior Piezometer	339956.84	925268.08	33.66	34.01	14.01	4.01	19.65	29.65
1D-GS	7/16/2019	Interior Piezometer	340835.86	924696.34	25.47	28.41	-14.03	-24.03	39.50	49.50
2D-GS	7/17/2019	Interior Piezometer	340859.09	926371.79	24.61	27.62	-9.90	-19.90	34.50	44.50
4D-GS	8/28/2019	Interior Piezometer	338531.53	926826.32	12.66	15.59	-22.85	-32.85	35.50	45.5
5D-GS	8/28/2019	Interior Piezometer	340060.72	924739.72	26.62	29.46	-16.89	-26.89	43.50	53.5
6D-GS	7/18/2019	Interior Piezometer	339541.23	926085.07	36.12	39.24	-12.38	-22.38	48.50	58.50
7D-GS	7/17/2019	Interior Piezometer	340169.89	925694.47	45.24	48.19	-14.26	-24.26	59.50	69.50
TW-1	9/4/2019	Interior Test Well	340860.52	926407.05	24.71	27.76	-14.79	-29.79	39.50	54.5
TW-2	8/29/2019	Interior Test Well	339536.45	926050.77	35.84	39.02	-19.16	-49.16	55.00	85
TW-3	9/5/2019	Interior Test Well	338569.04	926814.53	13.84	16.37	-15.66	-35.66	29.50	49.5

**Notes:**

1. ft NAVD88 = feet North American Vertical Datum of 1988
2. ft bgs = feet below ground surface
3. interior indicates within the footprint of the former CCR Unit
4. Northing and Easting surveyed in Mississippi East State Plane Coordinate NAD 83 datum

**Table 2.**  
**Summary of Groundwater Protection Standards**  
**Plant Watson, Gulfport, Mississippi**

Analyte	Units	Background	MCL or RSL	Site-Specific GWPS
Antimony	mg/L	0.002	0.006	0.006
Arsenic	mg/L	0.0013	0.01	0.01
Barium	mg/L	0.11	2	2
Beryllium	mg/L	0.001	0.004	0.004
Cadmium	mg/L	0.001	0.005	0.005
Chromium	mg/L	0.0022	0.1	0.1
Cobalt	mg/L	0.0005	0.006	0.006
Combined Radium-226+228	pCi/L	2.492	5	5
Fluoride	mg/L	0.49	4	4
Lead	mg/L	0.001	0.015	0.015
Lithium	mg/L	0.019	0.04	0.04
Mercury	mg/L	0.0002	0.002	0.002
Molybdenum	mg/L	0.005	0.1	0.1
Selenium	mg/L	0.005	0.05	0.05
Thallium	mg/L	0.001	0.002	0.002

**Notes:**

1. Background levels from the March 2020 Statistical Analyses
2. MCL = Maximum Contaminant Level; RSL = Regional Screening Level
3. GWPS = Groundwater Protection Standard
4. mg/L = milligrams per liter; pCi/L = picocuries per liter



**Table 3.**  
**Evaluation of Groundwater Corrective Measures**  
**Plant Watson, Gulfport, Mississippi**

Groundwater Corrective Measure <sup>2</sup>	Evaluation Criteria <sup>1</sup>						
	Performance	Reliability	Ease of Implementation	Potential Impacts	Time Requirement to Implement Remedy	Time Requirement to Achieve Groundwater Protection Standards (GWPS) <sup>4</sup>	Institutional Requirements
In-Situ Injections	Moderate; likely needs to be combined with an alternative technology to attenuate some inorganic constituents (e.g., lithium)	Medium; dependent on permeability and heterogeneity of the subsurface and distribution of amendments; requires evaluation of the potential for rebound under variable redox conditions	Easy to moderate; injection infrastructure required; potential for clogging	Minimal; potential to mobilize naturally-occurring constituents	12 - 24 months	Estimated > 10 years (for small localized area); duration depends on a number of factors, including amendment longevity, required re-injection events, and flux of impacted groundwater	Underground injection control (UIC) permit; possible deed restrictions
Pump and Treat (P&T; Hydraulic Containment and Dewatering)	High; reduces constituents to below GWPS when online	Medium to high; system downtime for maintenance may impact reliability	Moderate; requires ex-situ treatment design and well network installation; treatment of lithium may be challenging	Groundwater extraction may alter the geochemistry within the hydraulic capture zone and will alter groundwater flow hydraulics in the vicinity of the former CCR Unit	18 - 24 months	Estimated > 25 years	Potential modifications to existing National Pollutant Discharge Elimination System (NPDES) permit (discharge option) or new UIC permit (groundwater reinjection option); possible consumptive use permit for groundwater extraction; possible deed restrictions
Monitored Natural Attenuation (MNA) <sup>3</sup>	Medium to high; dependent on oxidation-reduction conditions, aquifer reactivity, and aquifer attenuation capacity; typically coupled with effective source control	Moderate to high; depends on aquifer attenuation capacity and longevity of aquifer conditions that results in attenuation remaining favorable	Easy; monitoring well network already in place	Negligible	12 - 24 months	Estimated > 25 years (when used in isolation - shorter durations may be achieved when coupled with other groundwater technologies)	Possible deed restrictions
Permeable Reactive Barrier (PRB)	Moderate; likely needs to be combined with an alternative technology to attenuate some inorganic constituents (e.g., lithium)	Medium; reactive media will need to be replaced periodically	Moderate to difficult; trenching required to install reactive materials in the subsurface; space constraints may complicate installation	Potential to mobilize naturally-occurring constituents; potential to alter groundwater flow hydraulics in the vicinity of the former CCR Unit	24 - 36 months	Estimated > 25 years (arsenic, combined radium, and molybdenum only; duration depends on a number of factors, including PRB longevity and continued flux of impacted groundwater through the PRB)	Possible deed restrictions
Subsurface Vertical Barrier Walls	High; may need to be combined with an alternative technology (e.g., PRB) for optimal performance	High; O&M requirements vary depending on if groundwater extraction and subsequent treatment is required	Moderate to difficult; limited by installation depth	Will alter groundwater flow hydraulics in the vicinity of the former CCR Unit	18 - 24 months	Estimated > 25 years	Possible deed restrictions

