# Gavin Bottom Ash Complex

Gavin Power, LLC

## 2018 Annual Groundwater Monitoring and Corrective Action Report

Gavin Power Plant
Cheshire, Ohio

31 January 2019

Project No.: 0469558

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ERM

## Signature Page

31 January 2019

# Gavin Bottom Ash Complex

## 2018 Annual Groundwater Monitoring and Corrective Action Report
## Gavin Power Plant
## Cheshire, Ohio

| | |
|---|---|
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## Acronyms and Abbreviations

| **Name** | **Description** |
|---|---|
| ASD | Alternate Source Demonstration |
| BAC | Bottom Ash Complex |
| CCR | Coal Combustion Residual |
| CFR | Code of Federal Regulations |
| ERM | Environmental Resources Management |
| SSI | Statistically significant increase |
| TDS | Total Dissolved Solids |

# 1. INTRODUCTION

The General James M. Gavin Power Plant (Plant) is a coal-fired generating station located in Gallia County in Cheshire, Ohio, along the Ohio River. The Plant consists of three regulated coal combustion residual (CCR) management units that are subject to regulation under Title 40, Code of Federal Regulations, Part 257, Subpart D (40 CFR § 257.50 *et seq.*) (also known as the CCR Rule): the Residual Waste Landfill, the Fly Ash Reservoir, and the Bottom Ash Complex (BAC). The BAC is adjacent to and immediately south of the main Plant area (Figure 1-1). The BAC consists of two ponds situated along the Ohio River. The larger pond is the Bottom Ash Pond and the smaller pond is the Recirculation Pond or Reclaim Pond. The BAC receives bottom ash and miscellaneous Plant wastewaters including coal-pile runoff, cooling-tower blowdown, pyrites, and various Plant sump wastewaters. It has been operational since 1974.

This report was produced by Environmental Resources Management (ERM), on behalf of Gavin Power, LLC, and documents the status of the groundwater monitoring program for the BAC, which includes the following as required by 40 CFR § 257.90(e):

- A summary of key actions completed;
- A description of problems encountered and actions taken to resolve the problems; and
- Identification of key activities for the coming year.

Consistent with the notification requirements of the CCR Rule, this annual groundwater monitoring report will be posted to the Plant's operating record no later than 31 January 2019 (40 CFR § 257.105(h)(1)). Within thirty days of placing the report in the operating record, notification will be made to the Ohio Environmental Protection Agency, and the report will be placed on the Plant's publicly accessible internet site (40 CFR § 257.106(h)(1), 257.107(h)(1)). Table 1-1 cross-references the reporting requirements under the CCR Rule with the contents of this report.

# Table 1-1: Regulatory Requirement Cross-References

| Regulatory Citation in 40 CFR Part 257, Subpart D | Requirement (paraphrased) | Where Addressed in this Report |
|---|---|---|
| § 257.90(e) | Status of the groundwater monitoring program. | Section 2 |
| § 257.90(e) | Summarize key actions completed. | Section 2.3 |
| § 257.90(e) | Describe any problems encountered and actions taken to resolve problems. | Section 2.3 |
| § 257.90(e) | Key activities for upcoming year. | Section 4.0 |
| § 257.90(e)(1) | Map, aerial image, or diagram of CCR Unit and monitoring wells. | Figures 1-1, 2-1 |
| § 257.90(e)(2) | Identification of new monitoring wells installed or abandoned during the preceding year and narrative description. | Not applicable—there were no new monitoring wells installed or abandoned during the preceding year. |
| § 257.90(e)(3) | Summary of groundwater data, wells sampled, date sampled, and whether sample was required under detection or assessment monitoring. | Section 2.3, 3.2 |
| § 257.90(e)(4) | Narrative discussion of any transition between monitoring programs. | Section 4.0 |
| § 257.94(e)(2) (via § 257.90(e)(5)) | Any alternate source demonstration (ASD) reports and related certifications. | Appendices A–C |

# 2. PROGRAM STATUS § 257.90(E)

## 2.1 Monitoring Well Network

The groundwater monitoring well network consists of three upgradient monitoring wells (BAC-01, MW-1, and MW-6) and four downgradient monitoring wells (BAC-02, BAC-03, BAC-04, and BAC-05). All of the monitoring wells are screened in the uppermost aquifer around the BAC. The uppermost aquifer is approximately 25 feet to 35 feet thick and consists of fine to coarse sand; it is located below an approximately 20-foot-thick confining layer of silty clay with interbedded sand and silt, and above a shale bedrock unit.

The monitoring well locations are shown on the site location map and aerial image provided on Figure 2-1. No new wells were installed or decommissioned after the certification of the well network by Geosyntec in 2016 (Geosyntec 2016).

## 2.2 2016 and 2017 Groundwater Monitoring

The BAC monitoring wells were sampled eight times between August 2016 and July 2017. Consistent with the CCR Rule and the Statistical Analysis Plan developed for Gavin Power (ERM 2017), ERM used a prediction limit approach to identify potential impacts to groundwater. ERM established prediction limits based on the upgradient data, and then compared them to the most recent (July 2017) results from the downgradient wells (ERM 2018a). This comparison resulted in the identification of statistically significant increases (SSIs) for certain analytes in the downgradient wells as summarized in Table 2-1.

**Table 2-1: SSIs in July 2017**

| Analyte | BAC-02 | BAC-03 | BAC-04 | BAC-05 |
|---|---|---|---|---|
| Boron | X | X | X | X |
| Calcium | X | ϕ | ϕ | ϕ |
| Chloride | X | X | X | ϕ |
| Fluoride | ϕ | ϕ | ϕ | X |
| pH | X | X | X | X |
| Sulfate | X | X | X | X |
| TDS | X | ϕ | X | ϕ |

*ϕ = No SSI, X = SSI; TDS = total dissolved solids*
*Results are for the downgradient wells sampled from 14 to 19 July 2017*

Alternate sources were successfully identified for each of the SSIs identified in the July 2017 data and documented in the Gavin BAC ASD Report (ERM 2018b). The first ASD Report of 2018 identified the mixing of upgradient groundwater and Ohio River surface water as the key factor controlling groundwater pH between the BAC and the Ohio River; regional discharge of groundwater as the source of calcium, chloride, fluoride, sulfate, and total dissolved solids (TDS); and the Kyger Creek Northern Fly Ash Pond as the source of boron. A copy of the first ASD Report is included in Appendix A.

## 2.3 2018 Sampling Summary

In 2018, the BAC was under a detection monitoring program, and each of the seven monitoring wells was sampled in May and September 2018 for the 40 CFR Part 257, Subpart D, Appendix III analytes. A summary of the 2018 sample dates and the well gradient designation (upgradient or downgradient of the CCR unit) is provided in Table 2-2.

**Table 2-2: Sampling Dates for Each Well**

| Well | Location | Date Sampled | | |
|---|---|---|---|---|
| | | **5/15/18** | **5/16/18** | **9/18/18** |
| BAC-01 | Upgradient | | X | X |
| BAC-02 | Downgradient | X | | X |
| BAC-03 | Downgradient | X | | X |
| BAC-04 | Downgradient | X | | X |
| BAC-05 | Downgradient | | X | X |
| MW-1 | Upgradient | X | | X |
| MW-6 | Upgradient | | X | X |

During the May and September sampling events, no significant problems were encountered and no actions were needed to resolve problems.

## 2.4 Data Quality

ERM reviewed field and laboratory documentation to assess the validity, reliability, and usability of the analytical results. Samples collected in 2018 were analyzed by TestAmerica of North Canton, Ohio. Data quality information reviewed for these results included field sampling forms, chain-of-custody documentation, holding times, laboratory methods, laboratory method blanks, laboratory control sample recoveries, field duplicate samples, matrix spikes/matrix spike duplicates, quantitation limits, and equipment blanks. Based on the review of the data quality information, no analytical results were rejected and it was not necessary to add data qualifiers to any of the 2018 results. ERM's data quality review found the laboratory analytical results to be valid, reliable, and useable for decision-making purposes.

# 3. 2018 RESULTS

## 3.1 2018 Groundwater Flow Direction and Velocity

Gavin personnel measured depth to groundwater at each monitoring well prior to each sampling event. Groundwater elevations, calculated by subtracting the depth to groundwater from the surveyed reference elevation for each well, were reviewed for each sampling event. A potentiometric surface map for May 2018 is presented on Figure 3-1 and a potentiometric surface map for September 2018 is presented on Figure 3-2.

The hydraulic gradient for both 2018 sampling events was to the northeast, toward the Ohio River. Based on records from the U.S. Geological Survey gauging station at Point Pleasant, West Virginia, neither the May nor the September sampling events occurred during or after a period of flooding of the Ohio River. The northeasterly groundwater flow direction observed in May and September 2018 is consistent with the flow directions observed previously during times of lower river stage.

Measured hydraulic gradients were 0.0007 and 0.001 in the May and September sampling events, respectively. Based on the measured hydraulic gradients, an assumed porosity of 0.3, an estimated hydraulic conductivity of 0.5 centimeters per second based on the grain size distribution of the sandy alluvium (Freeze and Cherry 1979), the velocity of groundwater in the alluvial aquifer beneath the BAC varied between 1300 and 1800 feet per year when the groundwater elevation data were collected.

## 3.2 Comparison of Results to Prediction Limits

Consistent with the CCR Rule and with the Statistical Analysis Plan (ERM 2017) in the operating record, a prediction limit approach was used to identify potential impacts to groundwater. Upper prediction limits were developed for the Appendix III parameters; in the case of pH, a lower prediction limit was also developed. Documentation of the development of the upper prediction limits and lower prediction limit for the BAC is provided in the 2017 Annual Groundwater Monitoring and Corrective Action Report (ERM 2018a).

### *3.2.1 May 2018 Results*

A comparison of the May 2018 results to the prediction limits identified SSIs for certain analytes in the downgradient wells, as summarized in Table 3-1.

**Table 3-1: SSIs from May 2018 Sampling Event**

| Analyte | BAC-02 | BAC-03 | BAC-04 | BAC-05 |
|---|---|---|---|---|
| Boron | X | X | X | X |
| Calcium | X | ϕ | ϕ | ϕ |
| Chloride | X | X | X | X |
| Fluoride | ϕ | ϕ | ϕ | ϕ |
| pH | X | X | X | X |
| Sulfate | X | X | X | X |
| TDS | X | X | X | ϕ |
| *Notes: ϕ = No SSI, X = SSI*<br>*Results are for the downgradient wells sampled from 15 May to 17 May 2018.* | | | | |

Alternate sources were identified for each of the SSIs detected in the May 2018 data and documented in the first Gavin BAC Semiannual Sampling Event of 2018 ASD Report (ERM 2018c). This ASD Report identified the mixing of upgradient groundwater and Ohio River surface water as the key factor controlling groundwater pH between the BAC and the Ohio River; regional discharge of groundwater as the source of calcium, chloride, sulfate, and TDS; and the Kyger Creek Northern Fly Ash Pond as the source of boron. A copy of the first Gavin BAC Semiannual Sampling Event of 2018 ASD Report is included in Appendix B.

### *3.2.2 September 2018 Results*

A comparison of the September 2018 results to the prediction limits identified SSIs for the following analytes in the downgradient wells, as summarized in Table 3-2.

**Table 3-2: SSIs from September 2018 Sampling Event**

| Analyte | BAC-02 | BAC-03 | BAC-04 | BAC-05 |
|---|---|---|---|---|
| Boron | X | X | X | X |
| Calcium | X | ϕ | ϕ | ϕ |
| Chloride | X | X | X | X |
| Fluoride | X | ϕ | ϕ | ϕ |
| pH | X | X | X | X |
| Sulfate | X | X | X | X |
| TDS | X | ϕ | ϕ | ϕ |

*Notes: ϕ = No SSI, X = SSI*
*Results are for the downgradient wells sampled on 18 September 2018.*

Alternate sources were identified for each of the SSIs associated with the September 2018 data and documented in the Gavin BAC Second Semiannual Sampling Event of 2018 ASD Report (ERM 2018d). This ASD Report identified the mixing of upgradient groundwater and Ohio River surface water as the key factor controlling groundwater pH between the BAC and the Ohio River; regional discharge of groundwater as the source of calcium, chloride, fluoride, sulfate, and TDS; and the Kyger Creek Northern Fly Ash Pond as the source of boron. A copy of the Gavin BAC Second Semiannual Sampling Event of 2018 ASD Report is included in Appendix C.

A summary of all analytical results obtained from the BAC groundwater monitoring is provided in Appendix D.

# 4. KEY FUTURE ACTIVITIES

The three ASD Reports prepared to date (provided in Appendices A, B, and C) concluded that sources other than the BAC were responsible for the identified SSIs. As required by 40 CFR § 257.94(e)(2), the demonstrations were completed within 90 days of detecting the SSIs and were certified by a qualified professional engineer. Because it met these requirements, the BAC currently remains in detection monitoring. Two rounds of groundwater sampling will be performed in 2019 at the BAC, and results will be compared to the prediction limits.

# 5. REFERENCES

ERM (Environmental Resources Management). *Groundwater Monitoring Plan. Bottom Ash Complex, Fly Ash Reservoir, and Residual Waste Landfill*, *Gavin Plant, Cheshire Ohio*. 2017.

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ERM. *Gavin Bottom Ash Complex Alternate Source Demonstration Report*. 2018b.

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ERM. *Gavin Bottom Ash Complex Second Semiannual Sampling Event of 2018 Alternate Source Demonstration Report*. 2018d.

Freeze and Cherry. 1979. *Groundwater*. Prentice Hall Inc., Upper Saddle River, NJ.

Geosyntec. *Groundwater Monitoring Network Evaluation, Gavin Site—Bottom Ash Complex, Cheshire, Ohio*. 2016.

USEPA (United States Environmental Protection Agency). 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Unified Guidance. USEPA/530/R/09/007*. Washington D.C.: Office of Resource Conservation and Recovery. 2009.

# FIGURES

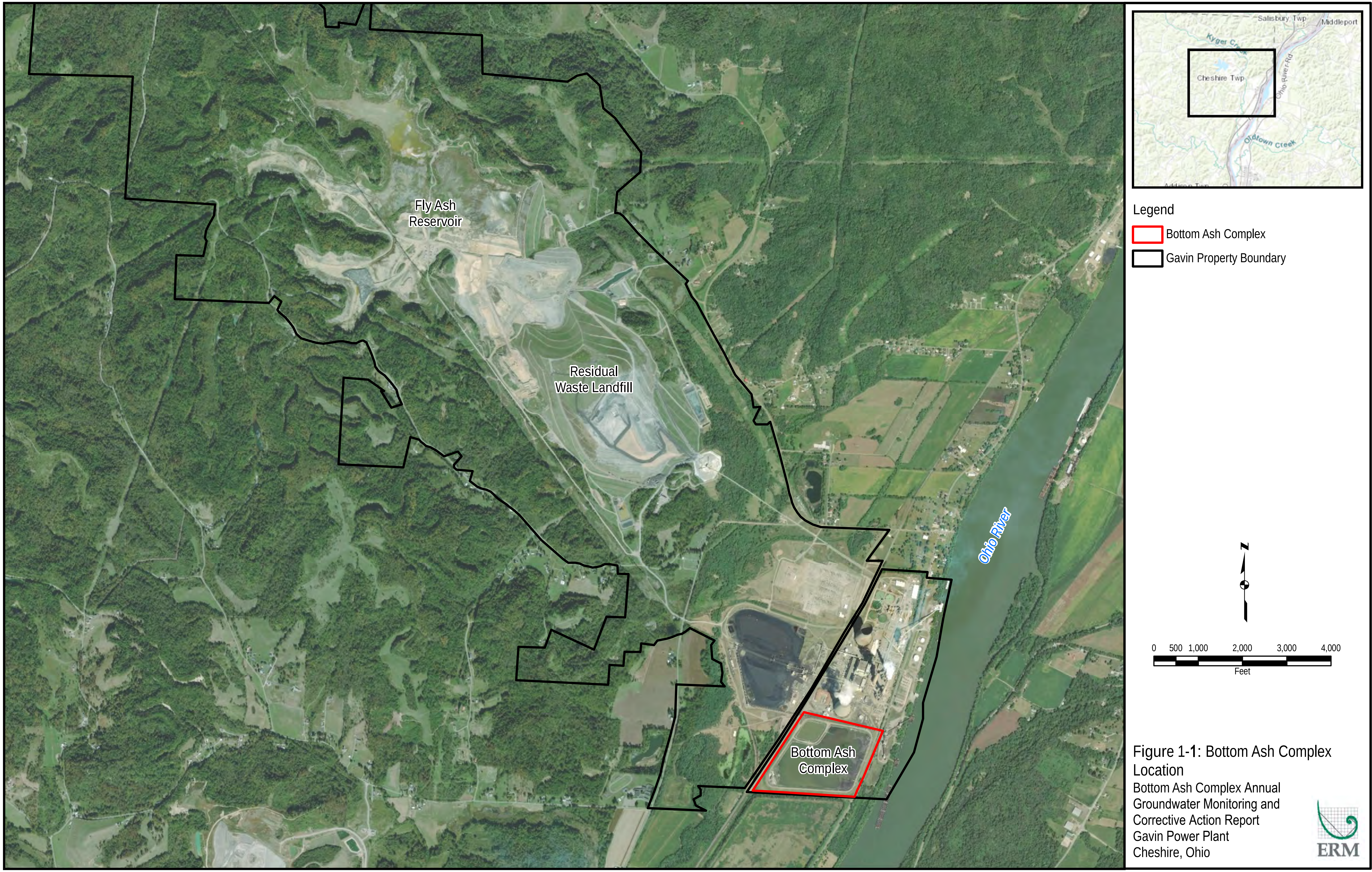
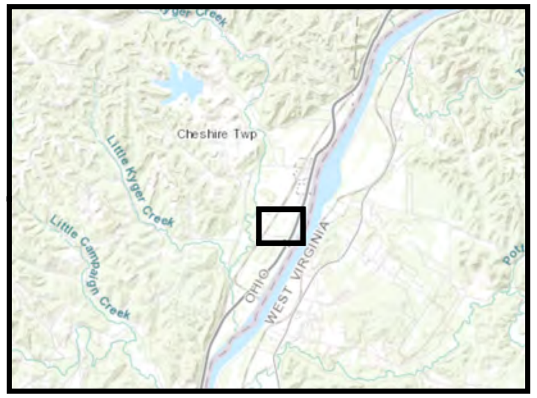


Figure 1-1: Bottom Ash Complex Location

Bottom Ash Complex Annual
Groundwater Monitoring and
Corrective Action Report
Gavin Power Plant
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\2nd_SemiAnnual_ASD\Figure1_2_BACLocation_20181221.mxd - Dana.Heusinkveld - 12/28/2018



Legend

⊕ Federal Sampling Program Groundwater Monitoring Well

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
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**Figure 2-1**: Monitoring Well Network Bottom Ash Complex Annual Groundwater Monitoring and Corrective Action Report
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Legend

| | |
|---|---|
| ⌖ | Federal Sampling Program Groundwater Monitoring Well |
| 539.85 | Groundwater Elevation (ft) |
| — | Potentiometric Contour (ft) |
| → | Interpreted Groundwater Flow Direction |

NOTES:
1. Locations are approximate
2. Groundwater elevations based on measurements made on 5/15/2018
3. Aerial Imagery: ESRI World Imagery Reproduced under license in ArcGIS 10.5

Figure **3-1**: May 2018 Groundwater Flow Direction

Bottom Ash Complex Annual Groundwater Monitoring and Corrective Action Report
Gavin Power Plant
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\BAC_AnnualGWMonitoring_CorrectiveActionReport\Figure2_BAC_May2018_GWFlowDirection_20181129.mxd - Dana.Heusinkveld - 12/14/2018

NOTES:
1. Locations are approximate
2. Groundwater elevations based on measurements made on 9/6/2017
3. Aerial Imagery: ESRI World Imagery Reproduced under license in ArcGIS 10.5

Figure 3-2: September 2018 Ground-water Flow Direction Bottom Ash Complex Annual Groundwater Monitoring and Corrective Action Report
Gavin Power Plant
Cheshire, Ohio

ERM

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# APPENDIX A GAVIN BOTTOM ASH COMPLEX ALTERNATE SOURCE DEMONSTRATION REPORT

# Gavin Bottom Ash Complex Alternate Source Demonstration

07.03.2018

Project No.: 0402270

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## Acronyms and Abbreviations

| | |
|---|---|
| amsl | Above mean sea level |
| ASD | Alternate Source Demonstration |

| | |
|---|---|
| CCR | Coal Combustion Residuals |
| CCR Rule | Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments |
| CCR Unit | Bottom Ash Complex CCR Surface Impoundment |
| CFR | Code of Federal Regulations |
| EPA | United States Environmental Protection Agency |
| EPA Guidance | Solid Waste Disposal Facility Criteria Technical Manual, EPA 530-R-93-017, Subpart E (Nov. 1993) |
| Gavin | Gavin Power, LLC |
| Plant | General James M. Gavin Power Plant |
| MSWLFs | Municipal Solid Waste Landfills |
| NFAP | Kyger Creek North Fly Ash Pond |
| OEPA | Ohio Environmental Protection Agency |
| SFAP | Kyger Creek South Fly Ash Pond |
| SSI | statistically significant increase |
| USGS | United States Geological Survey |

# 1 Introduction

## 1.1 Regulatory and Legal Framework

In accordance with 40 Code of Federal Regulations (CFR) Part 257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (“CCR Rule”), Gavin Power, LLC (“Gavin”) has been implementing the groundwater monitoring requirements of Section 257.90 et seq. for its Bottom Ash Complex (BAC) CCR Surface Impoundment (the “CCR Unit”) at the General James M. Gavin Power Plant (the “Plant”). Gavin collected and analyzed at least eight baseline detection monitoring samples for each upgradient and downgradient well in the certified groundwater monitoring network before October 17, 2017, pursuant to 40 CFR Section 257.94(b). Gavin calculated background levels and conducted statistical analyses for Appendix III constituents in accordance with 40 CFR Section 257.93(h). Statistically Significant Increases (SSIs) over background concentrations in downgradient monitoring wells for Appendix III constituents were reported in the Annual Groundwater Monitoring and Corrective Action Report (ERM 2018).

An SSI for one or more Appendix III constituents is a potential indication of a release of constituents from the CCR unit to groundwater. In the event of an SSI, the CCR Rule provides that “the owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality” (see 40 CFR § 257.94(e)(2)). If it can be demonstrated that the SSIs are due to a source other than the CCR unit, then the CCR unit may remain in the Detection Monitoring Program instead of transitioning to an Assessment Monitoring Program. An Alternate Source Demonstration (ASD) must be made in writing, and the accuracy of the information must be verified through certification by a qualified Professional Engineer.

The CCR Rule and the regulatory preamble do not contain requirements or reference agency guidance for a successful ASD. However, the United States Environmental Protection Agency (EPA) previously issued guidance for conducting ASDs under the regulatory program governing Municipal Solid Waste Landfills (MSWLFs), upon which EPA modeled the groundwater monitoring provisions of the CCR Rule (see 80 Fed. Reg. 21302, 21396 (Apr. 17, 2015)). Because of the substantial similarity between the language governing ASDs in the CCR Rule and the MSWLF regulations, EPA’s guidance document provides a useful framework for ASDs under the CCR Rule.

EPA’s guidance document, Solid Waste Disposal Facility Criteria Technical Manual, EPA 530-R-93-017, Subpart E (Nov. 1993) (“EPA Guidance”), lays out six lines of evidence that should be pursued in a demonstration that an SSI resulted from a source other than the regulated disposal unit:

1. An alternative source exists.
2. Hydraulic connection exists between the alternative source and the well with the significant increase.
3. Constituent(s) (or precursor constituents) are present at the alternative source or along the flow path from the alternative source prior to possible release from the unit.

4. The relative concentration and distribution of constituents in the zone of contamination are more strongly linked to the alternative source than to the unit when the fate and transport characteristics of the constituents are considered.
5. The concentration observed in ground water could not have resulted from the unit given the waste constituents and concentrations in the unit leachate and wastes, and site hydrogeologic conditions.
6. The data supporting conclusions regarding the alternative source are historically consistent with the hydrogeologic conditions and findings of the monitoring program.