Notes:

1. Evaluation criteria is based on the regulatory guidance in 40 CFR 257.96(C).
2. These corrective measures will be coupled with the completed source control at Plant Watson which is closure in place with capping, including a final cover system.
3. MNA is often used in combination with other remedial technologies.
4. The estimated durations are approximate and based on case histories and professional judgment. Detailed duration estimates requires further evaluation.

**Table 4.  
Advantages and Disadvantages of Groundwater Corrective Measures  
Plant Watson, Gulfport, Mississippi**

Groundwater Corrective Measure	Advantages (Electric Power Research Institute, 2015 <sup>1</sup> )	Disadvantages (Electric Power Research Institute, 2015 <sup>1</sup> )
In-Situ Injections	<ul style="list-style-type: none"> <li>• Can generally be installed at any time during or after closure</li> <li>• Minimal site disruption</li> <li>• Ability to treat small, localized areas</li> <li>• Applicable in congested, sensitive or less accessible areas where other technologies may not be feasible</li> </ul>	<ul style="list-style-type: none"> <li>• Expected to treat arsenic, combined radium, and molybdenum, but not lithium</li> <li>• Does not remove constituents, just converts to a less mobile and/or less toxic form</li> <li>• May be reversed or constituents may remobilize if site geochemical conditions change</li> <li>• Limited access to low-permeability zones</li> <li>• Other treatment technologies may be required</li> </ul>
Pump and Treat (P&T; Hydraulic Containment and Dewatering)	<ul style="list-style-type: none"> <li>• Generally installed post-closure or post-source control as permanent treatment; earlier for risk reduction or hydraulic containment</li> <li>• The technology is widely used and easily available</li> <li>• Systems can be installed as deep as typical well drilling technology</li> <li>• Systems can be operated for decades and can be modified over time to increase or decrease extraction rates or modify the system to adapt to changing conditions</li> <li>• Treatment systems can be designed to effectively remove constituents from the extracted groundwater</li> <li>• Systems can be very effective at hydraulically containing impacted groundwater</li> <li>• Effective for conservative constituents (e.g., lithium)</li> </ul>	<ul style="list-style-type: none"> <li>• Design of ex-situ treatment system required</li> <li>• There can be significant, long-term O&amp;M requirements</li> <li>• Treatment wastes must be managed and disposed</li> <li>• Studies have found that, in most cases, cleanup levels are not met in the source zone at hydraulic containment sites</li> <li>• Long (tens of years) remediation times</li> <li>• Constituent levels can rebound if treatment is halted</li> <li>• System may reach a point of diminishing returns where concentrations stabilize above regulatory standards for inorganic constituents</li> <li>• Other treatment technologies may be required</li> </ul>
Monitored Natural Attenuation (MNA)	<ul style="list-style-type: none"> <li>• Can generally be implemented at any time during or after closure; often coupled with source control</li> <li>• Minimal site disruption</li> <li>• Relatively easy implementation</li> <li>• Smaller carbon footprint than more active measures; sustainable</li> <li>• Applicable in congested, sensitive or less accessible areas where other technologies may not be feasible</li> </ul>	<ul style="list-style-type: none"> <li>• Time frames to achieve cleanup objectives range from 5 to 150 years, with 10 to 40 years being the most commonly proposed when used in isolation</li> <li>• Other treatment technologies may be required</li> </ul>
Permeable Reactive Barrier (PRB)	<ul style="list-style-type: none"> <li>• Can generally be installed at any time during or after closure</li> <li>• Relatively passive technology with low maintenance (except during media replacement)</li> <li>• Can be designed to work around some infrastructure and in more confined areas</li> <li>• No need to manage extracted groundwater</li> <li>• Reduced need to dispose treatment by-products until media needs to be replaced</li> </ul>	<ul style="list-style-type: none"> <li>• Construction methods can cause reduced permeability and impact performance of the wall</li> <li>• Impacted groundwater may flow under, over, or around the PRB wall</li> <li>• Reactive media will need to be replaced at some point; used media will need to be assessed for hazardous characteristics</li> <li>• Depth required may be at or beyond the limit of construction</li> <li>• Uncommon for treatment of molybdenum and combined radium; likely not applicable to lithium</li> <li>• Other treatment technologies may be required</li> </ul>
Subsurface Vertical Barrier Walls	<ul style="list-style-type: none"> <li>• Reliable and widely-accepted technology; applicable to a wide range of constituents</li> <li>• Minimal waste, no excavation required for sheet pile walls</li> <li>• Minimal site disturbance once installed</li> <li>• Limited site access for sheet pile walls less of a problem than with trench-type walls</li> <li>• Can be irregularly shaped in confined areas</li> <li>• Easily installed in areas with high groundwater and surface water</li> <li>• Sheet pile walls with an interlocking, sealable joint can improve impermeability and resistance</li> <li>• Sheet pile walls can be easily removed for temporary applications</li> </ul>	<ul style="list-style-type: none"> <li>• Sheet pile walls can corrode if steel and/or leak at the seams</li> <li>• Vibrations for sheet pile wall installation can impact nearby structures/impoundments</li> <li>• Mounding, end-around, or under-flow could occur if hydraulics not evaluated properly</li> <li>• Groundwater extraction often required within the barrier wall</li> <li>• Subsurface conditions may limit depth of wall installation</li> <li>• Other treatment technologies may be required</li> </ul>