This ASD addresses each of these lines of evidence for the SSIs identified in the groundwater beneath the BAC.

## 1.2 Background

The Plant is a coal-fired generating station located in Gallia County in Cheshire, Ohio, along the Ohio River (Figure 1-1). The BAC is one of three CCR management units at the Plant that are subject to regulation under the CCR Rule and is located adjacent to and immediately south of the main Plant area along the Ohio River (Figure 1-2). The BAC has been in operation since 1974 and receives bottom ash and miscellaneous Plant wastewaters including coal-pile runoff, cooling-tower blowdown, pyrites, and various Plant sump wastewaters.

The BAC consists of two ponds: the larger pond is the Bottom Ash Pond (BAP) and the smaller pond is the Reclaim Pond. The BAC's perimeter dikes are approximately 6,600 feet in length and range in height from approximately 25 feet to 35 feet above the surrounding grade. The BAC was not constructed with a liner that meets the requirements of section 40 CFR 257.71(a); however, soil borings drilled by American Electric Power in 2015 confirmed that the dikes were constructed of clay, and the native soils immediately beneath the BAC consist of an approximately 20-foot thick layer of silty clay with some interbedded sand and silt (Geosyntec 2016).

The groundwater monitoring well network consists of three upgradient monitoring wells (BAC-01, MW-1, and MW-6) and four downgradient monitoring wells (BAC-02, BAC-03, BAC-04, and BAC-05) positioned around the perimeter of the BAC (Figure 1-3). In addition, monitoring well B-0904 is located to the south of the BAC and is used in this report to evaluate the quality of groundwater migrating from the Kyger Creek North Fly Ash Pond (NFAP) and under the BAC. All of the monitoring wells are screened in the uppermost aquifer beneath the BAP and Reclaim Pond units. The uppermost aquifer has the following characteristics (Geosyntec 2019):

- Comprised of fine to coarse sand with some gravel that gets progressively finer with decreasing depth;
- Approximately 25 feet to 35 feet thick;
- Located below the approximately 20-foot thick silty clay confining layer, and above a shale bedrock unit.

The BAC monitoring wells were sampled eight times between August 2016 and July 2017. Consistent with the CCR Rule and the Statistical Analysis Plan developed for Gavin Power (ERM 2017), a prediction limit approach was used to identify potential impacts to groundwater. Prediction limits were established based on the upgradient data, and then compared to the most recent results from the downgradient wells. This comparison resulted in the identification of statistically significant increases for the following analytes in the downgradient wells as summarized in Table 1-1.

**Table 1-1. Statistically Significant Increases in Groundwater Beneath the BAC**

| Analyte | BAC-02 | BAC-03 | BAC-04 | BAC-05 |
|---|---|---|---|---|
| Boron | X | X | X | X |
| Calcium | X | ϕ | ϕ | ϕ |
| Chloride | X | X | X | ϕ |
| Fluoride | ϕ | ϕ | ϕ | X |
| pH | X | X | X | X |
| Sulfate | X | X | X | X |
| TDS | X | ϕ | X | ϕ |

Notes: ϕ = No SSI, X = SSI

## 1.3 Alternate Source Demonstration Roadmap

This ASD identifies the mixing of upgradient groundwater and Ohio River surface water as the key factor controlling groundwater pH between the BAC and the Ohio River; regional discharge of groundwater as the source of calcium, chloride, fluoride, sulfate, and TDS; and the Kyger Creek NFAP as the source of boron. Supporting information and additional discussion of each of the lines of evidence discussed in Section 1.1 are presented in subsequent sections of this report.

# 2 Description of Alternate Sources

## 2.1 Ohio River

The Ohio River extends approximately 981 river miles from Pittsburgh, Pennsylvania to Cairo, Illinois, and drains an area of approximately 205,000 square miles (Ohio River Valley Water Sanitation Commission 2018). The Ohio River is located approximately 700 feet east of the BAC and the alluvial aquifer beneath the BAC is hydraulically connected to the river. When the Ohio River floods, water from the river mixes with groundwater within the alluvial aquifer. Data from the Point Pleasant gauging station, which is located approximately 6 miles from the Plant, show the Ohio River typically floods in the winter and spring, and the duration and severity of the flooding events varies from year to year (Figure 2-1). The mixing of groundwater and river water that results from the river flooding is discussed in Section 3, and the quality of the Ohio River water that mixes with groundwater is discussed in Section 4.

## 2.2 Regional Background

The regional bedrock geology near the Plant includes Pennsylvanian age (299 to 311 million years old) sedimentary rocks from the Monongahela and Conemaugh Groups. These sedimentary rocks consist primarily of shale and siltstone, with minor amounts of mudstone, sandstone, and incidental amounts of limestone and coal (USGS 2005). These sedimentary rocks dip to the southeast. Overlying the Pennsylvanian age rocks are Quaternary age (1.8 million years old to present) alluvium that consist primarily of sand, silt, clay and gravel (OEPA 2018). The sedimentary rocks form the ridges and valleys west of the Ohio River, and the unconsolidated sand, silt, clay, and gravel is located along the Ohio River (Figure 2-2). The consolidated sedimentary rocks and the unconsolidated alluvium (sand, silt, clay, and gravel) form the two major aquifers near the Plant. The interaction of groundwater with rocks and minerals within these aquifers can influence the concentration of Appendix III constituents (boron, calcium, chloride, fluoride, pH, sulfate, and TDS) (Ohio River Valley Water Sanitation Commission 1984).

Naturally-occurring brine is known to exist at depths of 300 to 500 feet below the ground surface in the Ohio River valley, which is known to be rich in calcium, chloride, sulfate, and other trace elements (Ohio River Valley Water Sanitation Commission 1984). Naturally occurring brines in the Appalachian Basin are known to contain fluoride at concentrations as high as 33 mg/L (Kelly 1973, and Poth 1962). Some of the brines also exist close to the land surface. For example, brine was discovered at the land surface approximately 10 miles southwest of the Plant in Gallipolis, Ohio, and has been utilized for the commercial production of salt starting in 1807 (Geological Survey of Ohio 1932). Naturally occurring brine was also identified at the land surface in Jackson, Ohio, approximately 30 miles west of the Plant (ODNR 1995). The presence of brine in the region, both in the subsurface and at the land surface, indicates the potential for naturally occurring brine to contribute Appendix III constituents to shallow groundwater at the Plant.

Other regional activities with the potential to influence the concentration of Appendix III constituents in groundwater include:

- The drilling of oil and gas wells, which could allow brines from deeper strata to migrate upward to shallower water-bearing rock strata (OEPA 2003);

- Over-pumping water supply wells, which allows the upward migration of brines that naturally occur in deeper rock strata (Ohio River Valley Water Sanitation Commission 1984); and
- The use of brine on roadways for ice and dust control (OEPA 2012).

To account for natural and anthropogenic influences on Appendix III constituents on a regional scale, background groundwater data were obtained from US Geological Survey databases. The background groundwater data set is discussed further in Section 4.

## 2.3 Kyger Creek Generating Station

The Kyger Creek Generating Station is located along the Ohio River in Gallia County, south of the Plant (Figure 2-3). The Kyger Creek fly ash pond complex consists of the 110-acre NFAP and 60-acre South Fly Ash Pond (SFAP). The NFAP was the original fly ash pond; the SFAP, although presently used for fly ash, was formerly a boiler slag pond.

The ponds were constructed in 1955 using locally available native materials (i.e. soil). Between 2 and 10 feet of silty clay soils were removed to create base elevations of 550 feet above mean sea level (amsl) for the SFAP and 558 feet above mean sea level for the NFAP. No liner was installed at either of the ponds prior to emplacement of CCR materials. The NFAP was drained, capped, and closed in 1997. The NFAP cap includes 5 feet of boiler slag, 2 feet of compacted clay and one foot of topsoil. (AEP 2016; AEP 1994; CHA, 2010; OVEC 1996). The NFAP is located less than 300 feet from the BAC, and the units share an approximately 2,000 foot long border (Figure 2-3).

Groundwater monitoring wells were installed and sampled at the NFAP as part of the state-regulated closure process. Results were summarized in one or more reports submitted to the Ohio Environmental Protection Agency (OEPA). Although the reports are no longer available from the agency due to their document retention policies, agency correspondence was available. An internal OEPA memo dated 28 August 1998 (Appendix A) indicates the following:

- OEPA reviewed results from six monitoring wells sampled in October 1997, January 1998 and May of 1998;
- The monitoring wells were installed in pairs that consisted of one shallow and one deep well, which allowed for comparison of shallow and deep water quality at three locations; and
- Differences in water quality between the shallow and deep wells at two of three locations indicate shallow groundwater at the NFAP appears to be impacted, and the differences may be related to a release from the NFAP.

The NFAP has a higher potential to impact groundwater than the BAC because the NFAP contains fly ash, which has a greater tendency to leach CCR constituents, and the BAC contains bottom ash, which has a lower tendency to leach CCR constituents. This is described further in Section 7.

# 3 Hydraulic Connections to the Alternate Sources

## 3.1 Ohio River

Both the Gavin BAC and the Kyger Creek NFAP are located above the alluvial aquifer (Geosyntec 2016; AGES 2016). The approximate horizontal extent of the alluvial aquifer is shown on Figure 2-2. The alluvial aquifer exists as a fining upward sequence (the size of the aquifer materials gets smaller with decreasing depth) of sand, silt and clay deposits. The majority of the BAC monitoring wells are screened across the sand deposits in deeper portions of the alluvial aquifer. The depth to groundwater was measured at BAC wells on nine separate events between August 2016 and February 2018. These measurements were used to calculate groundwater elevations and interpret groundwater flow directions for each of the events (Figure 3-1 through Figure 3-9). Groundwater flowed toward the northeast during each of the gauging events except during February 2017 and February 2018, when groundwater flowed to the west or northwest.

During the seven gauging events when groundwater flowed toward the northeast, groundwater elevations in the alluvial aquifer beneath the BAC were between 542 and 538 feet amsl and the stage of the Ohio River (the elevation of the surface water in the river) was typically between 538 feet and 540 feet amsl (Figure 3-10). Under these conditions, the groundwater elevations were slightly higher than the river elevation, which resulted in groundwater flow toward the river.

During or immediately prior to the times when groundwater flowed to the west or northwest, the Ohio River stage was generally above 540 feet amsl and at times as high as 580 feet amsl (Figure 3-10). Under these conditions, the elevation of surface water in the river was higher, or had recently been higher than the elevation of groundwater in the alluvial aquifer, which resulted in a reversal of groundwater flow direction. The westward gradient (i.e. the groundwater flow reversal) observed in February 2018 (Figure 3-9) is consistent with the expected response of the aquifer immediately following a prolonged period of flooding (Figure 3-10). The correlation of the flow reversals with Ohio River flooding is strong evidence that the alluvial aquifer is hydraulically connected to the Ohio River.

To assess the impact of Ohio River flooding on the direction of groundwater flow beneath the BAC, the following steps were taken:

- Groundwater velocity was estimated based on measured or estimated hydraulic conductivity, hydraulic gradients and porosity;
- A general relationship between the Ohio River and BAC groundwater flow direction was established; and
- An average groundwater flow direction was determined based on the observed hydraulic gradients, the relationship between the river and groundwater flow directions and the estimated groundwater velocity.

ERM estimated the hydraulic conductivity of the alluvial aquifer to be approximately 0.5 centimetres per second, based on the grain size distribution of the sandy alluvium (Feeze and Cherry 1979). Based on the estimated hydraulic conductivity and measured hydraulic gradients, the average velocity of groundwater below the BAC is approximately 5 feet per day to the northeast during times of low river stage and 21 feet per day to the west or northwest during times of high river stage. Based on the relationship between the river and groundwater flow observed from 2016 to 2018 (Figure 3-1 to Figure 3-10), the threshold river stage for when flow reversals occur appears to be about 540 feet amsl.

## 3.2 Regional Background

Regional groundwater flow near and surrounding the Plant occurs within the fractured sedimentary rocks of the Conemaugh and Monongahela Groups (Figure 2-2). Within these sedimentary rocks, groundwater preferentially moves through fractures, and moves more slowly or not at all through un-fractured (i.e., solid rock matrix) portions of these rocks. Fractured bedrock permeability is a function of the fracture characteristics, such as whether a fracture is large enough to transmit groundwater, and whether groups of fractures are sufficiently interconnected to transmit water. Various studies have shown that the fracture networks are responsible for transmitting water through the sedimentary bedrock aquifers of the Appalachian Plateau, where the Plant is located (USGS 1981; USGS, 2016).

In general, groundwater flows from areas of higher hydraulic head (i.e., high topographic elevation) to areas of lower hydraulic head (i.e., low topographic elevation). Near the Plant, the areas with the highest hydraulic head are located west of the Plant, and the area of lowest hydraulic head is along the Ohio River. Table 3-1 summarizes the average hydraulic head from August 2016 to July 2017 for the Morgantown and Cow Run Sandstone under the Gavin Fly Ash Reservoir (FAR), the Gavin Residual Waste Landfill (RWL), and for the alluvial aquifer under the BAC.

**Table 3-1. Average Hydraulic Heads**

| | FAR | RWL | BAC |
|---|---|---|---|
| Average Hydraulic Head – Alluvial Aquifer (ft amsl) | NA (not applicable) | NA | 540.24 |
| Average Hydraulic Head – Morgantown (ft amsl) | 650.03 | 604.23 | NA |
| Average Hydraulic Head –Cow Run Sandstone (ft amsl) | 614.51 | 553.16 | NA |

The locations of the FAR and RWL are shown on Figure 1-2. As shown in Table 3-1, the average hydraulic head is highest in the FAR, intermediate at the RWL and lowest at the BAC, which demonstrates groundwater flow is from the areas of higher topographic elevation (i.e. the FAR) toward areas of lower topographic elevation (i.e., the BAC and Ohio River).

Precipitation that falls in the higher topographic elevation areas west of the Plant infiltrates the land surface and recharges the underlying aquifers. As groundwater migrates from west to east, it migrates both horizontally and vertically through the fracture network within the sedimentary bedrock, and then mixes with groundwater in the alluvial aquifer as the groundwater approaches the river. The mixture of groundwater derived from bedrock and alluvium then discharges to the Ohio River (Figure 3-11). Thus, regional groundwater is hydraulically connected to the downgradient BAC monitoring wells.

### 3.3 Kyger Creek Generating Station

The Ohio River stage elevation records (Figure 2-1) were used to identify the frequency and duration of flow reversals, and were combined with the groundwater velocity estimates to develop groundwater flow paths under the BAC (Figure 3-12). There are three key points associated with the groundwater flow paths:

1. The Kyger Creek NFAP is hydraulically upgradient of most but not all of the Gavin BAC;
2. Due to the northeast flow direction, the Kyger Creek NFAP is not upgradient of the western edge of the BAC, where upgradient monitoring wells MW-1, BAC-01 and MW-6 are located; and
3. State monitoring well B-0904 is directly downgradient of the NFAP and upgradient of the BAC.

Based on the presence of the same alluvial aquifer beneath both the Kyger Creek NFAP and the Gavin BAC (Figure 2-2), and the average northeastern direction of groundwater flow (Figure 3-12), it is evident that the Kyger Creek NFAP is hydraulically connected to the downgradient BAC monitoring wells.

# 4 Constituents are Present at the Alternate Sources or Along the Flow Pathways

## 4.1 Ohio River

The pH of the Ohio River is relatively close to neutral and the pH of groundwater emanating from the Kyger Creek North Fly Ash Pond is slightly acidic (Table 4-1, Figure 4-1). As described in Section 3, the hydrogeologic data indicates that water from the Ohio River mixes with groundwater from the alluvium underlying the BAC. When these waters mix under the BAC, the result is an intermediate pH, which is what is observed in the groundwater monitoring wells downgradient of the BAC.

**Table 4-1. Groundwater and Surface Water pH Values**

| Location | pH |
|---|---|
| Kyger Creek NFAP Groundwater (B-0904, February 2018) | 5.2 |
| BAC Downgradient Groundwater (BAC-02 through BAC-05) | 6.2 -6.8 |
| Ohio River (February 2018) | 7.3 |

These results are consistent with the observed groundwater flow directions described in Section 3 and demonstrate that the Ohio River is an alternate source for pH.

## 4.2 Regional Background

Background groundwater quality data were obtained from the United States Geological Survey (USGS) National Water Information System database. Groundwater results were selected for monitoring wells constructed within the alluvial, Conemaugh Group and Monongahela Group aquifers located within 50 miles of the Plant (Figure 4-2). The USGS background data was compared to downgradient BAC data (wells BAC-02, BAC-03, BAC-04 and BAC-05) and Ohio River data collected in February 2018. As shown in Table 4-2, the concentrations of calcium, chloride, fluoride, sulfate, and TDS in groundwater downgradient of the BAC is between the concentrations in USGS background groundwater and the Ohio River. These results support the conclusion that the discharge of groundwater from the sedimentary rock aquifers to the alluvial aquifer beneath the BAC is an alternate source for calcium, chloride, fluoride, sulfate, and TDS, and the results are consistent with the mixing of groundwater and Ohio River water described in Section 3.

**Table 4-2. Comparison of USGS Regional Background to BAC and Ohio River**

| Analyte | Units | USGS Background | Downgradient BAC[1] | Ohio River[1] |
|---|---|---|---|---|
| Calcium | mg/L | 520 | 94 - 190 | 28 |
| Chloride | mg/L | 9,900 | 21 - 97 | 25 |
| Fluoride | mg/L | 8.8 | 0.08 – 0.22 | 0.09 |
| Sulfate | mg/L | 2700 | 150 - 360 | 44 |
| TDS | mg/L | 9,910 | 420 - 900 | 190 |

[1] Results from samples collected in February 2018

## 4.3 Kyger Creek Generating Station

The concentration of boron in BAC groundwater (Figure 4-3) ranges from less than 0.1 milligrams per liter (mg/L) to 3.9 mg/L. Figure 4-3 shows the distribution of boron at the Kyger Creek NFAP and along the flow pathways as summarized below:

- The highest boron concentrations were measured in wells B-0904 and BAC-05, which are located closest to and downgradient of the Kyger Creek NFAP; and
- Concentrations decrease with distance downgradient from the NFAP along the northeastern flow path.

In addition to the OEPA correspondence that concluded NFAP groundwater appears to be impacted by a release from the NFAP (Appendix A), the SFAP data also suggest boron is present in Kyger Creek groundwater. Boron results from eight rounds of groundwater sampling conducted between October 2015 and September 2017 at SFAP downgradient monitoring wells (AEG 2018) are summarized in Table 4-3.

**Table 4-3. Kyger Creek SFAP Boron Results**

| Analyte | Units | Maximum | Average |
|---|---|---|---|
| Boron | mg/L | 17.7 | 6.8 |

The average concentration of boron in the SFAP is higher than the highest concentration of boron measured in groundwater beneath the BAC. Given that the SFAP and the NFAP both manage fly ash generated at the Kyger Creek Generating Station, it is reasonable to expect that the chemical characteristics of the landfilled fly ash are similar in both units. Given the elevated boron concentrations in groundwater downgradient of the SFAP, and considering that both units are unlined, elevated concentrations of boron in groundwater downgradient of the Kyger Creek NFAP are expected.

# 5 Linkages of Constituent Concentrations and Distributions between Alternate Sources and Downgradient Wells

## 5.1 Ohio River

As described in Section 3, the groundwater elevation and flow directions shown in Figure 3-1 to 3-9 provide strong evidence of groundwater flow reversals and the mixing of Ohio River surface water with BAC groundwater. The intermediate pH of BAC downgradient groundwater between the pH of Kyger Creek groundwater and the Ohio River is consistent with the mixing of surface water and groundwater. These lines of evidence show there is a linkage between BAC groundwater and the Ohio River.

## 5.2 Regional Background

As described in Section 3.2 and illustrated in Figure 3-11, groundwater flow in the Conemaugh Group and Monongahela Group sedimentary aquifers discharges to the alluvium along the Ohio River, including the region beneath the BAC. As described in Section 4.2, regional concentrations of calcium, chloride, fluoride, sulfate, and TDS are higher than groundwater concentrations downgradient of the BAC. Based on these observations, it is likely that the discharge of groundwater from the sedimentary rock aquifers to the alluvial aquifer under the BAC (Figure 5-1 and Figure 5-2) is an alternate source for these constituents.

## 5.3 Kyger Creek Generating Station

As described in Section 2, the OEPA reviewed groundwater data from the NFAP and identified differences in water quality between shallow and deep wells. They concluded that shallow groundwater at the NFAP appears to be impacted, and the differences may be related to a release from the NFAP (Appendix A).

In general, when a solute is released to groundwater, the highest concentrations are typically observed at the point of the release. As the solute is transported away from the source area, mixing caused by the movement of water through the aquifer results in decreasing concentrations with distance from the source area. As described in Section 4.1, and shown in Figure 4-3, the highest concentrations of boron are located at the the downgradient boundary of the NFAP, which is also the southern (upgradient) boundary of the BAC. Concentrations gradually decline with distance northward along the flow path. The relative concentration and distribution in groundwater are consistent with the NFAP as the source of boron, and are not consistent with the BAC as the source of boron.

Hydrogeologic cross sections were prepared to further demonstrate the connection between the NFAP and the BAC by incorporating the following information:

- Kyger Creek NFAP and BAC construction information;
- The lateral extent of the alluvial aquifer based on state mapping and observations of the alluvial deposits under the BAC made during the advancement of soil borings (Geosyntec 2016);
- Groundwater elevations measured in BAC monitoring wells; and
- The stage (surface water elevation) of the Ohio River.

During times of low river stage (Figure 5-1), groundwater in the alluvial aquifer moves in a north easterly direction from the NFAP, under the BAC, and eventually discharges to the Ohio River. During times of higher river stage (Figure 5-2), groundwater in the alluvial aquifer temporarily reverses direction and river water flows into the aquifer. Despite the temporary reversals of groundwater flow caused by flooding of the Ohio River, the overall, long-term flow direction is to the northeast, indicating that the source of boron detected in the monitoring wells downgradient of the BAC is connected with the Kyger Creek NFAP.

# 6 A Release from BAC is Not Supported as the Source

## 6.1 BAC Surface Water Concentrations are Lower than Groundwater Concentrations

The concentrations of boron, calcium, chloride, sulfate, and TDS in BAC surface water (i.e., the water impounded in the BAC) are lower than the maximum concentrations of these constituents in groundwater downgradient of the BAC (Table 6-1).

**Table 6-1. BAC Surface Water and Groundwater Concentrations**

| Analyte | BAC Surface Water (mg/L) | Downgradient BAC Groundwater (mg/L)[1] |
|---|---|---|
| Boron | 0.18 | 3.9 |
| Calcium | 71 | 190 |
| Chloride | 72 | 110 |
| Sulfate | 190 | 440 |
| TDS | 470 | 1110 |

[1] Maximum 2016 to 2017 detection at downgradient wells BAC-02, BAC-03, BAC-04, BAC-05

If the BAC were the source, the concentrations of these constituents in BAC surface water would need to be higher to produce the concentrations measured in groundwater (e.g., it is unlikely that a release of surface water with 0.18 mg/L boron would result in a groundwater boron concentration greater than 0.18 mg/L). These results support the conclusions that the BAC is not the source of the SSIs for boron, calcium, chloride, sulfate, and TDS in BAC downgradient wells.