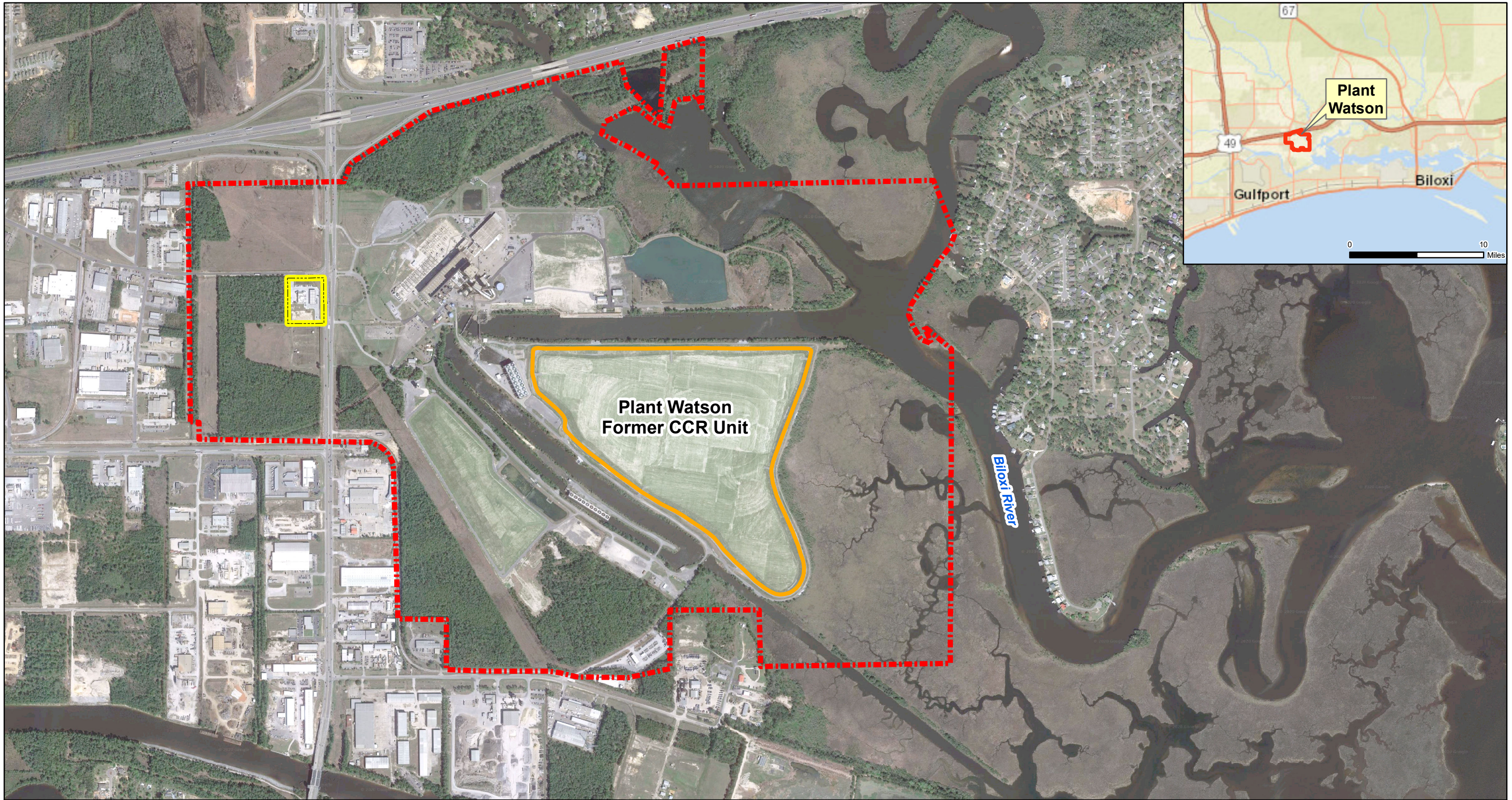
Note:

1. Reference: Electric Power Research Institute (EPRI), 2015. Corrective Action for Closed and Closing Ash Ponds. EPRI, Palo Alto, California: December 2015. 3002006292.

**Table 5.**  
**Conceptual Schedule for Groundwater Corrective Measures Selection**  
**Plant Watson, Gulfport, Mississippi**

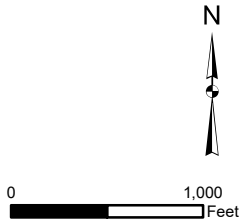
Number	Anticipated Tasks	Estimated Completion Date
1	Field Studies and Data Collection	Mid-2021
2	Groundwater Flow and/or Geochemical Modeling	Early-2021
3	Bench Testing and/or Pilot Studies	Mid-2021 to Early-2022
4	Public Meeting	Mid-2022
5	Selection of Final Remedy	Late-2022

# FIGURES



- Legend**
- Former CCR Unit Boundary
  - RaceTrac Gas Station Property Boundary
  - Plant Watson Property Boundary





**Notes:**  
 1. Property boundary georeferenced from Southern Company Services, 2020. Groundwater Monitoring Report. Mississippi Power Company. Plant Watson Ash Pond. 21 February.  
 2. CCR - Coal Combustion Residuals  
 3. Aerial Source: Google Earth Imagery 3/18/2019



<b>Plant Watson Location Map</b>	
Plant Watson Gulfport, Mississippi	
Pensacola, FL	August 2020
<b>Figure 1</b>	



**Legend**

- APMW-1  CCR Monitoring Well
- APMW-13  New Background CCR Monitoring Well
- APMW-11  Existing Background CCR Monitoring Well
-  Former CCR Unit Boundary

Notes:  
 1. CCR - Coal Combustion Residuals  
 2. Aerial Source: Google Earth Imagery 3/18/2019



**CCR Monitoring Well Network**  
 Plant Watson  
 Gulfport, Mississippi

**Geosyntec**   
 consultants

Pensacola, FL





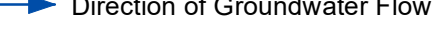

August 2020

**Figure**

**2**



**Legend**

-  Monitoring Well
-  Piezometer
-  Potentiometric Surface (ft NAVD88)
-  Inferred Potentiometric Surface (ft NAVD88)
-  Direction of Groundwater Flow
-  Former CCR Unit Boundary

Notes:  
 1. Potentiometric surface contours were generated by Southern Company Services.  
 2. Elevations are in feet (ft) relative to the North American Vertical Datum of 1988 (NAVD88).  
 3. CCR - Coal Combustion Residuals  
 4. Aerial Source: Google Earth Imagery 3/18/2019



**Unit 3 Aquifer Potentiometric Surface  
08/29/2019**

Plant Watson  
Gulfport, Mississippi

**Geosyntec**  
consultants

Pensacola, FL

August 2020

**Figure**

**3**



- Legend**
- Monitoring Well
  - Piezometer
  - Potentiometric Surface (ft NAVD88)
  - Inferred Potentiometric Surface (ft NAVD88)
  - Direction of Groundwater Flow
  - Former CCR Unit Boundary

Notes:  
 1. Potentiometric surface contours were generated by Southern Company Services.  
 2. Elevations are in feet (ft) relative to the North American Vertical Datum of 1988 (NAVD88).  
 3. CCR - Coal Combustion Residuals  
 4. Aerial Source: Google Earth Imagery 3/18/2019