## 6.2 Chemical Fingerprints

The geochemical fingerprint of surface water and groundwater from the BAC, groundwater from the NFAP, and surface water from the Ohio River were determined using a piper diagram. The piper diagram is a graphical procedure commonly used to interpret sources of dissolved constituents in water, and evaluate the potential for mixing of waters from different sources (Piper 1944). The samples presented on the diagram were collected from the BAC from 2012 through 2018. The diagram was prepared by plotting the relative proportions of cations (calcium, sodium, potassium, and magnesium) and anions (chloride, sulfate, carbonate, and bicarbonate) in the two lower triangles, and projecting the combined cation and anion results into an upper diamond region. Anion and cation results from each sample are normalized to 100, and the relative concentrations are plotted as a percentage basis. The primary observations and conclusions based on the BAC piper diagram (Figure 6-1) are the following:

- Multiple samples collected from a single location (e.g., the Ohio River, or well B-0904) tended to be tightly clustered, which indicates the chemical signatures of individual locations were consistent over time;
- Groundwater from BAC upgradient wells MW-1, BAC-02 and MW-6 has a unique geochemical signature dominated by calcium, bicarbonate, and chloride, and groundwater that flows under the northwest portion of the BAC is not influenced by the Kyger Creek NFAP or the Ohio River;
- Groundwater from well B-0904, which is downgradient of the Kyger Creek NFAP, is dominated by calcium, magnesium, and sulfate, and has a signature that is distinct from all other chemical signatures on the diagram;

- Surface water from the Ohio River plots closer to the center of the diagram, and is dominated by calcium, sulfate, and chloride;
- Groundwater from BAC downgradient wells BAC-02, BAC-03, BAC-04 and BAC-05 plots between the Ohio River and NFAP groundwater, which is an independent line of evidence that groundwater under a majority of the BAC is a mixture of groundwater from the NFAP (represented by well B-0904, which is upgradient of the BAC) and the Ohio River; and
- Surface water from the BAP has a different signature than downgradient groundwater, and thus is not likely the source of impacts to BAC groundwater.

# 7 Alternate Source Data are Historically Consistent with Hydrogeologic Conditions

## 7.1 Ohio River

The hydraulic connection of the Ohio River to the alluvial aquifer was established after the last deglaciation (USGS 2004). Seasonal flooding of the Ohio River, which has occurred regularly over the time frame that the Plant has existed, is the driving force behind the mixing of surface water and groundwater. Thus, the Ohio River constitutes an alternate source that is historically consistent with hydrogeologic conditions and findings of the monitoring program.

## 7.2 Regional Background

This report provides background groundwater quality for the fractured sedimentary rock aquifers found within and beyond the boundary of the Plant. The patterns of regional groundwater flow through fractured rock near the BAC were established after the last deglaciation, which occurred approximately 14,000 years ago (Hansen 2017). Estimated maximum groundwater velocities for the Morgantown and Cow Run sandstones range from 2 to 5 feet per year (ERM 2017), which would allow ample time for groundwater to migrate from upgradient regional areas onto the Gavin property since the end of the last glaciation. The data supporting these conclusions are historically consistent with hydrogeologic conditions and findings of the BAC monitoring program.

## 7.3 Kyger Creek Generating Station

The Kyger Creek NFAP was constructed in 1955 with its base on native soil, without an engineered liner to contain leachate. The unit was used to manage fly ash until it was drained and closed in 1997, and dewatered ash is still present within the NFAP. Groundwater flows under the NFAP in a north-easterly direction toward and under the Gavin BAC. Given the six decades this unit has contained fly ash, and the groundwater velocity estimates of 5 to 19 feet per day, ample time has passed for groundwater to have migrated from the Kyger Creek NFAP beneath the BAC. The following lines of evidence support the NFAP as an alternate source of boron:

- The distribution of boron in groundwater beneath the BAC (Section 4);
- The SFAP data suggest boron is present in Kyger Creek groundwater, and given the similarity in construction and types of CCR managed, it is reasonable to interpret SFAP data as representative of NFAP groundwater quality (Section 4);
- The chemical fingerprinting evidence shows groundwater from Kyger Creek mixes with Ohio River water under the BAC (Section 6);
- The concentration of boron in BAC surface water is significantly lower than the concentration in groundwater below the BAC (Section 6); and
- The OEPA concluded groundwater appears to be impacted by a release from the NFAP (Appendix A). .

In addition, a comparison of the materials managed provides evidence that the BAC is not the source, and the NFAP is a more likely source of boron. The NFAP has contained fly ash since 1955, while the BAC has been used primarily for the management of bottom ash since 1974. Bottom ash and fly ash have different physical and chemical properties, and laboratory investigations have shown elements (including Appendix III constituents) have a much greater potential to leach from fly ash compared to bottom ash (Cox et al. 1978, Jones et al. 2012). The higher concentrations of boron observed in SFAP groundwater compared to the lower concentration of boron observed in BAC surface water are consistent with the known leaching properties of fly ash and bottom ash, and support the NFAP and not the BAC as the source of boron in groundwater under the BAC. The data supporting these conclusions are historically consistent with hydrogeologic conditions and findings of the BAC monitoring program.

# 8 Conclusions

Eight groundwater sampling events were performed at the BAC from 2016 to 2017, and the results were summarized in the Annual Groundwater Monitoring and Corrective Action Report (ERM 2018). The report presented an evaluation of 2016 to 2017 data, and reported SSIs over background levels for each of the Appendix III parameters. In response to the SSIs, this ASD was prepared in accordance with 40 CFR 257.94(e)(2).

All SSIs in the downgradient BAC monitoring wells have been demonstrated to result from alternate sources, which were mixing with the Ohio River, regional groundwater discharge, and Kyger Creek. Table 8-1 summarizes the alternate sources identified for each of the Appendix III constituents:

**Table 8-1. BAC Alternate Source Demonstration Summary**

| | | Six Lines of Evidence from EPA Guidance | | | | | |
|---|---|---|---|---|---|---|---|
| **Analyte** | **SSI Location** | **Alternate Source** | **Hydraulic Connection** | **Constituent Present at Source or Along Flow Path** | **Constituent Distribution More Strongly Linked to Alternate Source** | **Constituent Could Not Be Derived from BAC** | **Data Are Consistent with Hydrogeologic Conditions** |
| Boron | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Kyger Creek NFAP | X | X | X | X | X |
| Calcium | BAC-02 | Regional Groundwater Discharge | X | X | X | X | X |
| Chloride | BAC-02<br>BAC-03<br>BAC-04 | Regional Groundwater Discharge | X | X | X | X | X |
| Fluoride | BAC-05 | Regional Groundwater Discharge | X | X | X | X | X |
| pH | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Mixing with Ohio River | X | X | X | X | X |
| Sulfate | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Regional Groundwater Discharge | X | X | X | X | X |
| TDS | BAC-02<br>BAC-04 | Regional Groundwater Discharge | X | X | X | X | X |

The evidence presented in this ASD shows that the BAC was not the source of the SSIs reported in the 2017 Annual Groundwater Monitoring and Corrective Action Report (ERM 2018). Thus Gavin will continue with Detection Monitoring in accordance with 40 CFR 257.94.

# Professional Engineer Certification

I hereby certify that I or an agent under my review has prepared this Alternate Source Demonstration Report for the Bottom Ash Complex in accordance with 40 CFR 257.94(e). To the best of my knowledge, the information contained in this Report is true, complete, and accurate.

**James A. Hemme, P.E.**
*State of Ohio License No.: 72851*

Date: __7/3/2018________________________

JAMES
HEMME
72851
7/3/18

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# Figures

## Figure 1-1: Gavin Plant Location

Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure1_1_GavinPowerPlantLocation.mxd - Dana.Heusinkveld - 6/29/2018

Figure 1-2: Bottom Ash Complex Location

Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure1_2_BACLocation_20180608.mxd - Dana.Heusinkveld - 6/21/2018

Legend

⌖ Federal Sampling Program Groundwater Monitoring Well

⌖ Monitoring Well (Not in Federal Program)

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
Reproduced under license in ArcGIS 10.4

N

0 62.5 125 250 375 500
Feet

## Figure 1-3: Existing Monitoring Well Network

Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure1_3_ExistingMWNetwork_20180530.mxd - Joseph.Hakam - 6/22/2018

**NOTES:**
Ohio river stage elevation data obtained from USGS
03201500 Ohio River at Point Pleasant, West Virginia.

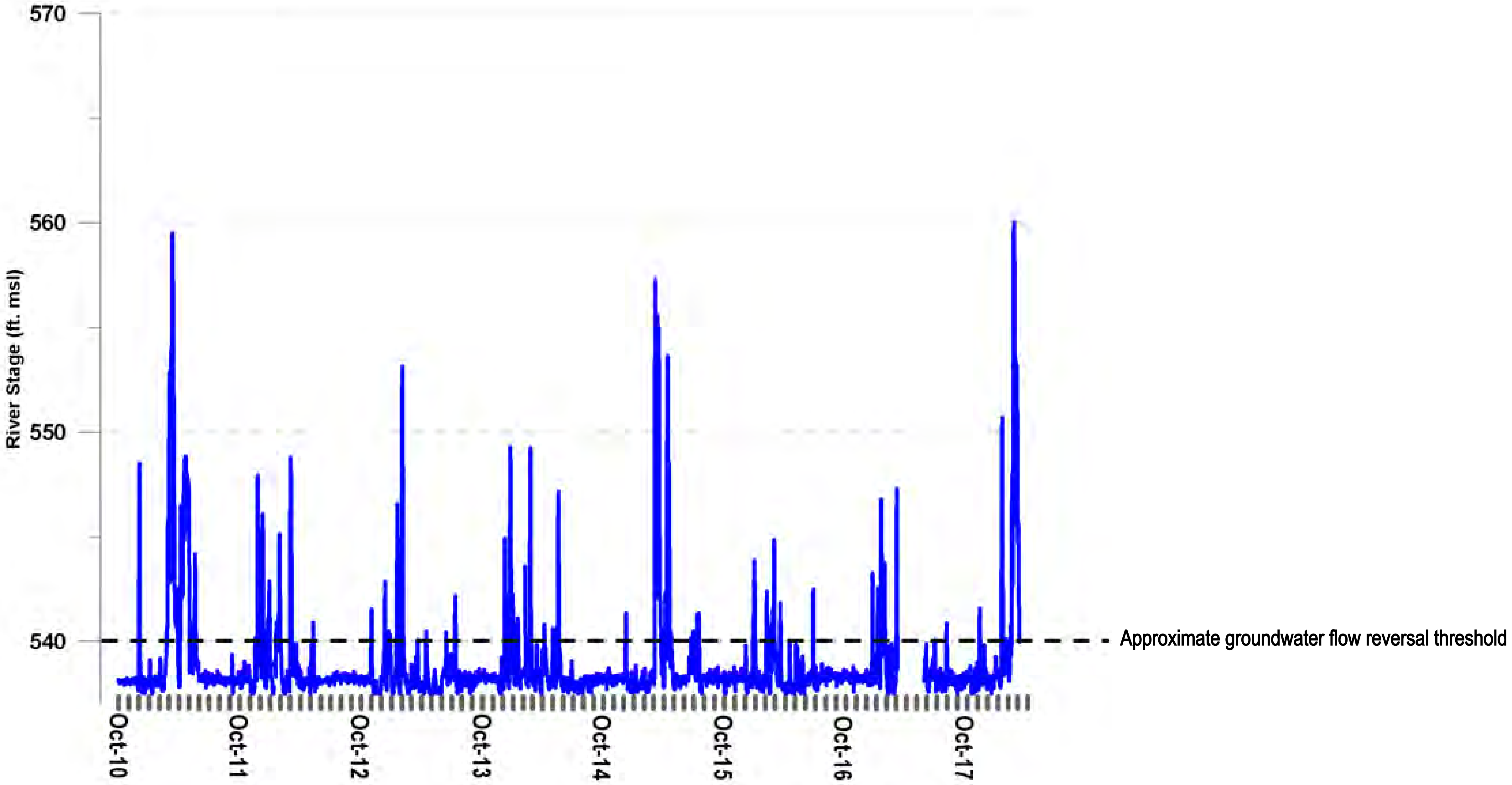
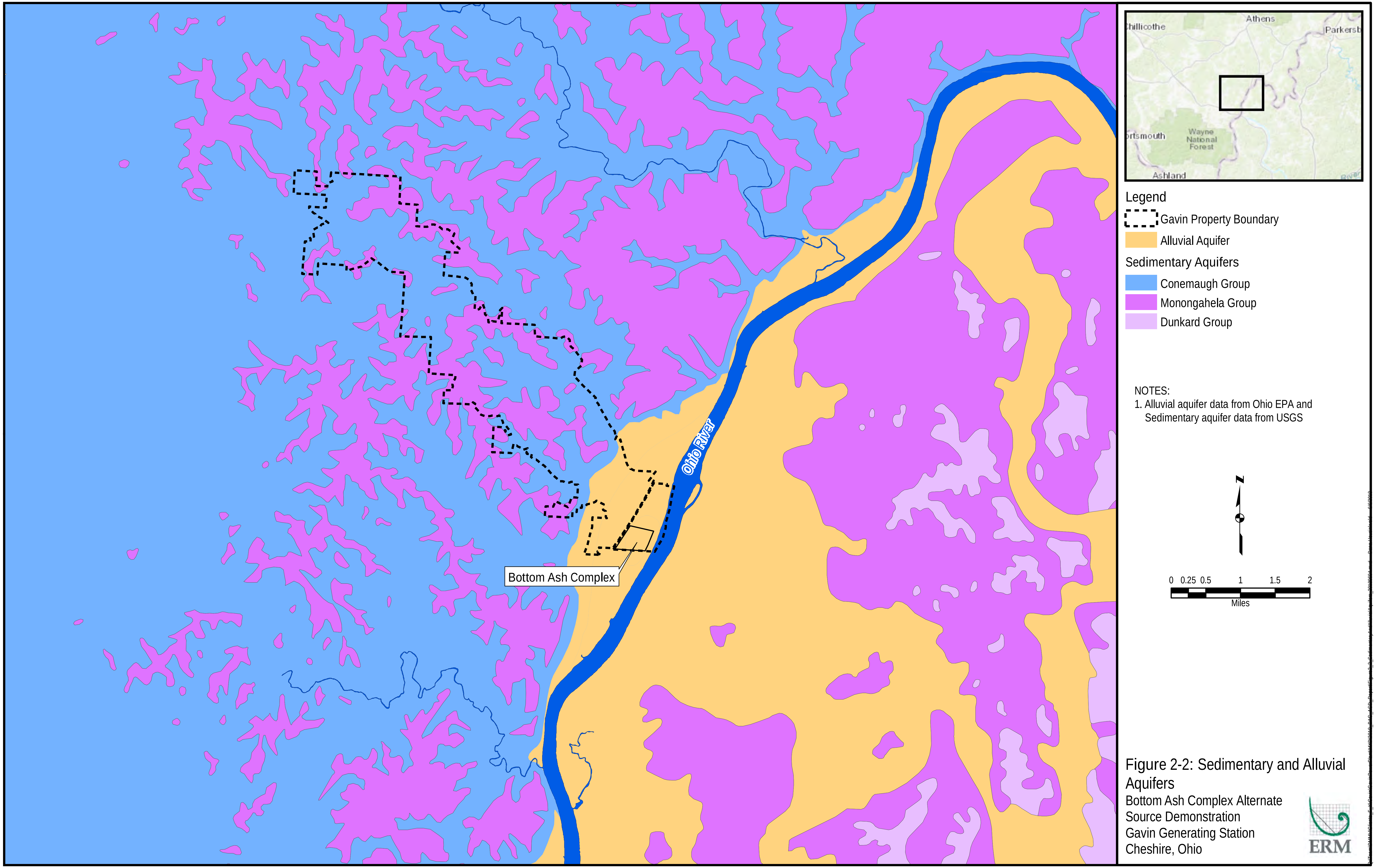


Figure 2-1: Ohio River Hydrograph (2011 to 2018)
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure2_1_OhioRiverHydrograph_Template_20180606.mxd - Dana.Heusinkveld - 6/21/2018



Legend

▭ Gavin Property Boundary

🟧 Alluvial Aquifer

Sedimentary Aquifers

🟦 Conemaugh Group

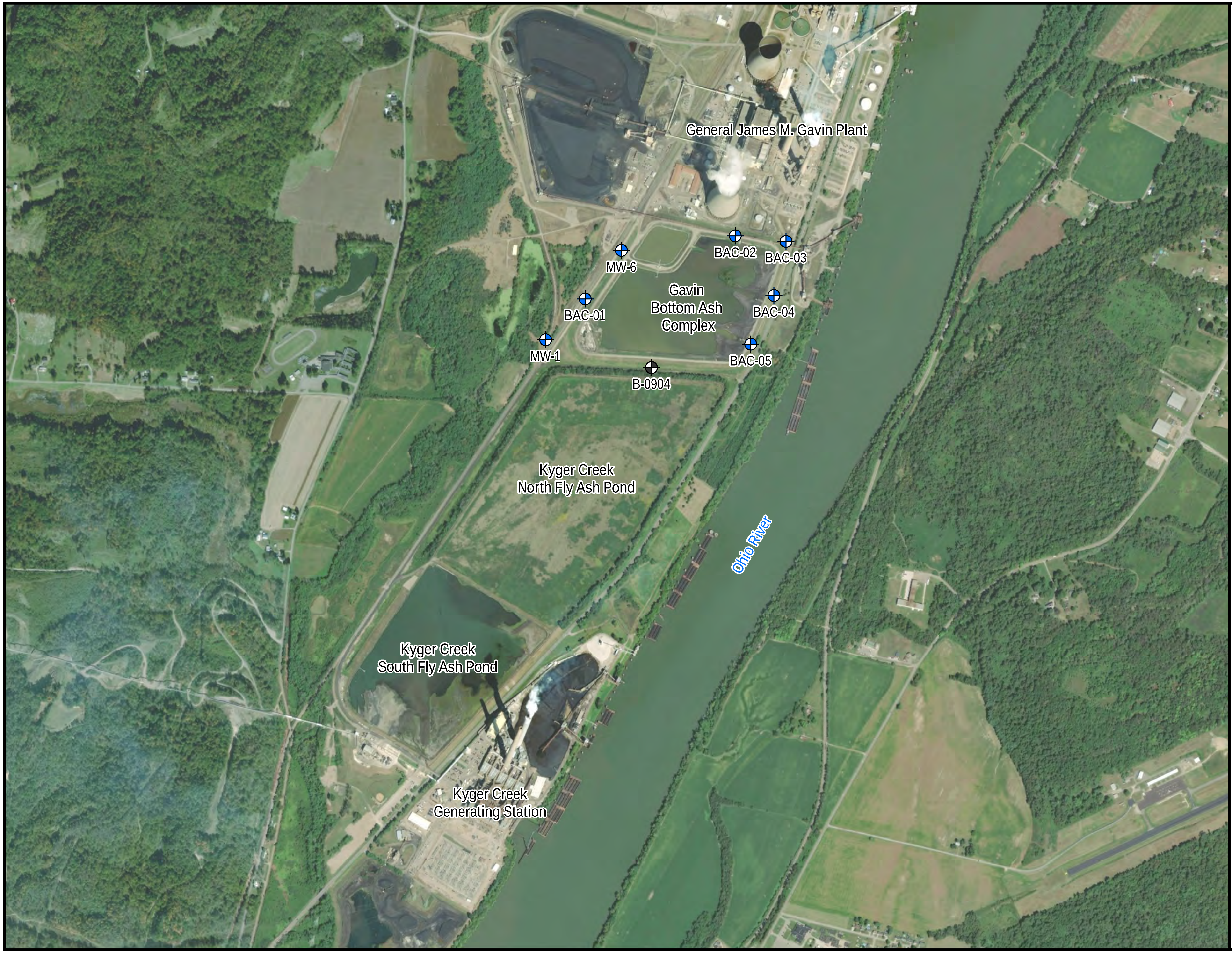
🟪 Monongahela Group

▨ Dunkard Group

NOTES:
1. Alluvial aquifer data from Ohio EPA and Sedimentary aquifer data from USGS

Figure 2-2: Sedimentary and Alluvial Aquifers
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM



Legend

⊕ Federal Sampling Program Groundwater Monitoring Well

⊕ Monitoring Well (Not in Federal Program)

NOTES:

1. Kyger Creek features are from AEP. 1994. Hydrogeologic Site Investigation Plan for the Proposed North Fly Ash Pond Closure, Kyger Creek Station, Ohio Valley Electric Corporation, Gallia County, Ohio.

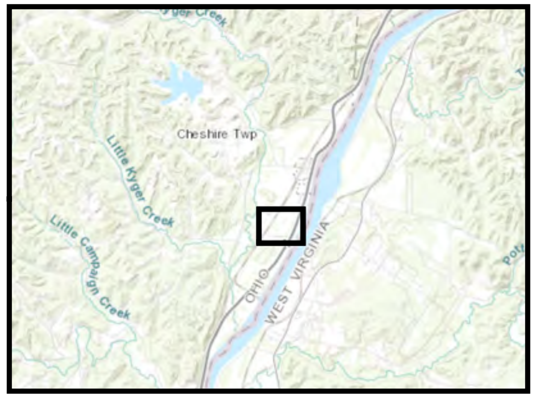
N

0 250 500 1,000 1,500 2,000
Feet

Figure 2-3: Location of Kyger Creek Generating Station
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure2_3_LocationOfKygerCreekStation_20180530.mxd - Dana.Heusinkveld - 6/25/2018



Legend

| | |
|---|---|
| ⊕ | Federal Sampling Program Groundwater Monitoring Well |
| 539.85 | Groundwater Elevation (ft) |
| — | Potentiometric Contour (ft) |
| → | Interpreted Groundwater Flow Direction |

NOTES:
1. Locations are approximate
2. Groundwater elevations based on measurements made on 8/25/2016
3. Aerial Imagery: ESRI World Imagery Reproduced under license in ArcGIS 10.5

N

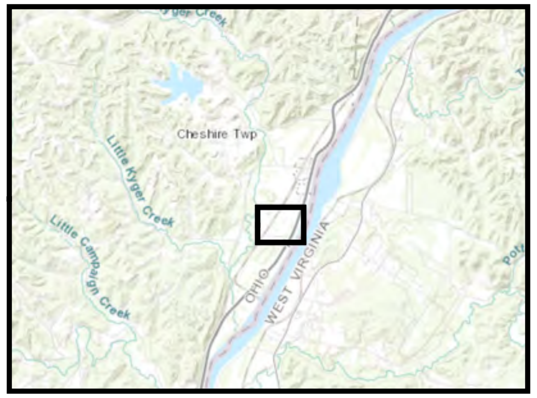
0 62.5 125 250 375 500
Feet

## Figure 3-1: August 2016 Groundwater Elevations and Flow Direction

Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_1_Aug2016GWElevationsAndFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018



## Legend

| | |
|---|---|
| ⊕ | Groundwater Elevation (10/3/2016) |
| ━ | Groundwater Elevation Contours (0.5 ft) |
| → | Interpreted Groundwater Flow Direction |

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
Reproduced under license in ArcGIS 10.5

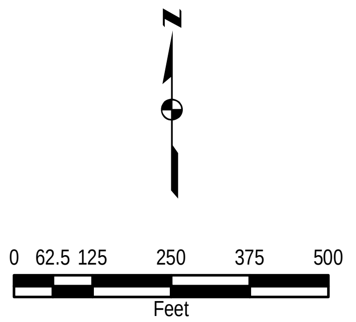


Figure 3-2: October 2016 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_2_Oct2016_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018

Legend

⊕ Groundwater Elevation (11/28/2016)

Groundwater Elevation Contours (0.5 ft)

→ Interpreted Groundwater Flow Direction

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
Reproduced under license in ArcGIS 10.5

Figure 3-3: November 2016 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_3_Nov2016_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018

Legend

| | |
|---|---|
| ⊕ | Federal Sampling Program Groundwater Monitoring Well |
| 539.85 | Groundwater Elevation (ft) |
| — | Potentiometric Contour (ft) |
| → | Interpreted Groundwater Flow Direction |

NOTES:
1. Locations are approximate
2. Groundwater elevations based on measurements made on 2/7/2017
3. Aerial Imagery: ESRI World Imagery. Reproduced under license in ArcGIS 10.5

Figure 3-4: February 2017 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_4_Feb2017_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018

Legend

⊕ Groundwater Elevation (03/28/2017)

— Groundwater Elevation Contours (0.5 ft)

→ Interpreted Groundwater Flow Direction

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
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Figure 3-5: March 2017 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_5_Mar2017_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018

Legend

⌖ Groundwater Elevation (05/3/2017)

━ Groundwater Elevation Contours (0.5 ft)