**Unit 3 Aquifer Potentiometric Surface  
03/16/2020**

Plant Watson  
Gulfport, Mississippi

**Geosyntec**  
consultants

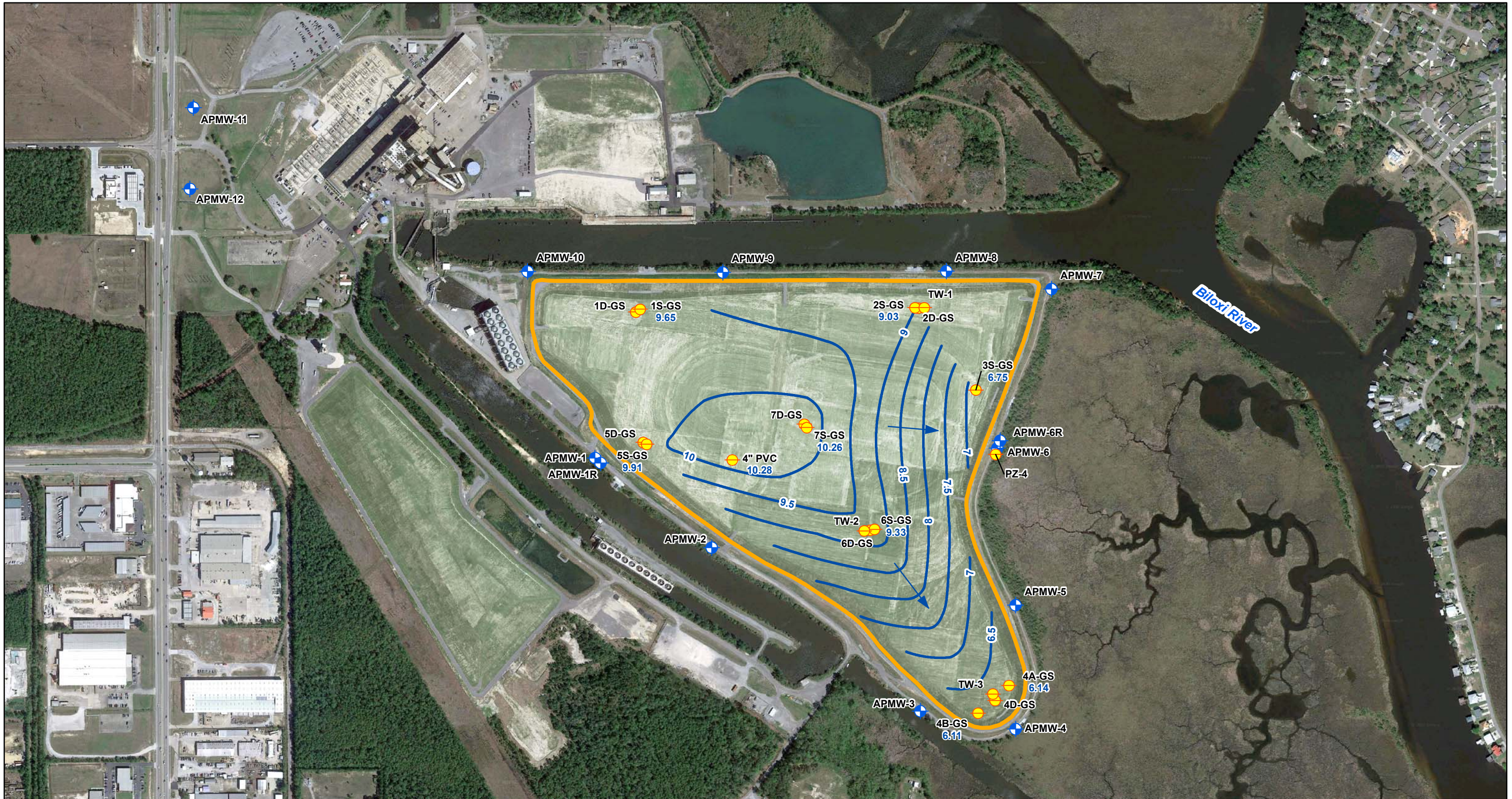
Pensacola, FL

August 2020

**Figure**

**4**



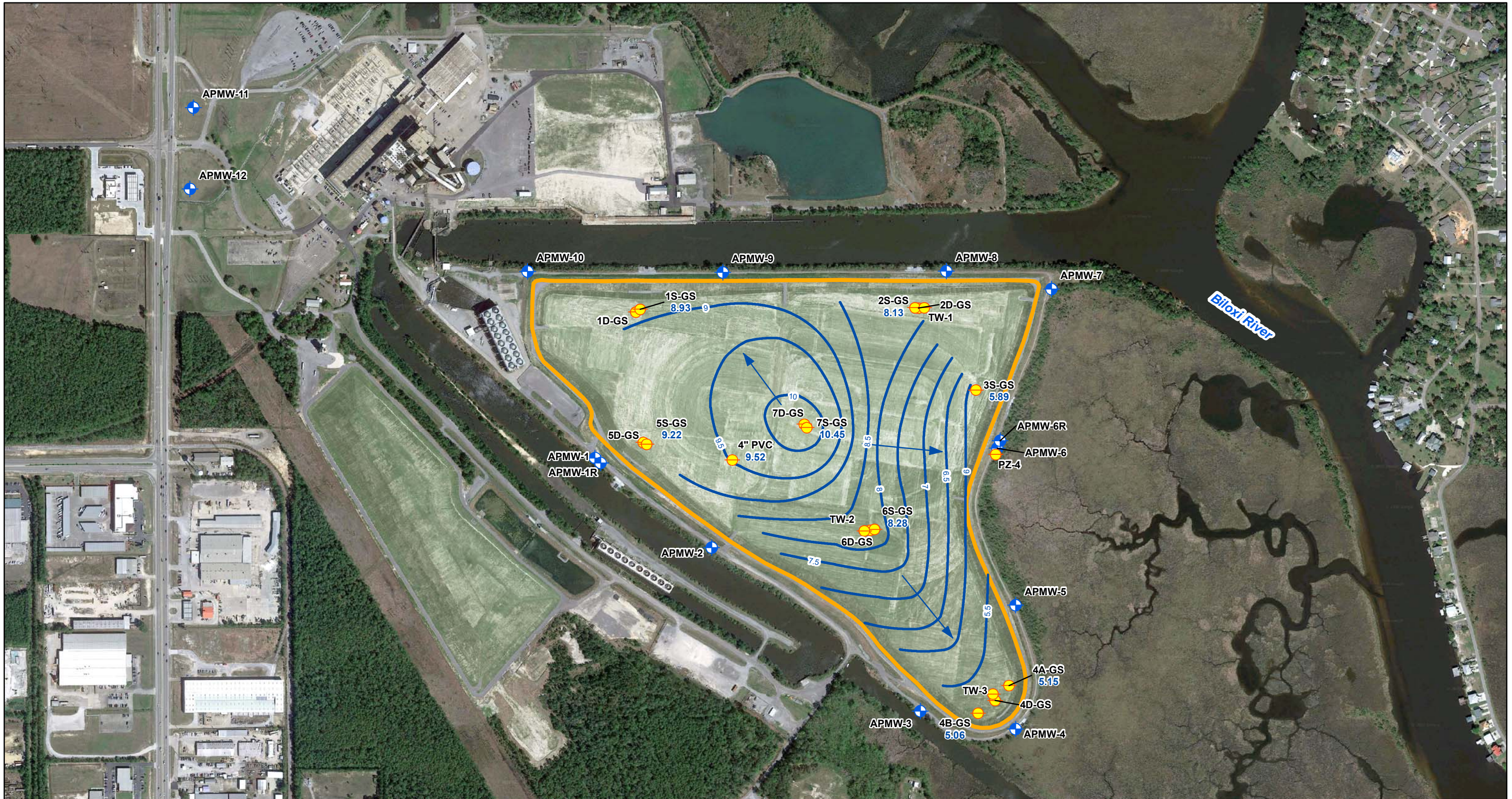


- Legend**
- Monitoring Well
  - Piezometer
  - Potentiometric Surface (ft NAVD88)
  - Direction of Groundwater Flow
  - Former CCR Unit Boundary

Notes:  
 1. Potentiometric surface contours were generated by Southern Company Services.  
 2. Elevations are in feet (ft) relative to the North American Vertical Datum of 1988 (NAVD88).  
 3. CCR - Coal Combustion Residuals  
 4. Aerial Source: Google Earth Imagery 3/18/2019



<b>Former CCR Unit</b> <b>Porewater Potentiometric Surface</b> <b>08/29/2019</b> Plant Watson Gulfport, Mississippi	
Pensacola, FL	August 2020
<b>Figure</b>	
<b>5</b>	