→ Interpreted Groundwater Flow Direction

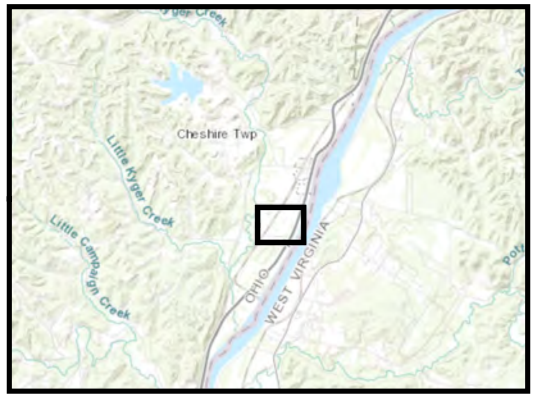
NOTES:
1.* Groundwater elevation from BAC-02 in May 2017 was anomalous and not used to prepare this figure
2. Locations are approximate
3. Aerial Imagery: ESRI World Imagery Reproduced under license in ArcGIS 10.5

Figure 3-6: May 2017 Groundwater Elevations and Flow Direction

Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_6_May2017_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018



## Legend

⊕ Groundwater Elevation (6/13/2017)

— Groundwater Elevation Contours (0.5 ft)

→ Interpreted Groundwater Flow Direction

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
Reproduced under license in ArcGIS 10.5

N

0 62.5 125 250 375 500
Feet

Figure 3-7: June 2017 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_7_Jun2017_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018

Legend

- ⊕ Groundwater Elevation (7/14/2017)
- Groundwater Elevation Contours (0.5 ft)
- → Interpreted Groundwater Flow Direction

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
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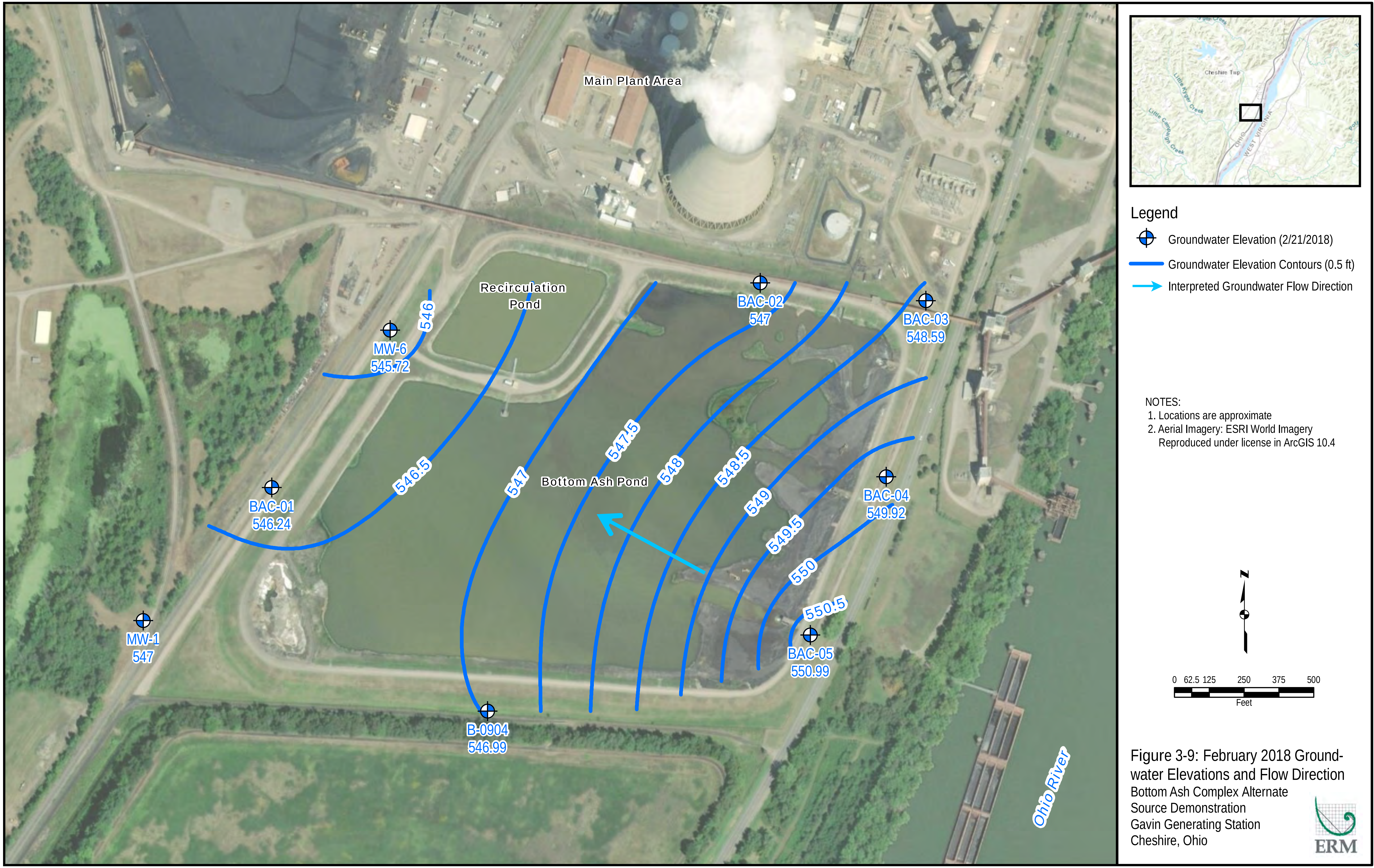
Figure 3-8: July 2017 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_8_Jul2017_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018



Legend

⌖ Groundwater Elevation (2/21/2018)

Groundwater Elevation Contours (0.5 ft)

Interpreted Groundwater Flow Direction

NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
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Figure 3-9: February 2018 Groundwater Elevations and Flow Direction
Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_9_Feb2018_GWElevationsandFlow_20180605.mxd - Dana.Heusinkveld - 6/21/2018

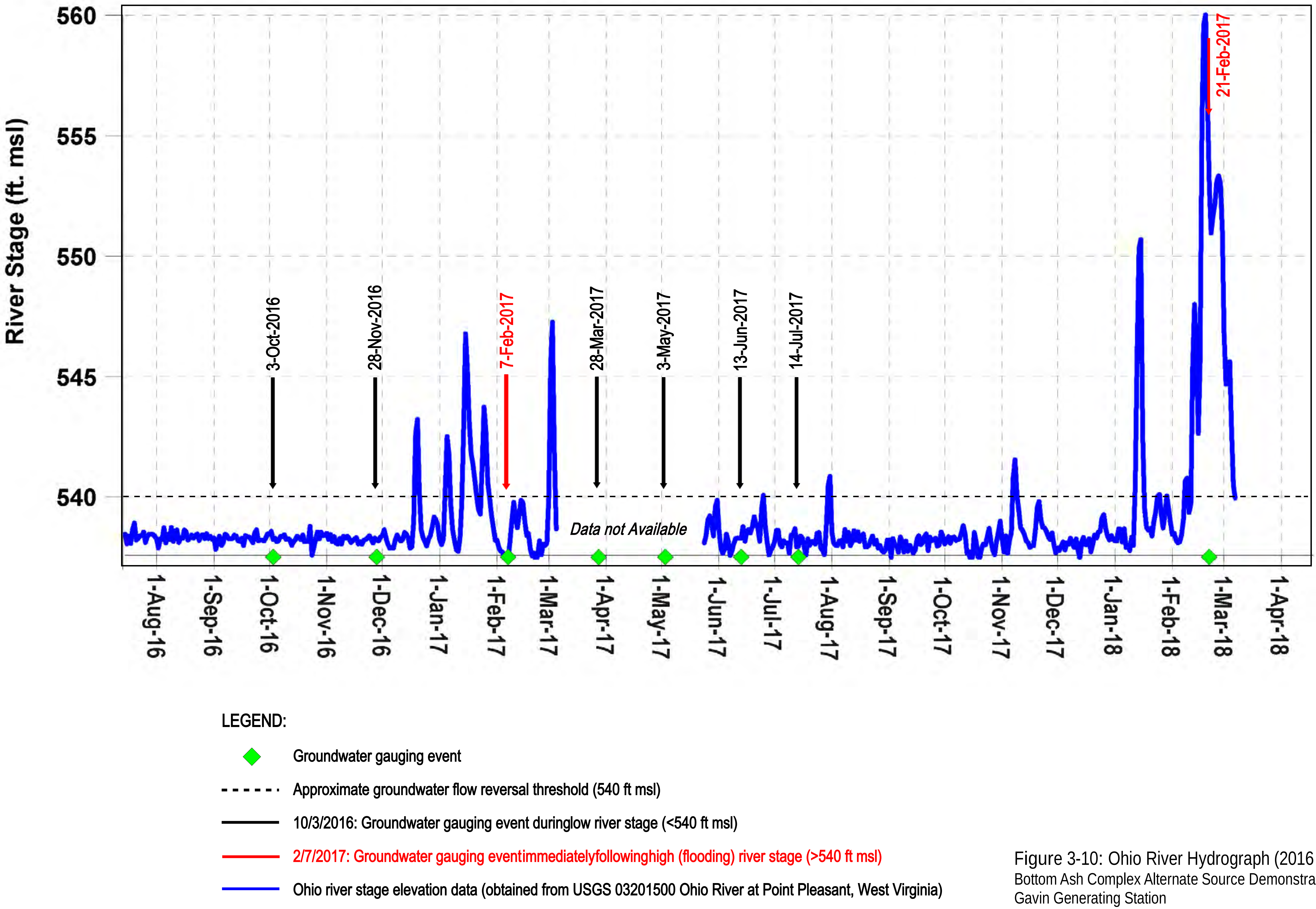
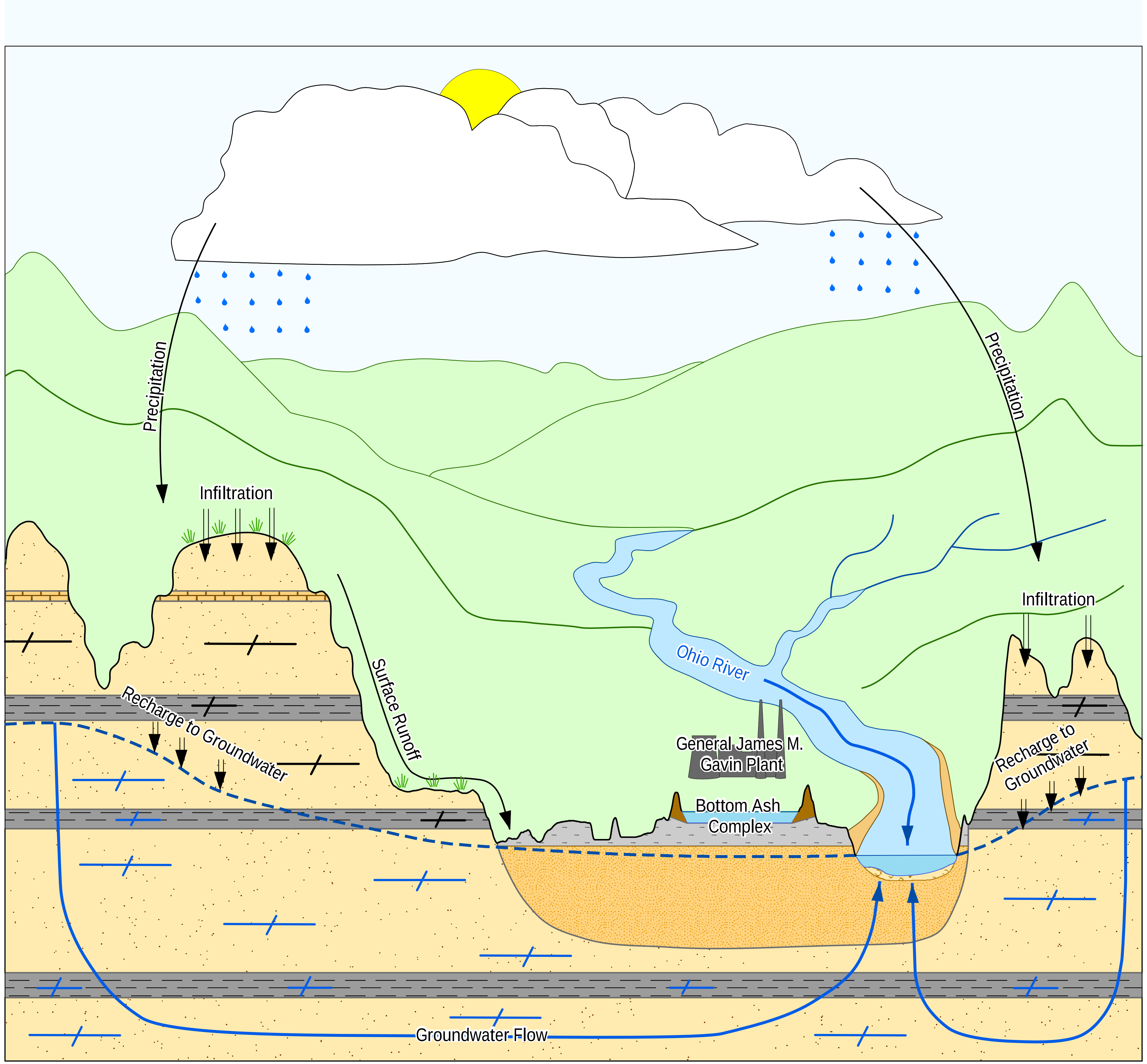
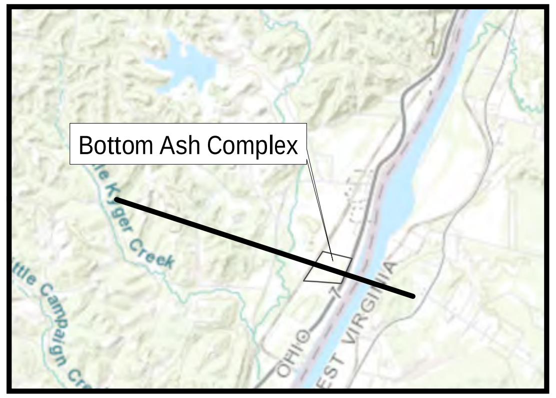


Figure 3-10: Ohio River Hydrograph (2016 to 2018)
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_10_OhioRiverHydrograph_Template_20180606.mxd - Dana.Heusinkveld - 6/21/2018





Legend

- → Groundwater Flow Direction
- - - Water Table
- — Saturated Fractures
- — Unsaturated Fractures
- ▨ Interbedded Silt/Clay
- ▨ Course Sand Deposits
- ▨ Fractured Limestone
- ▨ Fractured Shale
- ■ Fill
- ▨ Sand
- ▨ Sandstone

NOTES:
1. Sandstone bedrock units represent the Conemaugh Group and Monongahela Group Sedimentary Aquifers

0 320 640 1,280 1,920 2,560
Feet

## Figure 3-11: Regional Groundwater Flow Patterns

Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_11_RegionalGWFlowPatterns_20180608.mxd - Dana.Heusinkveld - 6/21/2018

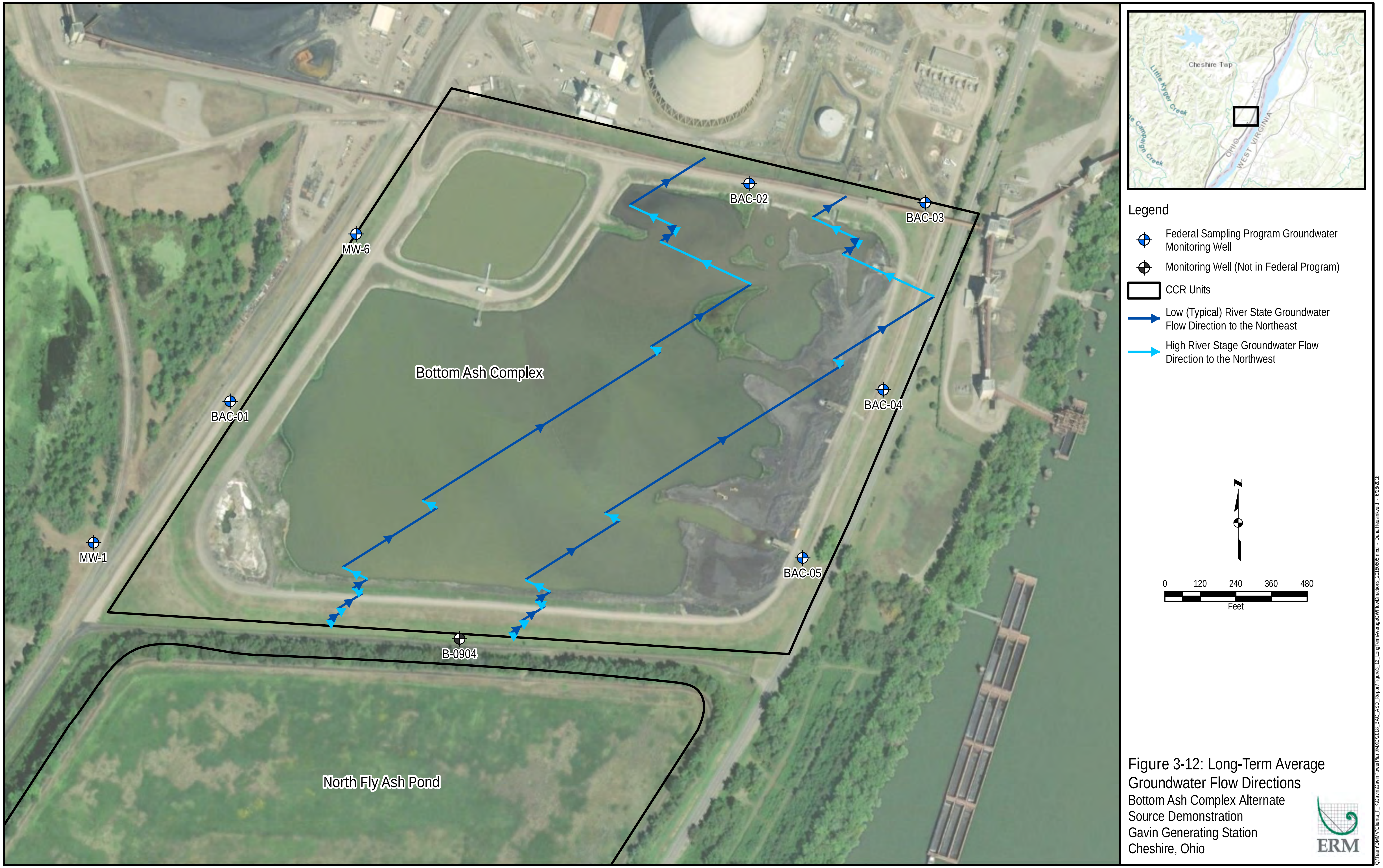
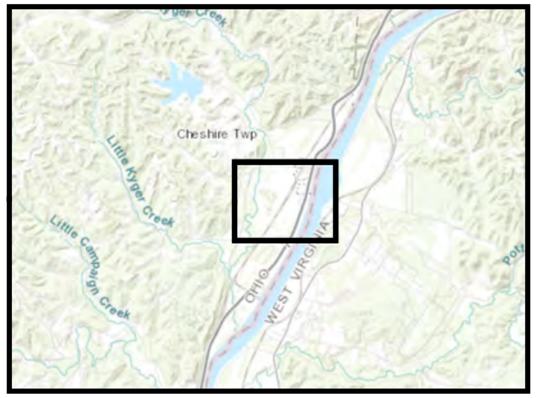


Figure 3-12: Long-Term Average Groundwater Flow Directions

Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_12_LongTermAverageGWFlowDirections_20180605.mxd - Dana.Heusinkveld - 6/26/2018



Legend

▭ CCR Units

pH in Groundwater (February - March 2018)

- ● < 6
- ● 6 - 6.5
- ● 6.5 - 7
- ● > 7

NOTES:

1. Measurements of pH at the monitoring wells were made on 3/1/2018" and "Measurement of pH at the Ohio River was made on 2/28/2018

N

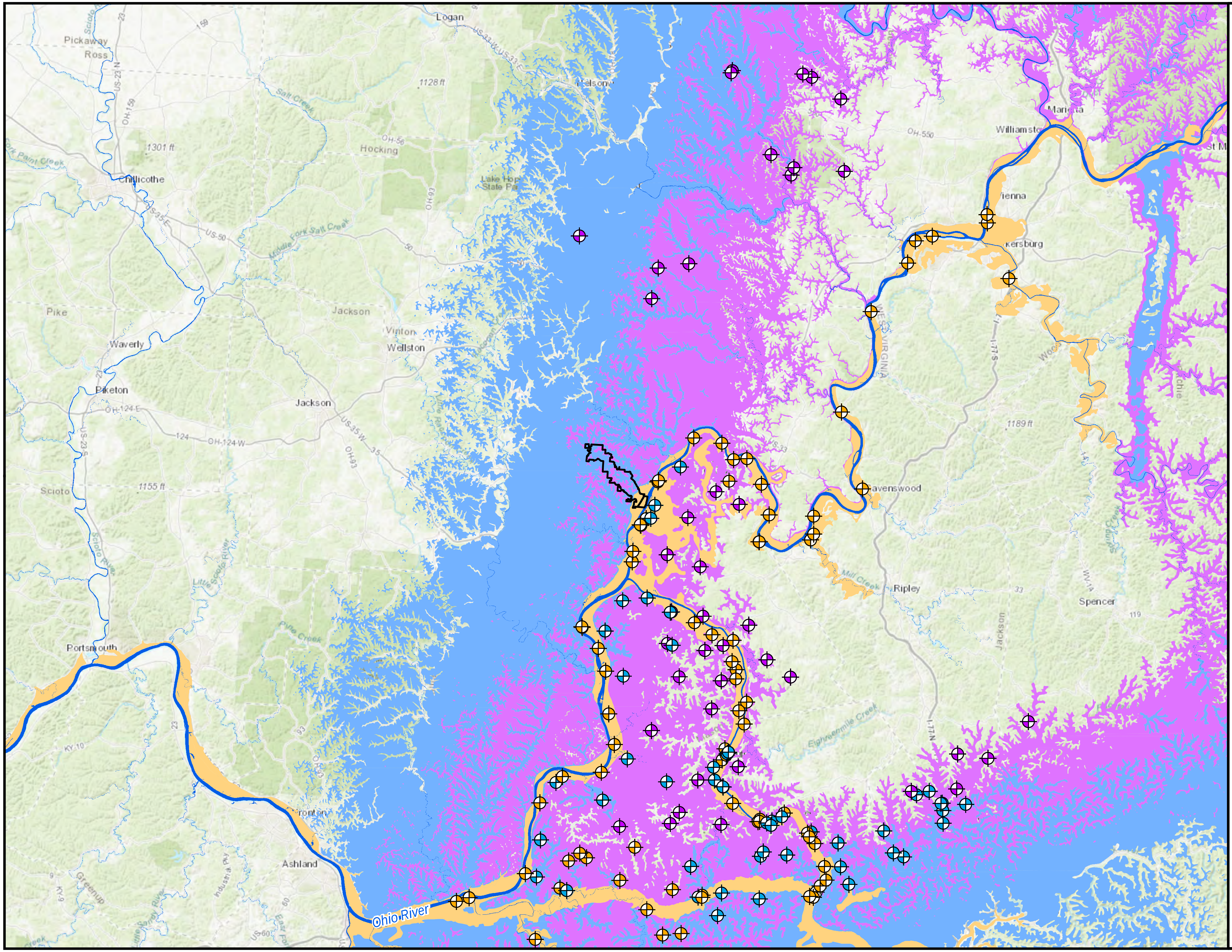
0 275 550 825 1,100
Feet

## Figure 4-1: pH of the Ohio River and BAC Groundwater

Bottom Ash Complex Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure4_1_pHofOhioRiverAndBACGW_20180605.mxd - Joseph.Hakam - 6/22/2018



Legend

☐ Gavin Property Boundary

🟧 Alluvial Aquifer

Sedimentary Aquifers

🟦 Conemaugh Group

🟪 Monongahela Group

USGS Groundwater Monitoring Wells

⊕ Alluvial Aquifer

⊕ Conemaugh Group (Sedimentary Aquifer)

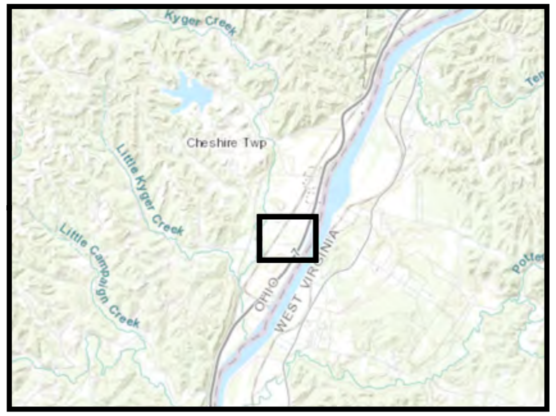
⊕ Monongahela Group (Sedimentary Aquifer)

NOTES:
1. Alluvial aquifer data from Ohio EPA and Sedimentary aquifer data from USGS

Figure 4-2: Locations of Background Groundwater Monitoring Wells
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure4_2_BackgroundGWMWLocations_20180621.mxd - Dana.Heusinkveld - 6/21/2018



Legend

- CCR Units
- Low (Typical) River State Groundwater Flow Direction to the Northeast
- High River Stage Groundwater Flow Direction to the Northwest

Groundwater Sampling Location

○
Well Name
Boron Concentration (mg/l)

Boron Concentration in Groundwater

- 🟨 <2 mg/L
- 🟧 2-3 mg/L
- 🟥 >3 mg/L

NOTES:
1. Groundwater data for MW-1, BAC-01, MW-6, BAC-02, BAC-03, BAC-04, BAC-05 and B-0904 are from March 2018
2. Surface water data for BAP is from February 2018

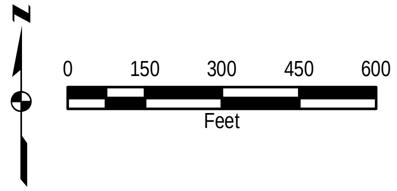
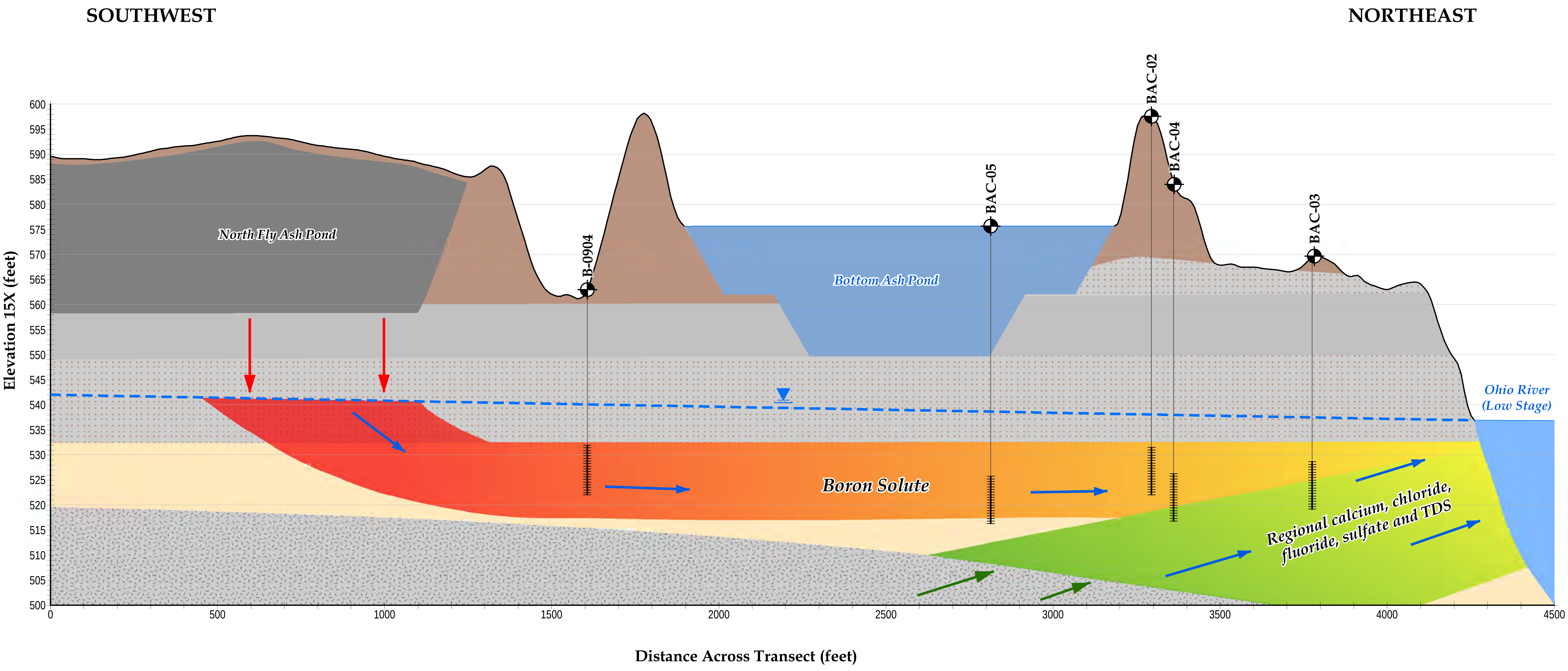
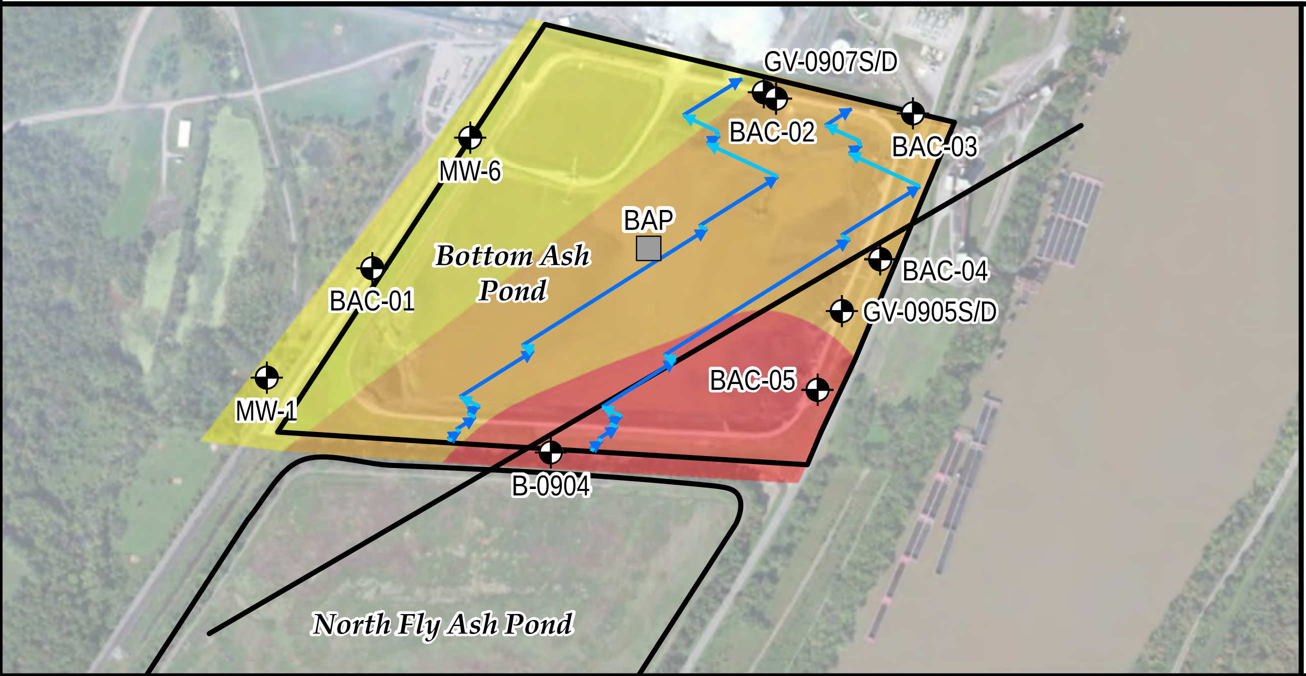


Figure 4-3: Boron Distribution in Groundwater in March 2018
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure4_3_BoronDistributionInGW_20180605.mxd - Dana.Heusinkveld - 6/26/2018





## Legend

⊕ Monitoring Well
━ Cross Section Location
─ Borehole
╫ Well Screen
- - Interpreted Low River Piezometric Surface
→ Low River Stage Flow Direction
→ High River Stage Flow Direction
→ Interpreted Groundwater Flow Vector
→ Interpreted Leachate from NFAP
→ Interpreted Regional Source of Ca, Cl, F, $SO_4$, and TDS

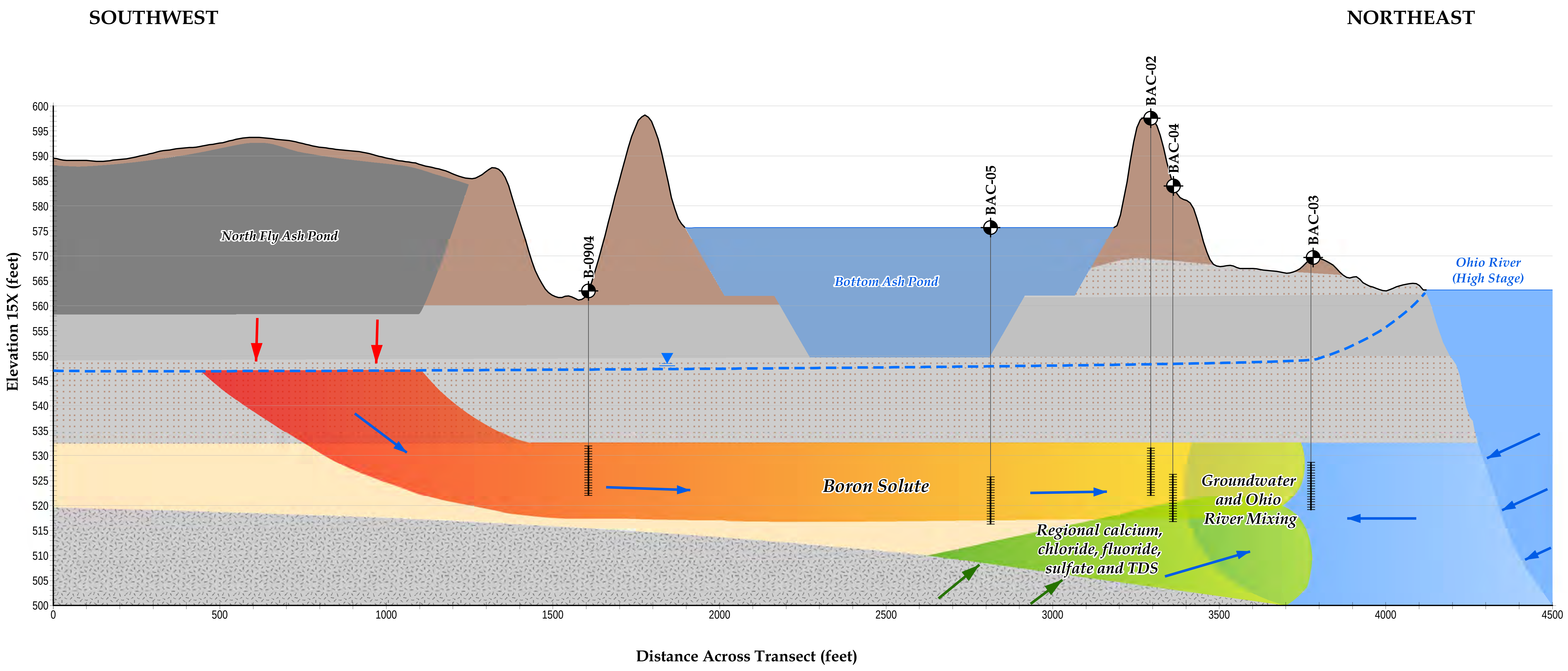
## Interpreted Geology

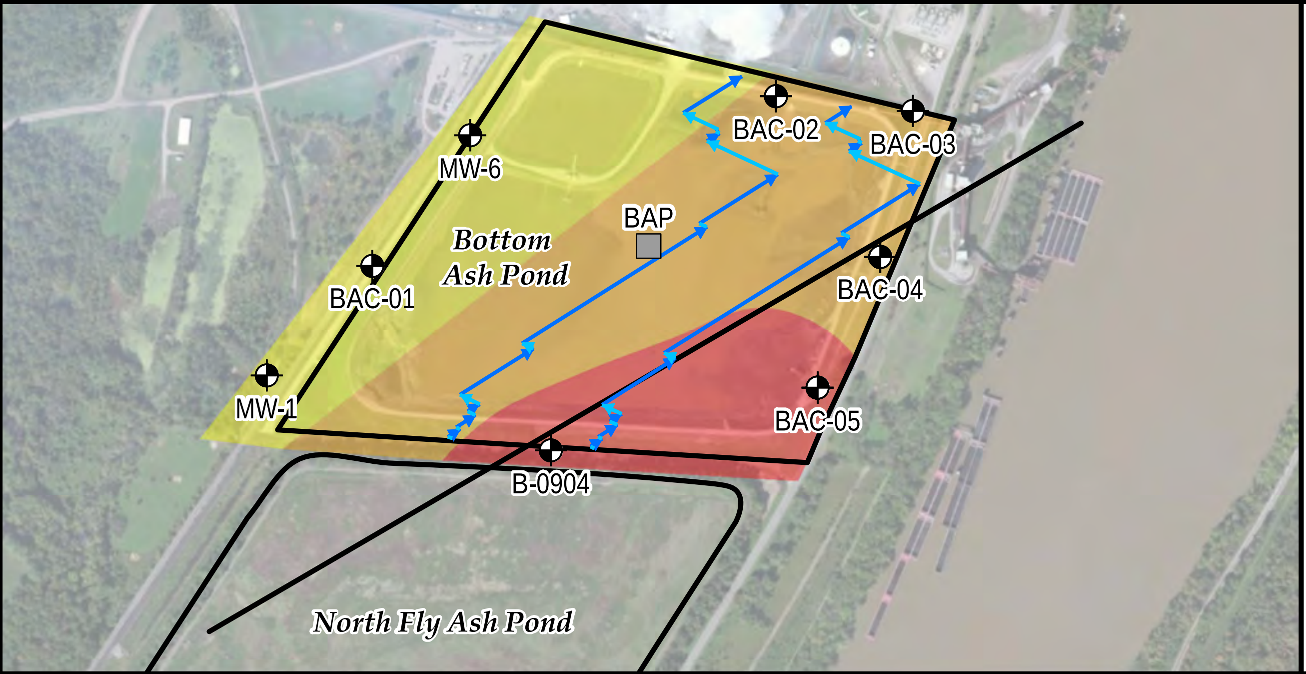
▨ Sandy Clayey Gravel with Bottom Ash
▨ Silt/Clay
▨ Silt/Clay Interbedded with Fine Sand
▨ Sand
▨ Bedrock

**Figure 5-1:** Low River Stage Cross Section
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

O:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure5_1_LowRiverStageCrossSection_20180605.mxd - dana.heusinkveld - 6/11/2018





## Legend

- ⊕ Monitoring Well
- — Cross Section Location
- — Borehole
- ╫╫╫ Well Screen
- - - Interpreted High River Piezometric Surface
- → Low River Stage Flow Direction
- → High River Stage Flow Direction
- → Interpreted Groundwater Flow Vector
- → Interpreted Leachate from NFAP
- → Interpreted Regional Source of Ca, Cl, F, $SO_4$, and TDS

## Interpreted Geology

- 🟫 Sandy Clayey Gravel with Bottom Ash
- ▨ Silt/Clay
- ▨ Silt/Clay Interbedded with Fine Sand
- 🟨 Sand
- ▨ Bedrock

**Figure 5-2:** High River Stage Cross Section
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

O:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure5_2_HighRiverStageCrossSection_20180605.mxd - dana.heusinkveld - 6/11/2018

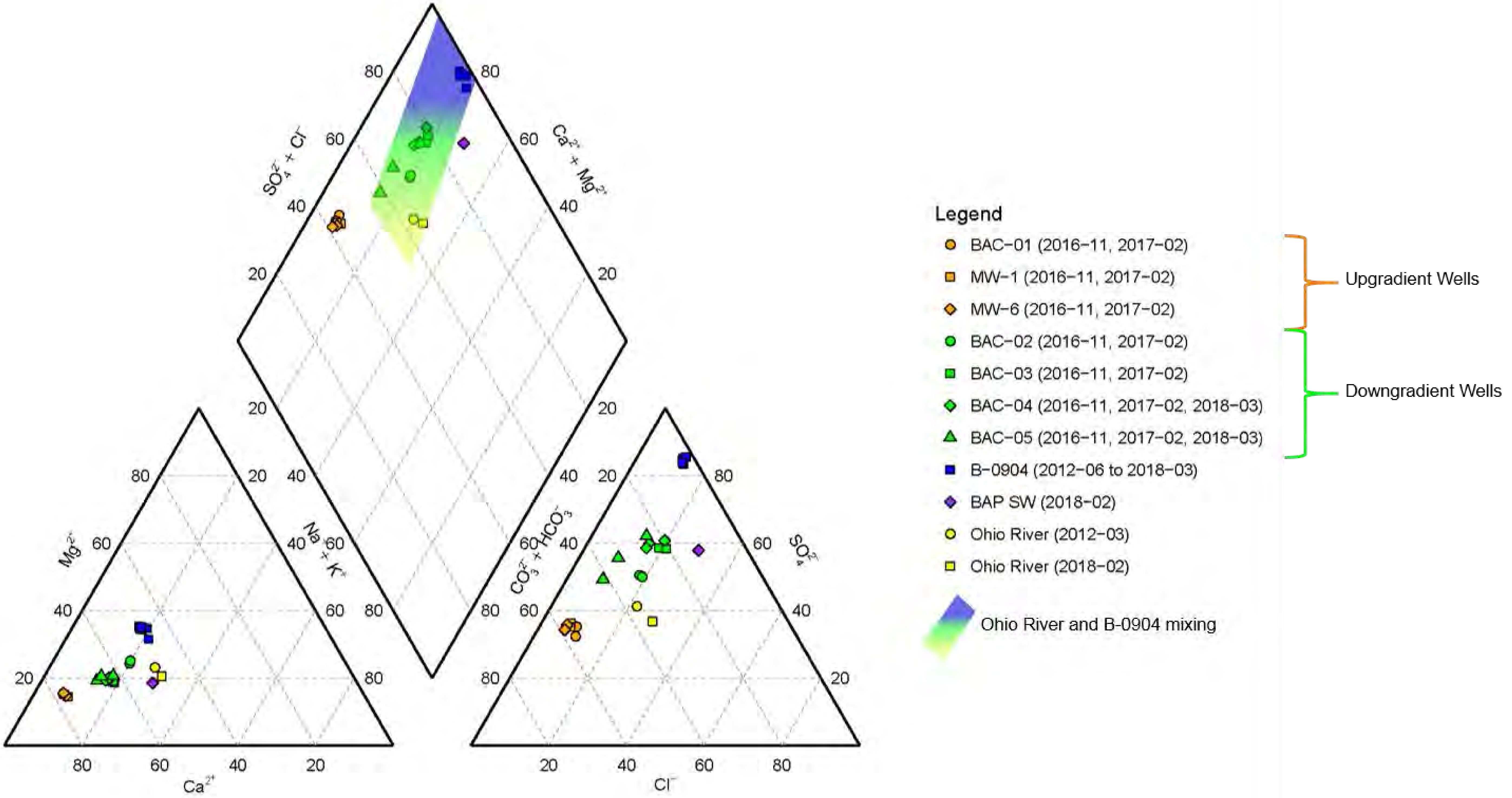


Figure 6-1: BAC Piper Diagram
Bottom Ash Complex Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure7_1_BACPiperDiagram_Template_20180606.mxd - Dana.Heusinkveld - 6/6/2018

# Appendix A:  OEPA Memorandum

Ohio EPA

State of Ohio Environmental Protection Agency

**Southeast District Office**
2195 Front Street
Logan, Ohio 43138-9031
(614) 385-8501
FAX (614) 385-6490

**George V. Voinovich**
**Governor**

To: Dan Messerly through Bruce Goff, DSW-SEDO

From: David Hunt DH through Mike Preston MMP, DDAGW-SEDO

Subject: Ohio Valley Electric Corporation - Ground Water Quality Results for May 1998
(DDAGW #: 07/22/98-04-3-05-0 3757)

Date: August 28, 1998

******************************************************************************

## Introduction

The Ohio Valley Electric Corporation (OVEC) site is located in Gallia County, Ohio on State Route 7 approximately five miles north of Gallipolis, Ohio. There are two fly ash ponds at the OVEC site: the north and the south ponds. The PTI for closure plan is only for the closure of the north pond, while the south pond will continue to be used for fly ash disposal. The PTI was approved without OVEC having to address DDAGW's comments on the proposed ground water monitoring plan. The geology of interest beneath the OVEC site consists of unconsolidated sand and gravel formations of the Ohio River Valley Aquifer. There are two industrial, nonpotable well fields up river and down river of the north and south ponds. The industrial well fields and the Ohio River are the major influence of the ground water flow patterns at the OVEC site.

There are ten ground water monitoring wells at the closure site (KC-9501 through KC-9510) However, only wells KC-9501, KC-9502, KC-9504, KC-9507, KC-9508 and KC-9509 have been selected by OVEC for ground water monitoring purposes. Dedicated bladder pumps have been installed in these six wells for sampling purposes. The ground water monitoring package submitted on July 10, 1998 included ground water data for these six wells. The package also included water level data for fourteen wells present at the site. The six wells are proposed to be sampled quarterly for two years. No up gradient well was sampled, which is necessary to determine if an intrawell statistical approach is appropriate. DDAGW has commented on this before, but OVEC maintains that they will implement the ground water monitoring program in the approved PTI, which does not include a background well being monitored.

In a previous IOC to DSW, DDAGW outlined that based upon a comparison of shallow wells verses deep wells it appears that the water quality at the OVEC site is being impacted. Please refer to the January 1998 IOC for further information on the November sampling results.

The following are DDAGW's comments on the ground water monitoring data results in the July 1998 submittal for the OVEC site.

**Observations**

1. Since no background well was sampled, DDAGW has made several comparisons with the ground water quality results to evaluate whether the north fly ash pond has impacted ground water. These comparisons include shallow wells to deep wells, the wells on site to two ambient stations within the Ohio River Valley Aquifer, and the two well clusters monitoring the north fly ash pond to the cluster on the southern side of the south fly ash pond. The following are several observations about the water quality.

   a. The shallow wells tend to have lower pH and alkalinity than the deeper wells at two of the three locations. The shallow wells KC-9502 and KC-9507 show pH ranging between 5.61 to 5.75, while the deeper well at the respective clusters, KC-9501 and KC-9504, showed pH near 7.0. Alkalinity in the deeper well 9501 was 181 ug/l, while the shallower well 9502 was at 19 ug/l.

   b. Shallow wells 9502 and 9507 have higher concentrations of manganese, and iron verses the deep wells 9501 and 9504. Well 9501 has a manganese concentration of 0.64 mg/l while the shallow well at the same cluster has a manganese concentration of 12.6 mg/l. Iron is 1.03 mg/l in the deep well (9504) but is 16.8 mg/l in shallow well (9507).

   c. In addition to the iron and manganese, 9507 (shallow well) has slightly higher concentrations of magnesium (Mg), TDS and sulfate (SO4) when compared to the deep well, 9504.

   d. The water quality for the cluster 9508 and 9509 was very similar for all parameters.

   e. There has been fairly good consistency in water quality between the three ground water sampling events that have been performed to date, with the following exceptions: well 9502 is showing an increasing trend of iron (3.79 in 10/97 to 6.67 in 5/98); conductivity in well 9507 dropped from 850 in 10/97 and 868 in 1/98 down to 499 in 5/98; 9508 is showing a slight increase in iron between the three events while manganese is slightly decreasing.

   f. Shallow wells 9502 and 9507 are close to being directly down gradient of the north fly ash pond while 9508 is located side gradient, or southward, of the south fly ash pond. Since there is no real difference between the deep and shallow wells at the 9508/09 location it stands to reason that the differences in water quality between shallow and deep at the other two locations may be related to a release from the north fly ash pond. Alkalinity, barium, calcium and pH are higher in the shallow well 9508 than found in 9502 and 9507. Iron and manganese are much higher in 9502 and 9507 verses 9508. TDS, sulfate, and magnesium are higher in 9507 than found at 9508.

g. DDAGW maintains two ground water ambient stations within the Ohio River Valley Aquifer near the OVEC site. The Middleport Well #4 and the Gallia Rural Water #4 stations are located near the OVEC site. Water quality from July 1998 at these two ambient locations was compared to the water quality being found at the OVEC site. Magnesium, barium, sodium, calcium and chloride are all similar in concentration in the ambient wells as found at the OVEC site. However, iron and manganese levels are much higher (1 to 2 orders of magnitude higher) in all of the wells (shallow and deep) at the OVEC site when compared to the ambient water quality. Interestingly, the OVEC deep wells show very similar alkalinity to the ambient wells.