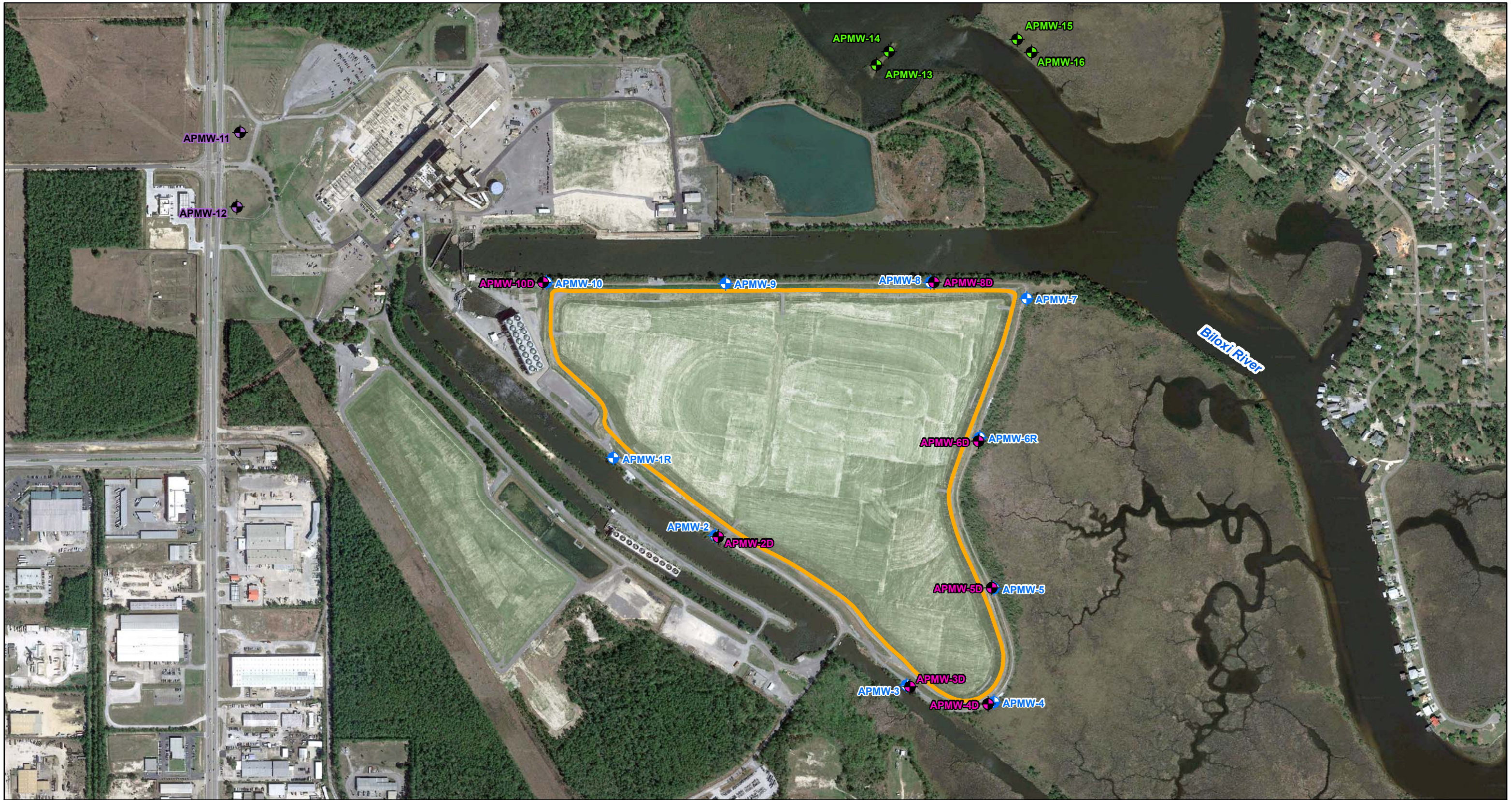


- Legend**
- ◆ Monitoring Well
  - Piezometer
  - Potentiometric Surface (ft NAVD88)
  - Direction of Groundwater Flow
  - Former CCR Unit Boundary

Notes:  
 1. Elevations are in feet (ft) relative to the North American Vertical Datum of 1988 (NAVD88).  
 2. CCR - Coal Combustion Residuals  
 3. Aerial Source: Google Earth Imagery 3/18/2019



<p><b>Former CCR Unit</b>  <b>Porewater Potentiometric Surface</b>  <b>03/16/2020</b>          Plant Watson          Gulfport, Mississippi</p>	
<p><b>Geosyntec</b>          consultants</p>	
<p>Pensacola, FL</p>	<p>August 2020</p>
<p><b>Figure</b> <b>6</b></p>	



**Legend**

- APMW-1 CCR Monitoring Well
- APMW-13 New Background CCR Monitoring Well
- APMW-11 Existing Background CCR Monitoring Well
- APMW-2D Vertical CCR Delineation Monitoring Well
- Former CCR Unit Boundary

Notes:  
 1. CCR - Coal Combustion Residuals  
 2. Aerial Source: Google Earth Imagery 3/18/2019