**Comments**

1. No water level map was submitted with the three water quality reports. A potentiometric map should be submitted with the water quality data report.

2. In the June 25, 1997 memo on the ground water quality SAP, DDAGW recommended the inclusion of the background well KC-9506 in the initial two year sampling. As noted, this is particularly important in determining if an intrawell statistical approach is the best method for evaluating whether a release has occurred. Given the water quality from the first three quarters of monitoring, it appears that there are differences in water quality between the shallow and deep wells in two of the three clusters. Other differences in water quality were also evaluated above. These differences in water quality may be reflective of a release to ground water from the north pond. If a release has occurred at the OVEC site, then intrawell statistics cannot be used to evaluate a release. In order for OVEC to effectively demonstrate that no release has occurred and that intrawell comparison is appropriate, DDAGW continues to recommend that KC-9506 be included in the sampling effort.

3. Based on the water quality data and the submitted water level depth data, DDAGW continues to recommend that another monitoring well cluster be installed between the clusters 9501/9502 and 9504/9507 on the east side of the north fly ash pond. OVEC declined to install this well cluster in 1997 given that OEPA approved the PTI without this well as a component of the proposed ground water monitoring program. If OVEC will not install this monitoring well as part of detection monitoring program, then the cluster would likely be installed during assessment activities. Based on the review of the water quality data it is likely that assessment activities will be necessary.

**Conclusion**

DDAGW has completed its review of the July 1998 Ground Water Quality Report for the North Pond closure at the OVEC site in Gallia County. DDAGW made several observations concerning the water quality data generated to date. Based on the water quality data it appears that there is a difference in water quality between the shallow and deep portions of the Ohio River Valley Aquifer on the down gradient side of the site. This may be an indication of a release from the north or south ponds. Should you have any further questions regarding this review or the site in general, please contact me.

cc: Scott Sutliffe, DDAGW-CO

G:\dhunt\ovec\gwqual98.may
DDAGW #: 07/22/98-04-3-05-0 3757

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**Environmental Resources Management**

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# APPENDIX B GAVIN BOTTOM ASH COMPLEX FIRST SEMIANNUAL SAMPLING EVENT OF 2018 ALTERNATE SOURCE DEMONSTRATION REPORT

# Gavin Bottom Ash Complex

Gavin Power, LLC

## First Semi-Annual Sampling Event of 2018 Alternate Source Demonstration

10.12.2018

Project No.: 0402270

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ERM

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## Acronyms and Abbreviations

| | |
|---|---|
| ASD | Alternate Source Demonstration |
| BAC | Bottom Ash Complex |
| BAP | Bottom Ash Pond |
| CCR | Coal Combustion Residuals |
| CCR Rule | Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments |
| CCR Unit | Bottom Ash Complex CCR Surface Impoundment |
| CFR | Code of Federal Regulations |
| EPA Guidance | Solid Waste Disposal Facility Criteria Technical Manual, EPA 530-R-93-017 |
| Gavin | Gavin Power, LLC |
| mg/L | milligrams per liter |
| NFAP | Kyger Creek North Fly Ash Pond |
| Plant | General James M. Gavin Power Plant |
| SFAP | Kyger Creek South Fly Ash Pond |
| SSI | statistically significant increase |
| TDS | Total Dissolved Solids |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |

# 1. INTRODUCTION

## 1.1 Regulatory and Legal Framework

In accordance with 40 Code of Federal Regulations (CFR) Part 257 Subpart D—Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments ("CCR Rule"), Gavin Power, LLC ("Gavin") has been implementing the groundwater monitoring requirements of 40 CFR § 257.90 *et seq.* for its Bottom Ash Complex (“BAC”) CCR Surface Impoundment (the "CCR Unit") at the General James M. Gavin Power Plant (the "Plant"). Gavin calculated background levels and conducted statistical analyses for Appendix III constituents in accordance with 40 CFR § 257.93(h). Currently, Gavin is performing detection monitoring in accordance with 40 CFR § 257.94. Statistically Significant Increases (SSIs) over background concentrations in downgradient monitoring wells for Appendix III constituents for the first semi-annual groundwater sampling event of 2018 were detected and are detailed in this report.

An SSI for one or more Appendix III constituents is a potential indication of a release of constituents from the CCR unit to groundwater. In the event of an SSI, the CCR Rule provides that “the owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality” (40 CFR § 257.94(e)(2)). If it can be demonstrated that the SSIs are due to a source other than the CCR unit, then the CCR unit may remain in the Detection Monitoring Program instead of transitioning to an Assessment Monitoring Program. An Alternate Source Demonstration (ASD) must be made in writing, and the accuracy of the information must be verified through certification by a qualified Professional Engineer.

The CCR Rule and the regulatory preamble do not contain requirements or reference agency guidance for a successful ASD. However, EPA previously issued guidance for conducting ASDs under the regulatory program governing Municipal Solid Waste Landfills (MSWLFs), upon which EPA modeled the groundwater monitoring provisions of the CCR Rule (80 Fed. Reg. 21302, 21396 (Apr. 17, 2015)). Because of the substantial similarity between the language governing ASDs in the CCR Rule and the MSWLF regulations, EPA’s guidance document provides a useful framework for ASDs under the CCR Rule.

EPA’s guidance document, “Solid Waste Disposal Facility Criteria Technical Manual, EPA 530-R-93-017, Subpart E” (Nov. 1993) (“EPA Guidance”), lays out six lines of evidence that should be pursued in a demonstration that an SSI resulted from a source other than the regulated disposal unit:

1. An alternative source exists.

2. Hydraulic connection exists between the alternative source and the well with the significant increase.

3. Constituent(s) (or precursor constituents) are present at the alternative source or along the flow path from the alternative source prior to possible release from the unit.

4. The relative concentration and distribution of constituents in the zone of contamination are more strongly linked to the alternative source than to the unit when the fate and transport characteristics of the constituents are considered.

5. The concentration observed in ground water could not have resulted from the unit given the waste constituents and concentrations in the unit leachate and wastes, and site hydrogeologic conditions.

6. The data supporting conclusions regarding the alternative source are historically consistent with the hydrogeologic conditions and findings of the monitoring program.

This ASD addresses each of these lines of evidence for the SSIs detected in the groundwater beneath the BAC.

## 1.2 Background

The Plant is a coal-fired generating station located in Gallia County in Cheshire, Ohio, along the Ohio River (Figure 1-1). The BAC is one of three CCR management units at the Plant that are subject to regulation under the CCR Rule and is located adjacent to and immediately south of the main Plant area along the Ohio River (Figure 1-2). The BAC consists of two ponds: the larger pond is the Bottom Ash Pond (BAP) and the smaller pond is the Reclaim Pond (Figure 1-3). These ponds are used to manage the Plant's bottom ash and other miscellaneous Plant wastewaters.

The groundwater monitoring well network consists of three upgradient monitoring wells (BAC-01, MW-1, and MW-6) and four downgradient monitoring wells (BAC-02, BAC-03, BAC-04, and BAC-05) positioned around the perimeter of the BAC (Figure 1-3). In addition, monitoring well B-0904 is located to the south of the BAC and is used in this report to evaluate the quality of groundwater migrating from the Kyger Creek North Fly Ash Pond (NFAP) and under the BAC. All of the monitoring wells are screened in the uppermost aquifer beneath the BAP and Reclaim Pond units. The uppermost aquifer has the following characteristics (Geosyntec 2016):

- Consists of fine to coarse sand with some gravel that gets progressively finer with decreasing depth;
- Approximately 25 feet to 35 feet thick; and
- Located below an approximately 20-foot-thick silty clay confining layer, and above a shale bedrock unit.

The 2017 Annual Groundwater Monitoring and Corrective Action Report was prepared to document the status of the groundwater monitoring program for the BAC (ERM, 2018a), and included results from eight rounds of sampling performed from August 2016 to August 2017. The report compared upper and lower prediction limits that were based on the upgradient data to the most recent results from the downgradient wells. Results above the upper prediction limits or below the lower prediction limits were identified as SSIs over background. The SSIs for the August 2016 to August 2017 period were addressed in the July 2018 Gavin Bottom Ash Complex Alternate Source Demonstration (ASD) Report (ERM 2018b). More recently, and relevant to this report, a comparison of results collected in the first semi-annual groundwater sampling event for 2018 identified SSIs in all wells for all Appendix III analytes except for fluoride, as summarized in Table 1-1.

### Table 1-1: Statistically Significant Increases in Groundwater beneath the BAC

| Analyte | BAC-02 | BAC-03 | BAC-04 | BAC-05 |
|---|---|---|---|---|
| Boron | X | X | X | X |
| Calcium | X | ϕ | ϕ | ϕ |
| Chloride | X | X | X | X |
| Fluoride | ϕ | ϕ | ϕ | ϕ |
| pH | X | X | X | X |
| Sulfate | X | X | X | X |
| Total Dissolved Solids | X | X | X | ϕ |

*Notes: ϕ = No SSI, X = SSI*

Results are for the downgradient wells sampled from 15 May to 17 May 2018.

This ASD continues to identify the mixing of upgradient groundwater and Ohio River surface water as the key factor controlling groundwater pH between the BAC and the Ohio River; regional discharge of groundwater as the source of calcium, chloride, fluoride, sulfate, and TDS; and the Kyger Creek NFAP as the source of boron. Supporting information and additional discussion of each of the lines of evidence discussed in Section 1.1 are presented in subsequent sections of this report.

## 2. DESCRIPTION OF ALTERNATE SOURCES

The July 2018 ASD report (ERM, 2018b) previously identified and described in detail three alternate sources for the Appendix III constituents: the Ohio River, the regional geology, and the neighboring Kyger Creek Generating Station. A summary of each of these alternate sources is provided below.

### 2.1 Ohio River

The Ohio River extends approximately 981 river miles from Pittsburgh, Pennsylvania to Cairo, Illinois, and drains an area of approximately 205,000 square miles (Ohio River Valley Water Sanitation Commission 2018). The Ohio River is located approximately 700 feet east of the BAC and the alluvial aquifer beneath the BAC is hydraulically connected to the river. When the Ohio River floods, water from the river mixes with groundwater within the alluvial aquifer (ERM 2018b). The mixing of groundwater and river water is discussed in Section 3, and the quality of the Ohio River water that mixes with groundwater is discussed in Section 4.

### 2.2 Regional Background

The regional bedrock geology near the Plant includes Pennsylvanian-age sedimentary rocks from the Monongahela and Conemaugh Groups. These sedimentary rocks consist primarily of shale and siltstone, with minor amounts of mudstone, sandstone, and incidental amounts of limestone and coal (USGS 2005). Overlying the Pennsylvanian-age rocks are Quaternary-age alluvium that consist primarily of sand, silt, clay, and gravel (OEPA 2018). These sedimentary rocks form the ridges and valleys west of the Ohio River, and the unconsolidated sand, silt, clay, and gravel is located along the Ohio River. The consolidated sedimentary rocks and the unconsolidated alluvium (sand, silt, clay, and gravel) form the two major aquifers near the Plant (Figure 2-1). The interaction of groundwater with rocks and minerals within these aquifers can influence the concentration of Appendix III constituents (Ohio River Valley Water Sanitation Commission 1984).

Naturally-occurring brine, which is known to be rich in calcium, chloride, sulfate, and other trace elements, exists in the subsurface and at the land surface in the Ohio River valley (Geological Survey of Ohio 1932; Ohio River Valley Water Sanitation Commission 1984; ODNR 1995). Some of the brines also exist close to the land surface. For example, brine was discovered at the land surface approximately 10 miles southwest of the Plant in Gallipolis, Ohio, and was utilized for the commercial production of salt starting in 1807 (Geological Survey of Ohio 1932). Naturally occurring brine was also identified at the land surface in Jackson, Ohio, approximately 30 miles west of the Plant (ODNR 1995). The presence of brine in the region indicates the potential for naturally occurring brine to contribute Appendix III constituents to shallow groundwater at the Plant.

To account for natural and anthropogenic influences on Appendix III constituents on a regional scale, background groundwater data were obtained from US Geological Survey databases. The background groundwater data set is discussed further in Section 4.

## 2.3 Kyger Creek Generating Station

The Kyger Creek Generating Station is located along the Ohio River in Gallia County, south of the Plant (Figure 2-2). The Kyger Creek fly ash pond complex consists of the 110-acre NFAP and 60-acre South Fly Ash Pond (SFAP). The construction history and groundwater monitoring results of these ponds are summarized in the July 2018 ASD report (ERM 2018b). The NFAP is located less than 300 feet from the BAC, and the units share an approximately 2,000-foot-long border (Figure 2-2). The NFAP has a higher potential to impact groundwater than the BAC because the NFAP contains fly ash, which, when compared to bottom ash, has a greater tendency to leach CCR constituents (Cox et al. 1978; Jones et al. 2012). This is described further in Section 7.

# 3. HYDRAULIC CONNECTIONS TO THE ALTERNATE SOURCES

Detailed explanations of the hydraulic connections between the alternate sources and the downgradient wells of the BAC were previously provided in the July 2018 BAC ASD report (ERM 2018b). A summary of each of these connections is provided below.

## 3.1 Ohio River

Both the Gavin BAC and the Kyger Creek NFAP are located above the alluvial aquifer (Geosyntec 2016; AGES 2016; ERM 2018b). Groundwater in the alluvial aquifer typically flows from the BAC and NFAP toward the Ohio River (ERM 2018b). Exceptions to this flow direction occur when the river stage (elevation of the surface water in the river) exceeds approximately 540 feet above mean sea level (ERM 2018b). When this occurs, groundwater flow reverses and flows generally westward from the Ohio River toward the BAC and NFAP (ERM 2018b). The correlation of the flow reversals with Ohio River flooding is strong evidence that the alluvial aquifer is hydraulically connected to the Ohio River (ERM 2018b).

## 3.2 Regional Background

Regional groundwater within the fractured sedimentary bedrock flows from northwest to southeast toward the Ohio River. Precipitation that falls in areas of higher topographic elevation northwest of the Plant infiltrates the land surface and recharges the underlying aquifers. Groundwater then flows from areas of higher hydraulic head (i.e., high topographic elevation) to areas of lower hydraulic head (i.e., low topographic elevation). As groundwater flows from northwest to southeast, it migrates both horizontally and vertically through the fracture network within the sedimentary bedrock. Near the plant, groundwater in the bedrock aquifer mixes with groundwater in the alluvial aquifer, which then discharges to the Ohio

River (Figure 3-1). Thus, regional groundwater is hydraulically connected to the downgradient BAC monitoring wells (ERM 2018b).

## 3.3 Kyger Creek Generating Station

The Ohio River stage elevation records were used to identify the frequency and duration of flow reversals, and were combined with the groundwater velocity estimates to develop groundwater flow paths under the BAC (ERM 2018b). There are three key points associated with the groundwater flow paths:

- The Kyger Creek NFAP is hydraulically upgradient of the four monitoring wells (BAC-02, BAC-03, BAC-04 and BAC-05) that are downgradient of the Gavin BAC.
- Due to the northeast flow direction, the Kyger Creek NFAP is not upgradient of the western edge of the BAC, where upgradient monitoring wells MW-1, BAC-01 and MW-6 are located.
- State monitoring well B-0904 is directly downgradient of the NFAP and upgradient of the BAC.

Based on the presence of the same alluvial aquifer beneath both the Kyger Creek NFAP and the Gavin BAC, and the average north-eastern direction of groundwater flow, it is evident that the Kyger Creek NFAP is hydraulically connected to the downgradient BAC monitoring wells (ERM 2018b).

# 4. CONSTITUENTS ARE PRESENT AT THE ALTERNATE SOURCES OR ALONG THE FLOW PATHWAYS

## 4.1 Ohio River

The pH of the Ohio River is relatively close to neutral and the pH of groundwater emanating from the Kyger Creek NFAP is slightly acidic (ERM 2018b). As described in Section 3, the hydrogeologic data indicate that water from the Ohio River mixes with groundwater from the alluvium underlying the BAC. When these waters mix under the BAC, the result is an intermediate pH. This pattern was observed in the May 2018 data, as summarized in Table 4-1 and on Figure 4-1.

**Table 4-1: Groundwater and Surface Water pH Values**

| Location | pH |
|---|---:|
| Kyger Creek NFAP Groundwater (B-0904, May 2018) | 5.0 |
| BAC Downgradient Groundwater (BAC-02 through BAC-05, May 2018) | 6.1–6.2 |
| Ohio River (May 2018) | 6.7 |

The May 2018 results are consistent with the 2017 results presented in the first BAC ASD report (ERM, 2018b) and demonstrate that the Ohio River is an alternate source for pH.

## 4.2 Regional Background

Background groundwater quality data were obtained from the United States Geological Survey (USGS) National Water Information System database. Groundwater results were selected for monitoring wells constructed within the alluvial, Conemaugh Group, and Monongahela Group aquifers located within 50 miles of the Plant (Figure 4-2). The USGS background data were compared to downgradient BAC data (wells BAC-02, BAC-03, BAC-04, and BAC-05) and Ohio River data collected in May 2018. As shown in Table 4-2, the concentrations of calcium, chloride, sulfate, and total dissolved solids (TDS) in groundwater downgradient of the BAC is between the concentrations in USGS background groundwater and the Ohio River. These results are consistent with the 2017 results presented in the first BAC ASD report (ERM 2018b) and demonstrate that the discharge of groundwater from the sedimentary bedrock aquifers to the alluvial aquifer beneath the BAC is an alternate source for calcium, chloride, sulfate, and TDS.

### Table 4-2: Comparison of USGS Regional Background to BAC and Ohio River

| Analyte | Units | USGS Background (max) | Downgradient BAC[a] | Ohio River[a] |
|---|---|---|---|---|
| Calcium | mg/L | 520 | 74–170 | 32 |
| Chloride | mg/L | 9,900 | 32–110 | 21 |
| Sulfate | mg/L | 2700 | 200–390 | 74 |
| TDS | mg/L | 9,910 | 470–980 | 210 |

[a] *Results from samples collected in May 2018*

## 4.3 Kyger Creek Generating Station

The concentration of boron in groundwater downgradient of the BAC (Figure 4-3) ranges from 2.4 milligrams per liter (mg/L) to 2.9 mg/L. Figure 4-3 shows the distribution of boron at the northern boundary of the Kyger Creek NFAP and along the flow pathways as summarized below:

- The highest boron concentrations were measured in wells B-0904, BAC-05, and BAC-04, which are located closest to and downgradient of the Kyger Creek NFAP. Notably, monitoring well B-0904 is upgradient of the BAC.
- Concentrations decrease with distance downgradient from the NFAP along the northeastern flow path.

In addition to the OEPA correspondence that concluded NFAP groundwater appears to be impacted by a release from the NFAP (Appendix A of July 208 BAC ASD [ERM 2018b]), the SFAP data also suggest boron is present in Kyger Creek groundwater. Boron results from eight rounds of groundwater sampling conducted between October 2015 and September 2017 at SFAP downgradient monitoring wells (AEG 2018) are summarized in Table 4-3.

### Table 4-3: Kyger Creek SFAP Boron Results

| Analyte | Units | Maximum | Average |
|---|---|---|---|
| Boron | mg/L | 17.7 | 6.8 |

The average concentration of boron in the SFAP is higher than the highest concentration of boron measured in groundwater beneath the BAC. The SFAP and the NFAP both manage fly ash generated at the Kyger Creek Generating Station so it is reasonable to expect that the chemical characteristics of the landfilled fly ash are similar in both units. Given the elevated boron concentrations in groundwater downgradient of the SFAP, and considering that both units are unlined, elevated concentrations of boron in groundwater downgradient of the Kyger Creek NFAP are expected. Thus, this information demonstrates that the Kyger Creek Generating Station is an alternate source for boron.

# 5. LINKAGES OF CONSTITUENT CONCENTRATIONS AND DISTRIBUTIONS BETWEEN ALTERNATE SOURCES AND DOWNGRADIENT WELLS

## 5.1 Ohio River

As described in Section 3 and in detail in the July 2018 BAC ASD (ERM 2018b), the groundwater elevation and flow directions provide strong evidence of groundwater flow reversals and the mixing of Ohio River surface water and groundwater. The intermediate pH of groundwater downgradient of the BAC (between the pH of Kyger Creek groundwater and the pH of the Ohio River) is consistent with the mixing of surface water and groundwater. These lines of evidence show there is a linkage between groundwater and the Ohio River.

## 5.2 Regional Background

As described in Section 3.2 and illustrated in Figure 3-1, groundwater flowing in the sedimentary bedrock aquifers discharges to the alluvial aquifer along the Ohio River, including the region beneath the BAC. As described in Section 4.2, regional concentrations of calcium, chloride, sulfate, and TDS are higher than groundwater concentrations downgradient of the BAC. Based on these observations, it is likely that the discharge of groundwater from the sedimentary bedrock aquifers to the alluvial aquifer under the BAC (Figure 5-1 and Figure 5-2) is an alternate source for these constituents.

## 5.3 Kyger Creek Generating Station

During times when the river stage is low (Figure 5-1), groundwater in the alluvial aquifer moves in a north-easterly direction from the NFAP, under the BAC, and eventually discharges to the Ohio River. During times of higher river stage (Figure 5-2), groundwater in the alluvial aquifer temporarily reverses direction and river water flows into the alluvial aquifer. Despite the temporary reversals of groundwater flow caused by flooding of the Ohio River, the overall, long-term flow direction is to the northeast, indicating that the source of boron detected in the monitoring wells downgradient of the BAC is connected with the Kyger Creek NFAP.

# 6. A RELEASE FROM THE BAC IS NOT SUPPORTED AS THE SOURCE

## 6.1 BAC Surface Water Concentrations are Lower than Groundwater Concentrations

The concentrations of boron, calcium, chloride, sulfate, and TDS in BAC surface water (i.e., the water impounded in the BAC) are lower than the maximum concentrations of these constituents in groundwater downgradient of the BAC (Table 6-1).

### Table 6-1: BAC Surface Water and Groundwater Concentrations

| Analyte | BAC Surface Water (mg/L)[a] | Downgradient BAC Groundwater (mg/L)[b] |
|---|---:|---:|
| Boron | 0.2 | 2.9 |
| Calcium | 84 | 170 |
| Chloride | 59 | 110 |
| Sulfate | 270 | 390 |
| TDS | 580 | 980 |

[a] *Results from May 2018*

[b] *Maximum detections in May 2018 at downgradient wells BAC-02, BAC-03, BAC-04, BAC-05*

If the BAC were the source, the concentrations of these constituents in BAC surface water would need to be higher to produce the concentrations measured in groundwater (e.g., it is unlikely that a release of surface water with 0.2 mg/L boron would result in a groundwater boron concentration greater than 0.2 mg/L). These results support the conclusions that the BAC is not the source of the SSIs for boron, calcium, chloride, sulfate, and TDS in BAC downgradient wells.

## 6.2 Chemical Fingerprints

The geochemical fingerprints of surface water from the BAC, groundwater from the BAC, groundwater from the NFAP, and surface water from the Ohio River were determined using a piper diagram. The piper diagram is a graphical procedure commonly used to interpret sources of dissolved constituents in water, and evaluate the potential for mixing of waters from different sources (Piper 1944). The samples presented on the diagram were collected from 2012 through 2018. The primary observations and conclusions based on the BAC piper diagram (Figure 6-1) are the following:

- Multiple samples collected from a single location (e.g., the Ohio River, or well B-0904) tended to be tightly clustered, which indicates the chemical signatures of individual locations were consistent over time.
- Groundwater from BAC upgradient wells MW-1, BAC-01, and MW-6 has a unique geochemical signature dominated by calcium, bicarbonate, and chloride. This groundwater flows under the west-northwest portion of the BAC and does not appear to be influenced by the Ohio River or NFAP.
- Groundwater from well B-0904, which is downgradient of the Kyger Creek NFAP and upgradient of the BAC, is dominated by calcium, magnesium, and sulfate, and has a signature that is distinct from all other chemical signatures on the diagram.
- Surface water from the Ohio River plots closer to the center of the diagram, and is dominated by calcium and sulfate.
- Groundwater from BAC downgradient wells BAC-02, BAC-03, BAC-04, and BAC-05 plots between the Ohio River and NFAP groundwater, which is an independent line of evidence that groundwater under a majority of the BAC is a mixture of groundwater from the NFAP (represented by well B-0904, which is upgradient of the BAC) and the Ohio River.
- Surface water from the BAP has a different signature than downgradient groundwater, and thus is not likely the source of impacts to BAC groundwater.

# 7. ALTERNATE SOURCE DATA ARE HISTORICALLY CONSISTENT WITH HYDROGEOLOGIC CONDITIONS

## 7.1 Ohio River

The hydraulic connection of the Ohio River to the alluvial aquifer was established after the last deglaciation (USGS 2004). Seasonal flooding of the Ohio River, which has occurred regularly over the period that the Plant has existed, is the driving force behind the mixing of surface water and groundwater. Thus, the Ohio River constitutes an alternate source that is historically consistent with hydrogeologic conditions and findings of the monitoring program.

## 7.2 Regional Background

This report provides background groundwater quality data for the fractured sedimentary bedrock aquifers found within and beyond the boundary of the Plant. The patterns of regional groundwater flow through fractured bedrock near the BAC were established after the last deglaciation, which occurred approximately 14,000 years ago (Hansen 2017). Estimated maximum groundwater velocities for the Morgantown and Cow Run sandstones range from 2 to 5 feet per year (ERM 2017), which would allow ample time for groundwater to migrate from upgradient regional areas onto the Gavin property since the end of the last glaciation. The data supporting these conclusions are historically consistent with hydrogeologic conditions and findings of the BAC monitoring program.

## 7.3 Kyger Creek Generating Station

The Kyger Creek NFAP was constructed in 1955 with its base on native soil, without an engineered liner to contain leachate. The unit was used to manage fly ash until it was drained and closed in 1997; dewatered ash is still present within the NFAP. Groundwater flows under the NFAP in a northeasterly direction toward and under the Gavin BAC. Given the six decades this unit has contained fly ash, and the groundwater velocity estimates of 5 to 19 feet per day, ample time has passed for groundwater to migrate from the Kyger Creek NFAP beneath the BAC. The following lines of evidence support the NFAP as an alternate source of boron:

- The distribution of boron in groundwater beneath the BAC (Section 4)
- The SFAP data suggest boron is present in Kyger Creek groundwater, and given the similarity in construction and types of CCR managed, it is reasonable to interpret SFAP data as representative of NFAP groundwater quality (Section 4)
- The chemical fingerprinting evidence shows groundwater from Kyger Creek mixes with Ohio River water under the BAC (Section 6)
- The concentration of boron in BAC surface water is significantly lower than the concentration in groundwater below the BAC (Section 6)
- The OEPA concluded groundwater appears to be impacted by a release from the NFAP (Appendix A of July 2018 BAC ASD [ERM 2018b])

In addition, a comparison of the materials managed provides evidence that the BAC is not the source, and the NFAP is a more likely source of boron. The NFAP has contained fly ash since 1955, while the BAC has been used primarily for the management of bottom ash since 1974. Bottom ash and fly ash have different physical and chemical properties, and laboratory investigations have shown elements (including Appendix III constituents) have a much greater potential to leach from fly ash compared to bottom ash (Cox et al. 1978; Jones et al. 2012). The higher concentrations of boron observed in SFAP groundwater compared to the lower concentration of boron observed in BAC surface water are consistent with the known leaching properties of fly ash and bottom ash. These observations support the NFAP and not the BAC as the source of boron in groundwater under the BAC. The data supporting these conclusions are historically consistent with hydrogeologic conditions and findings of the BAC monitoring program.

# 8. CONCLUSIONS

Between January and June 2018, SSIs were detected in the downgradient monitoring wells of the BAC. In response to the SSIs, this ASD was prepared in accordance with 40 CFR § 257.94(e)(2).

All SSIs in the downgradient BAC monitoring wells have been demonstrated to result from alternate sources: mixing with the Ohio River, regional groundwater discharge, and the Kyger Creek Power Plant. Table 8-1 summarizes the six lines of evidence for each of the SSIs:

### Table 8-1: BAC Alternate Source Demonstration Summary

| | | Six Lines of Evidence from EPA Guidance | | | | | |
|---|---|---|---|---|---|---|---|
| **Analyte** | **SSI Location** | **Alternate Source** | **Hydraulic Connection** | **Constituent Present at Source or Along Flow Path** | **Constituent Distribution More Strongly Linked to Alternate Source** | **Constituent Could Not Be Derived from BAC** | **Data Are Consistent with Hydrogeologic Conditions** |
| Boron | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Kyger Creek NFAP | X | X | X | X | X |
| Calcium | BAC-02 | Regional Groundwater Discharge | X | X | X | X | X |
| Chloride | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Regional Groundwater Discharge | X | X | X | X | X |
| pH | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Mixing with Ohio River | X | X | X | X | X |
| Sulfate | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Regional Groundwater Discharge | X | X | X | X | X |
| TDS | BAC-02<br>BAC-03<br>BAC-04 | Regional Groundwater Discharge | X | X | X | X | X |

The BAC was not the source of the SSIs associated with the first semi-annual sampling event groundwater results for 2018. Thus, Gavin will continue to conduct Detection Monitoring at the BAC in accordance with 40 CFR § 257.94(e)(2). The second semi-annual sampling event for 2018 is planned to be performed before 31 December 2018.

## PROFESSIONAL ENGINEER CERTIFICATION

I hereby certify that I or an agent under my review has prepared this Alternate Source Demonstration Report for the Bottom Ash Complex in accordance with 40 CFR § 257.94(e). To the best of my knowledge, the information contained in this Report is true, complete, and accurate.

**James A. Hemme, P.E.**
*State of Ohio License No.: 72851*

Date: 10/12/2018

JAMES
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72851
10/12/18

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USGS. 2004. *Geohydrology and Simulation of Ground-Water Flow in Ohio River Alluvial Aquifers near Point Pleasant, Lubek, Parkersburg, Vienna, Moundsville, and Glendale, West Virginia*, by Kozar, M.E., and K.J. McCoy. Scientific Investigation Report 2004-5088, U.S. Geological Survey, Reston, Virginia.

———. 2005. *Mineral Resources Data System.* U.S. Geological Survey, Reston, Virginia.

# FIGURES

## Figure 1-1: Gavin Plant Location

Bottom Ash Complex First Semi-Annual
Sampling Event of 2018 Alternate
Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure1_1_GavinPowerPlantLocation.mxd - Dana.Heusinkveld - 9/27/2018

Figure 1-2: Bottom Ash Complex Location

Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure1_2_BACLocation_20180608.mxd - Dana.Heusinkveld - 9/27/2018

Legend

- ⊕ Federal Sampling Program Groundwater Monitoring Well
- ⊕ Monitoring Well (Not in Federal Program)

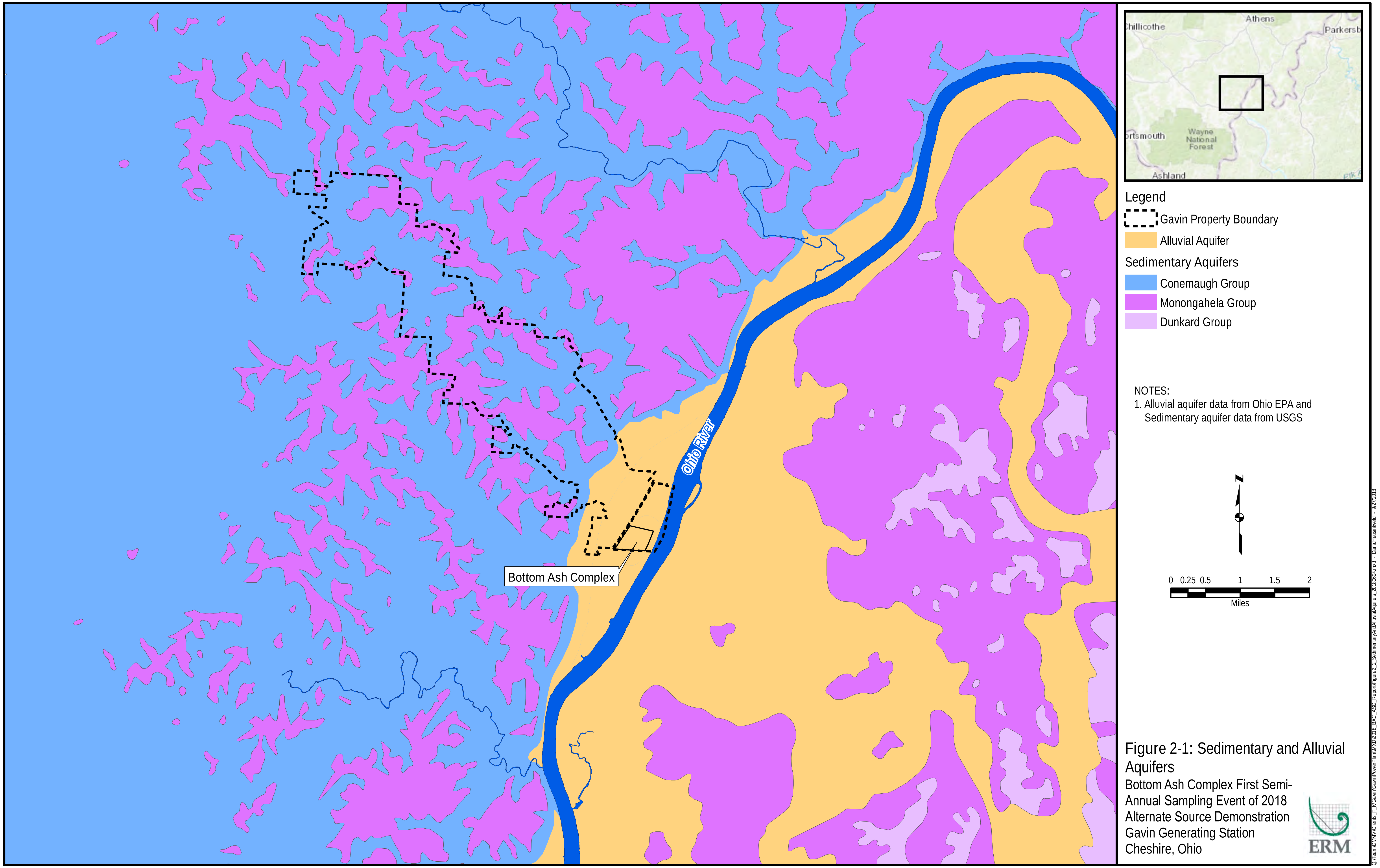
NOTES:
1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery
Reproduced under license in ArcGIS 10.4

## Figure 1-3: Existing Monitoring Well Network

Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure1_3_ExistingMWNetwork_20180530.mxd - Dana.Heusinkveld - 9/27/2018



Legend

⬚ Gavin Property Boundary

🟧 Alluvial Aquifer

Sedimentary Aquifers

🟦 Conemaugh Group

🟪 Monongahela Group

▨ Dunkard Group

NOTES:
1. Alluvial aquifer data from Ohio EPA and Sedimentary aquifer data from USGS

Figure 2-1: Sedimentary and Alluvial Aquifers

Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

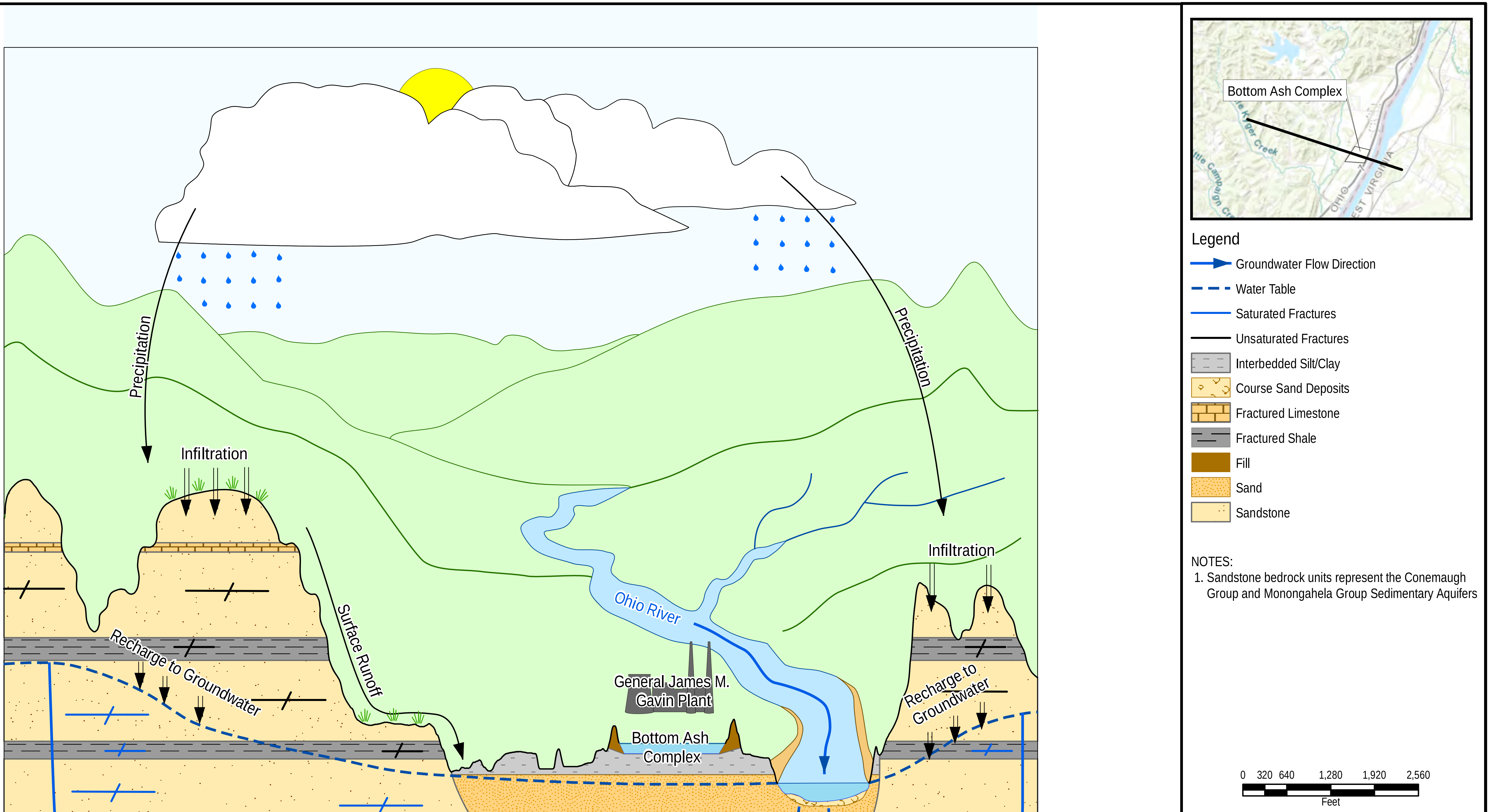
ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure2_2_SedimentaryAndAlluvialAquifers_20180604.mxd - Dana.Heusinkveld - 9/27/2018

NOTES:
1. Kyger Creek features are from AEP. 1994. Hydrogeologic Site Investigation Plan for the Proposed North Fly Ash Pond Closure, Kyger Creek Station, Ohio Valley Electric Corporation, Gallia County, Ohio.

Figure 2-2: Location of Kyger Creek Generating Station
Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure2_3_LocationOfKygerCreekStation_20180530.mxd - Dana.Heusinkveld - 9/27/2018



NOTES:
1. Sandstone bedrock units represent the Conemaugh Group and Monongahela Group Sedimentary Aquifers

## Figure 3-1: Regional Groundwater Flow Patterns

Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure3_11_RegionalGWFlowPatterns_20180608.mxd - Dana.Heusinkveld - 9/27/2018

Legend

▭ CCR Units

pH in Groundwater (May 2018)

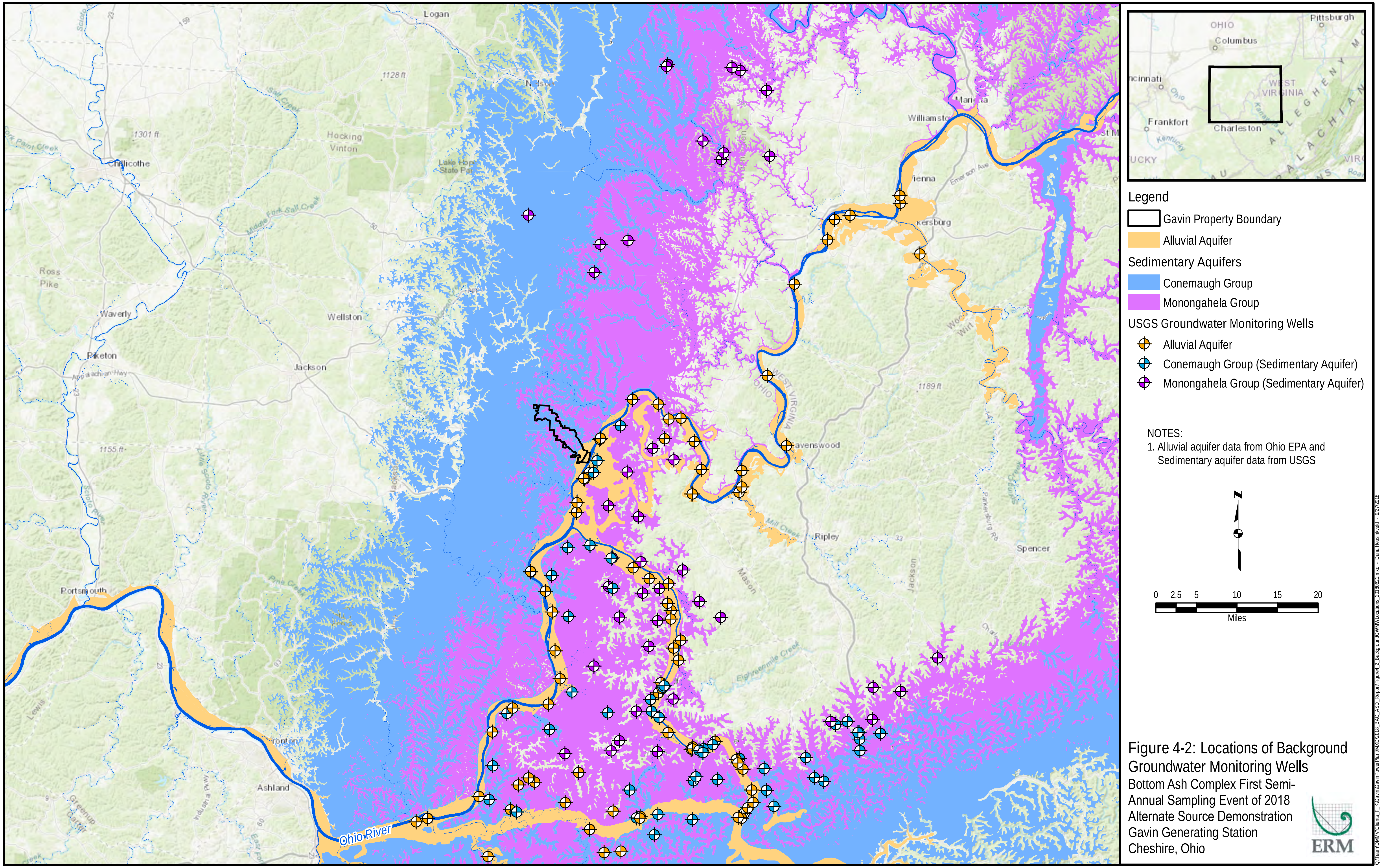
- ● < 6
- ● 6 - 6.5
- ● 6.5 - 7
- ● > 7

NOTES:
1. pH data was collected on 5/16/2018

## Figure 4-1: pH of the Ohio River and BAC Groundwater Bottom Ash Complex First Semi-Annual Sampling Event of 2018 Alternate Source Demonstration

Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure4_1_pHofOhioRiverAndBACGW_20180914.mxd - Dana.Heusinkveld - 9/27/2018



Legend

▭ Gavin Property Boundary

🟧 Alluvial Aquifer

Sedimentary Aquifers

🟦 Conemaugh Group

🟪 Monongahela Group

USGS Groundwater Monitoring Wells

⊕ Alluvial Aquifer

⊕ Conemaugh Group (Sedimentary Aquifer)

⊕ Monongahela Group (Sedimentary Aquifer)

NOTES:
1. Alluvial aquifer data from Ohio EPA and Sedimentary aquifer data from USGS

Figure 4-2: Locations of Background Groundwater Monitoring Wells
Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

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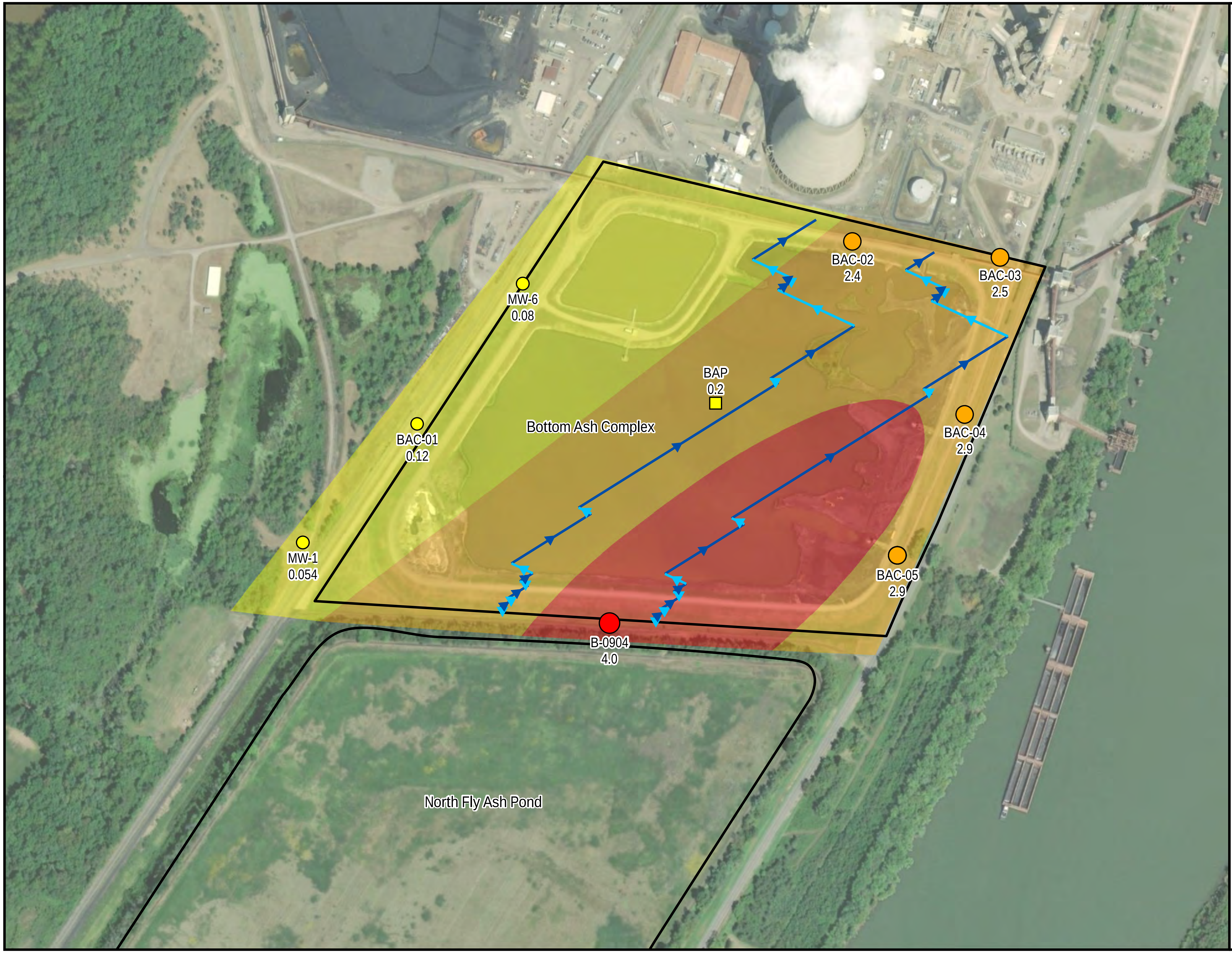
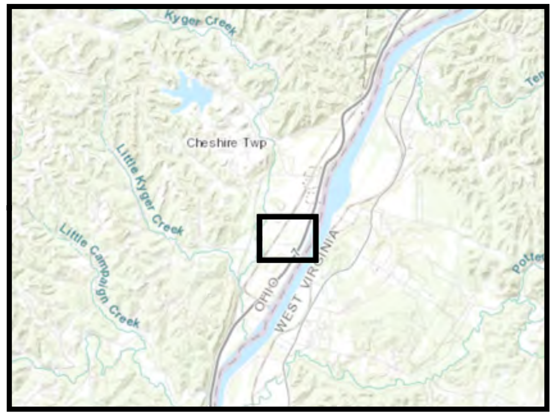