**Vertical Delineation  
Monitoring Well Locations**

Plant Watson  
Gulfport, Mississippi

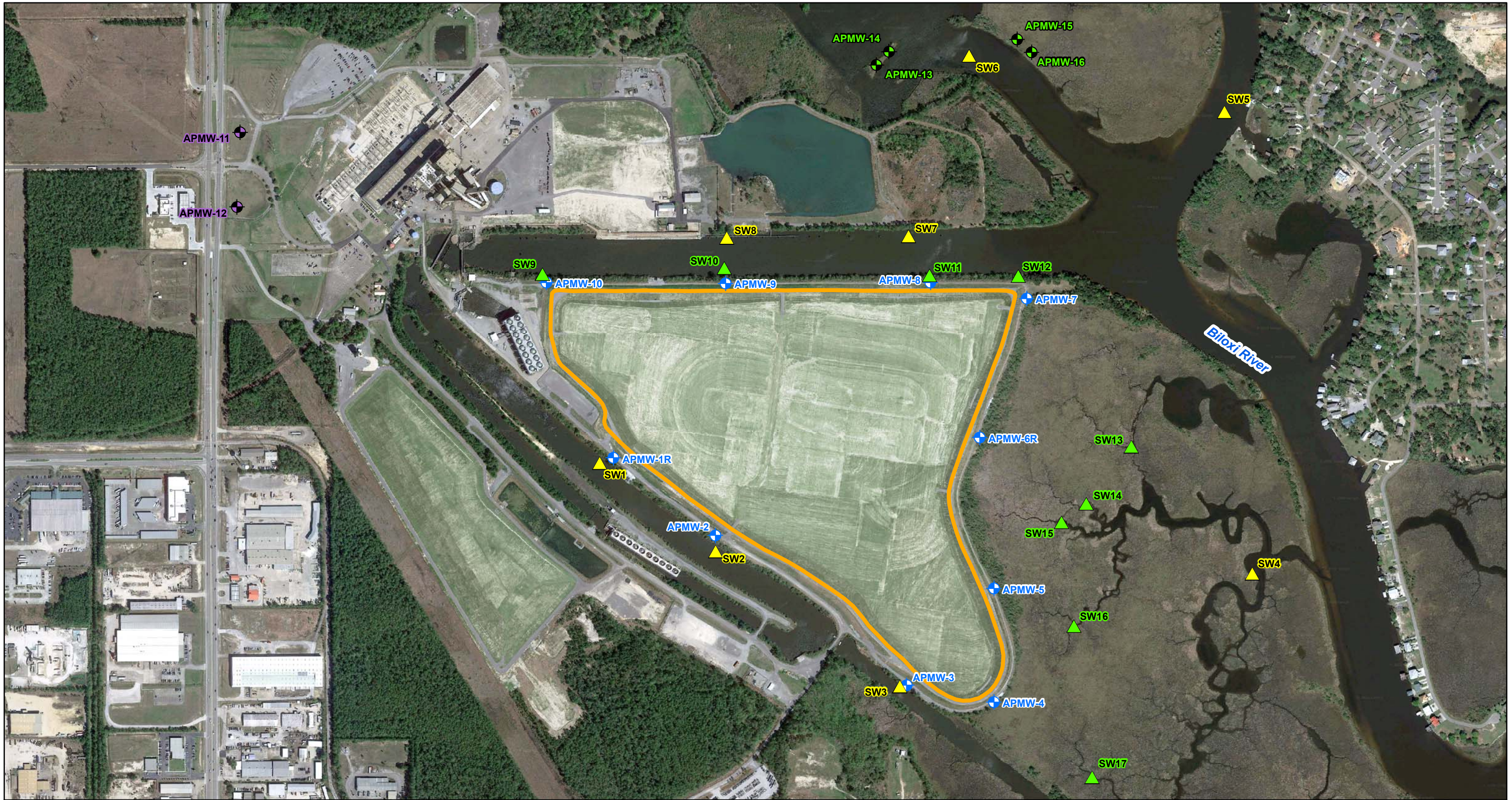
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Pensacola, FL







August 2020

**Figure**

**7**



**Legend**

- APMW-1  CCR Monitoring Well
- APMW-13  New Background CCR Monitoring Well
- APMW-11  Existing Background CCR Monitoring Well
- SW1  Existing Surface Water Location
- SW9  Additional Surface Water Monitoring Location
-  Former CCR Unit Boundary

Notes:  
 1. CCR - Coal Combustion Residuals  
 2. Aerial Source: Google Earth Imagery 3/18/2019



**Surface Water Sampling Locations for Horizontal Extent Assessment**

Plant Watson  
 Gulfport, Mississippi

**Geosyntec**  
 consultants

Pensacola, FL

August 2020

**Figure**

**8**