Legend

▭ CCR Units

→ Low (Typical) River State Groundwater Flow Direction to the Northeast

→ High River Stage Groundwater Flow Direction to the Northwest

Groundwater Sampling Location

○
Well Name
Boron Concentration (mg/L)

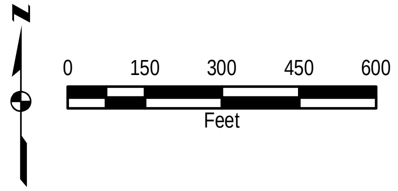
Boron Concentration in Groundwater

🟨 <2 mg/L

🟧 2-3 mg/L

🟥 >3 mg/L

NOTES:
1. Groundwater data for MW-1, BAC-01, MW-6, BAC-02, BAC-03, BAC-04, BAC-05 and B-0904 are from May 2018
2. Surface water data for BAP is from February 2018

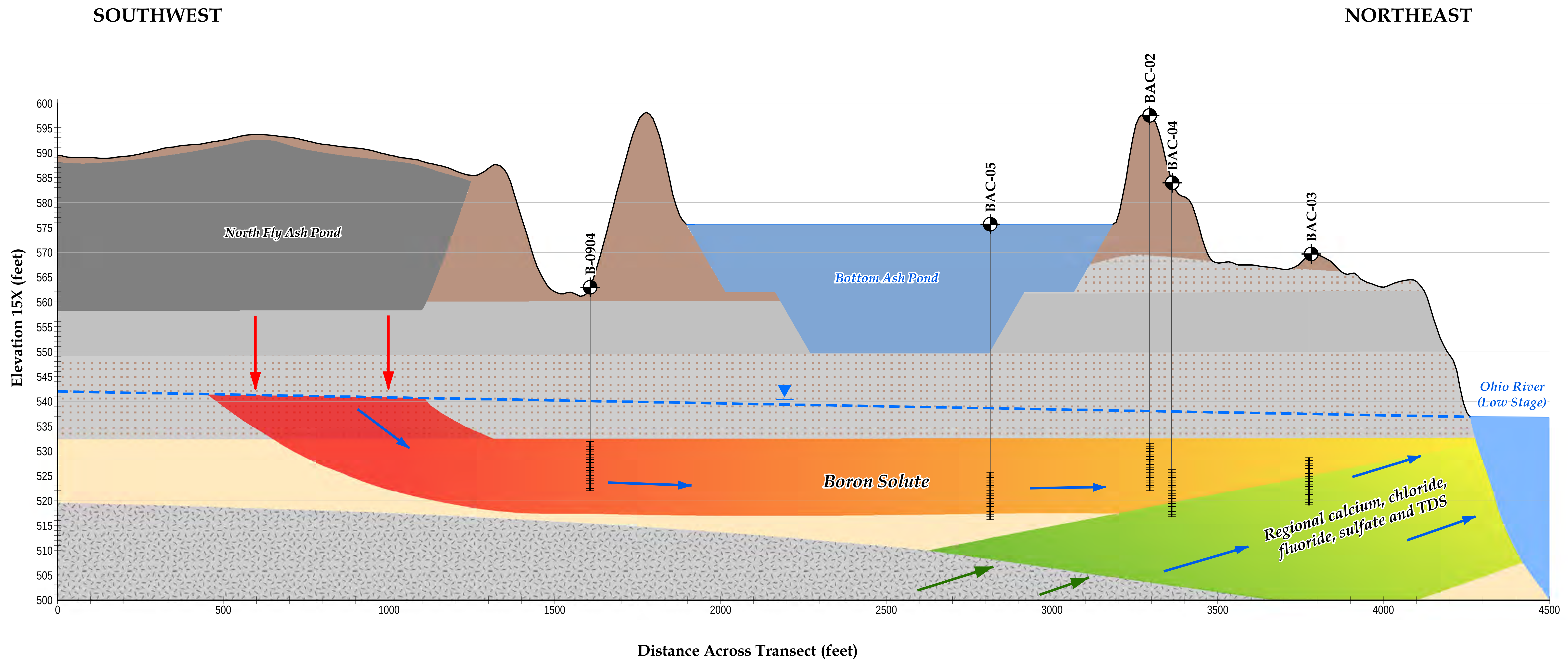


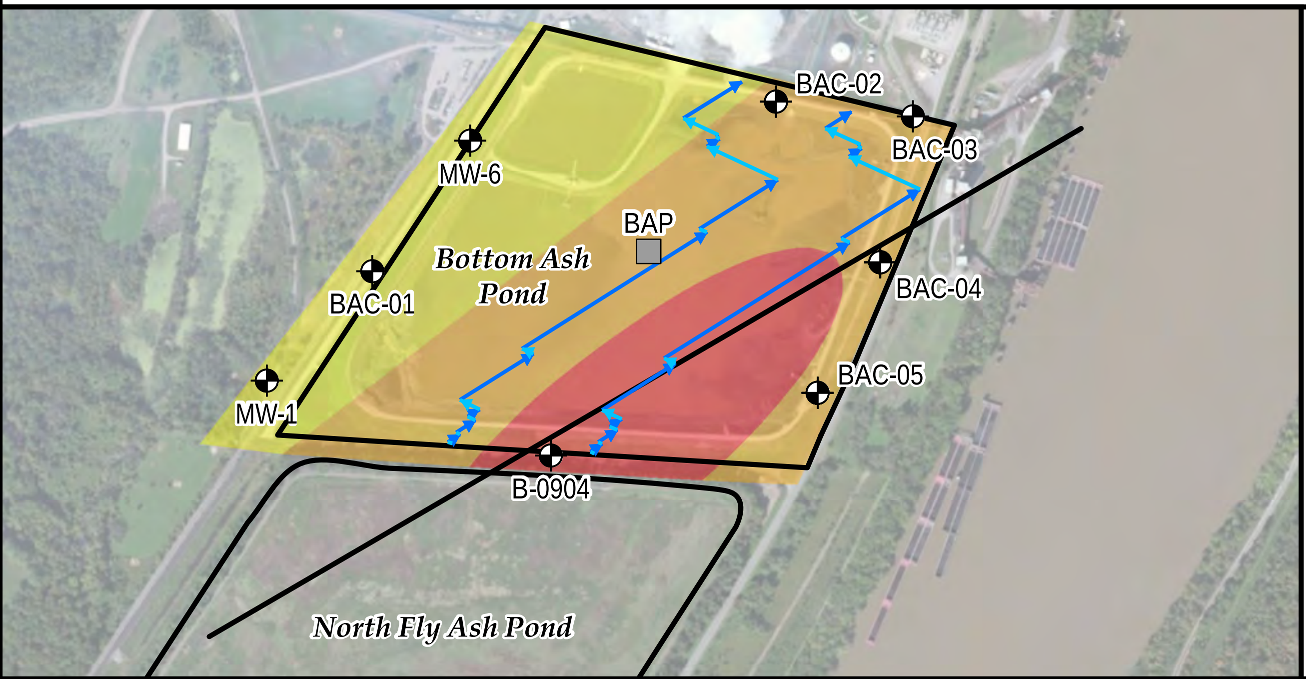
## Figure 4-3: Boron Distribution in Groundwater in May 2018

Bottom Ash Complex First Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\Figure4_3_BoronDistributionInGW_20180914.mxd - Dana.Heusinkveld - 9/26/2018





## Legend

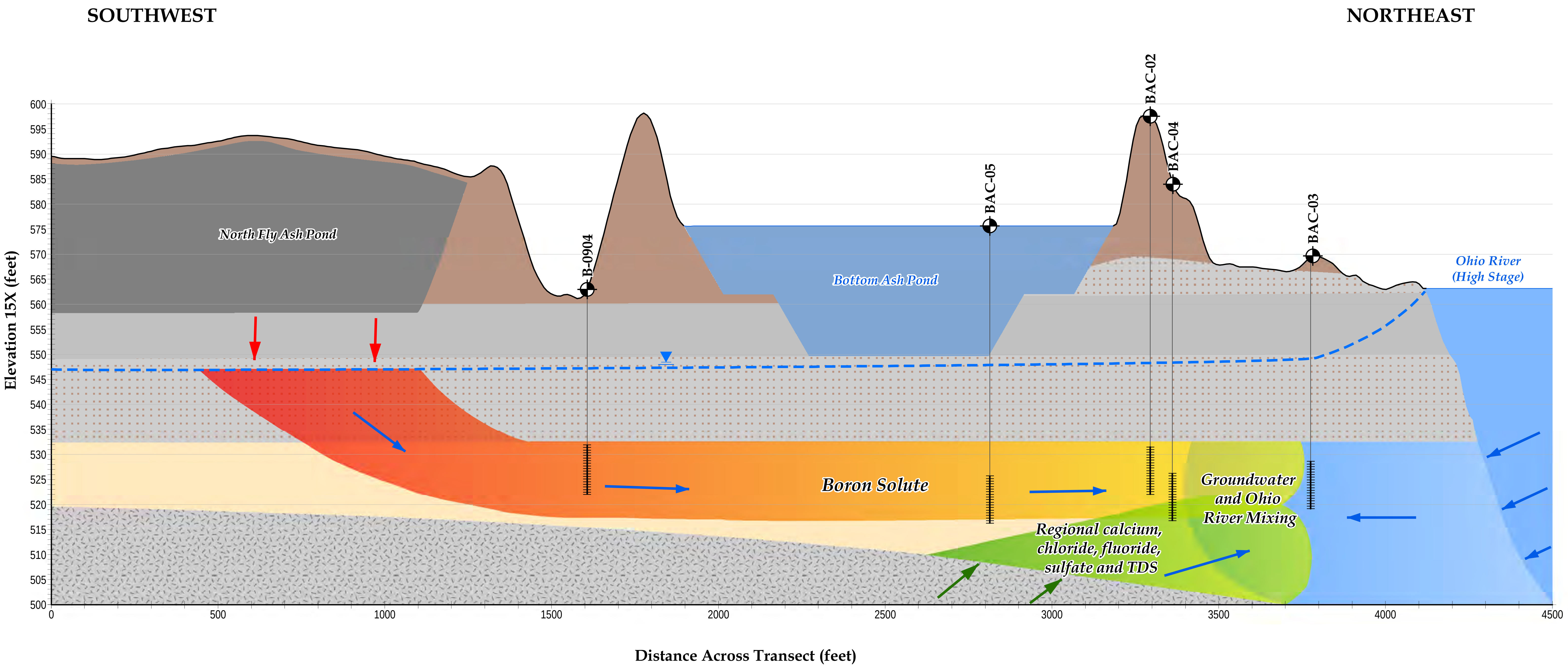
⊕ Monitoring Well
— Cross Section Location
— Borehole
╫╫╫ Well Screen
- - Interpreted Low River Piezometric Surface
→ Low River Stage Flow Direction
→ High River Stage Flow Direction
→ Interpreted Groundwater Flow Vector
→ Interpreted Leachate from NFAP
→ Interpreted Regional Source of Ca, Cl, F, $SO_4$, and TDS

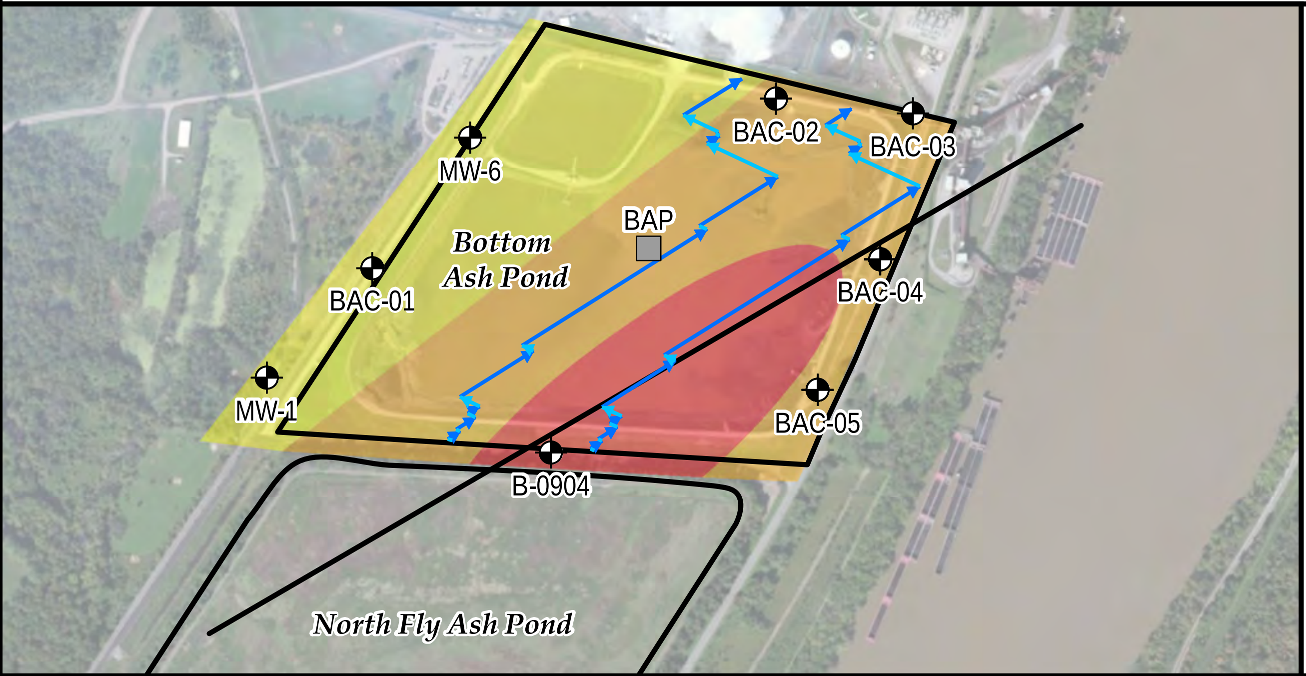
### Interpreted Geology

▨ Sandy Clayey Gravel with Bottom Ash
▨ Silt/Clay
▨ Silt/Clay Interbedded with Fine Sand
▨ Sand
▨ Bedrock

**Figure 5-1:** Low River Stage Cross Section
Bottom Ash Complex First Semi-Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM





## Legend

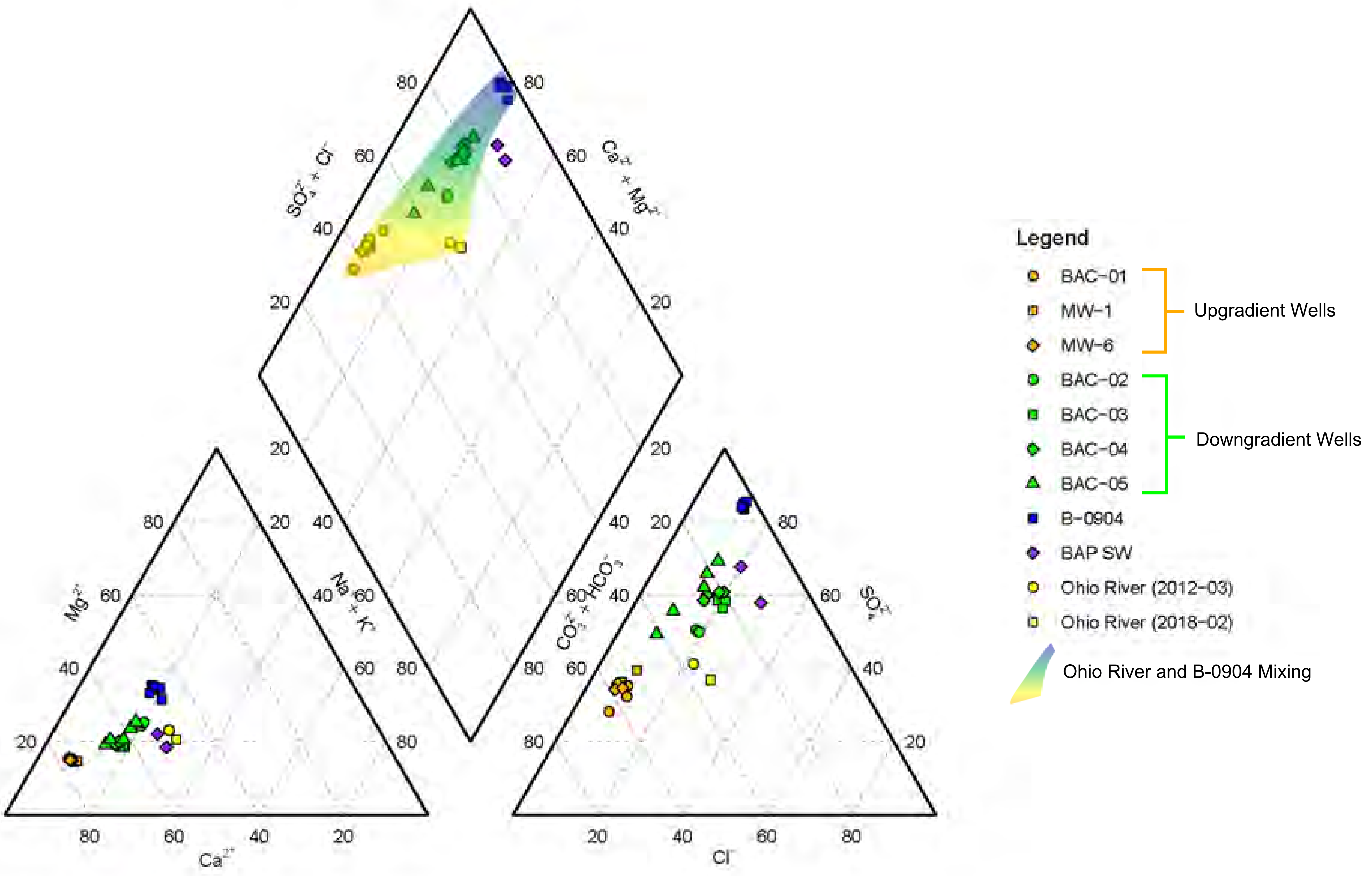
- ⊕ Monitoring Well
- ━ Cross Section Location
- ─ Borehole
- ┼┼┼ Well Screen
- ‒ ‒ Interpreted High River Piezometric Surface
- → Low River Stage Flow Direction
- → High River Stage Flow Direction
- → Interpreted Groundwater Flow Vector
- → Interpreted Leachate from NFAP
- → Interpreted Regional Source of Ca, Cl, F, $SO_4$, and TDS

## Interpreted Geology

- 🟫 Sandy Clayey Gravel with Bottom Ash
- ▒ Silt/Clay
- ▨ Silt/Clay Interbedded with Fine Sand
- 🟨 Sand
- ▩ Bedrock

**Figure 5-2:** High River Stage Cross Section
Bottom Ash Complex First Semi-Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM



**NOTES:**

1. Data Range: 3/12/2012 to 5/16/2018.
2. Only complete data including all 8 piper diagram analytes are presented.

Figure 6-1: BAC Traditional Piper Diagram
Bottom Ash Complex First Semi-Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

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# APPENDIX C GAVIN BOTTOM ASH COMPLEX SECOND SEMIANNUAL SAMPLING EVENT OF 2018 ALTERNATE SOURCE DEMONSTRATION REPORT

# Gavin Bottom Ash Complex

Gavin Power, LLC

## Second Semiannual Sampling Event of 2018 Alternate Source Demonstration Report

Gavin Power Plant
Cheshire, Ohio

31 January 2019

Project No.: 0469558

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## CONTENTS

### PROFESSIONAL ENGINEER CERTIFICATION

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## Acronyms and Abbreviations

| | |
|---|---|
| ASD | Alternate Source Demonstration |
| BAC | Bottom Ash Complex |
| BAP | Bottom Ash Pond |
| CCR | Coal Combustion Residuals |
| CCR Rule | Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments |
| CCR Unit | Bottom Ash Complex CCR Surface Impoundment |
| CFR | Code of Federal Regulations |
| Gavin | Gavin Power, LLC |
| mg/L | milligrams per liter |
| NFAP | Kyger Creek North Fly Ash Pond |
| OEPA | Ohio Environmental Protection Agency |
| Plant | General James M. Gavin Power Plant |
| SFAP | Kyger Creek South Fly Ash Pond |
| SSI | statistically significant increase |
| TDS | Total Dissolved Solids |
| USEPA | United States Environmental Protection Agency |
| USEPA Guidance | Solid Waste Disposal Facility Criteria Technical Manual, USEPA 530-R-93-017 |
| USGS | United States Geological Survey |

# 1. INTRODUCTION

## 1.1 Regulatory and Legal Framework

In accordance with 40 Code of Federal Regulations (CFR) Part 257 Subpart D—Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments ("CCR Rule"), Gavin Power, LLC ("Gavin") has been implementing the groundwater monitoring requirements of 40 CFR § 257.90 *et seq.* for its Bottom Ash Complex (BAC) CCR Surface Impoundment (the "CCR Unit") at the General James M. Gavin Power Plant (the "Plant"). Gavin calculated background levels and conducted statistical analyses for Appendix III constituents in accordance with 40 CFR § 257.93(h). Currently, Gavin is performing detection monitoring at the BAC in accordance with 40 CFR § 257.94. Statistically Significant Increases (SSIs) over background concentrations were detected in downgradient monitoring wells for Appendix III constituents for the second semiannual groundwater sampling event of 2018 and are explained in this Report.

An SSI for one or more Appendix III constituents is a potential indication of a release of constituents from the CCR unit to groundwater. In the event of an SSI, the CCR Rule provides that “the owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality” (40 CFR § 257.94(e)(2)). If it can be demonstrated that the SSI is due to a source other than the CCR unit, then the CCR unit may remain in the Detection Monitoring Program instead of transitioning to an Assessment Monitoring Program. An Alternate Source Demonstration (ASD) must be made in writing, and the accuracy of the information must be verified through certification by a qualified Professional Engineer (40 CFR § 257.94(e)(2)).

The CCR Rule and the regulatory preamble do not contain requirements or reference agency guidance for a successful ASD. However, the USEPA previously issued guidance for conducting ASDs under the regulatory program governing Municipal Solid Waste Landfills (MSWLFs), upon which the USEPA modeled the groundwater monitoring provisions of the CCR Rule (80 Fed. Reg. 21302, 21396 (Apr. 17, 2015)). Because of the substantial similarity between the language governing ASDs in the CCR Rule and the MSWLF regulations, USEPA’s guidance document provides a useful framework for ASDs under the CCR Rule.

This guidance document, “Solid Waste Disposal Facility Criteria Technical Manual, USEPA 530-R-93-017, Subpart E” (Nov. 1993) (“USEPA Guidance”), lays out the six lines of evidence that should be addressed to determine whether an SSI resulted from a source other than the regulated disposal unit:

1. An alternative source exists.
2. Hydraulic connection exists between the alternative source and the well with the significant increase.
3. Constituent(s) (or precursor constituents) are present at the alternative source or along the flow path from the alternative source prior to possible release from the unit.
4. The relative concentration and distribution of constituents in the zone of contamination are more strongly linked to the alternative source than to the unit when the fate and transport characteristics of the constituents are considered.
5. The concentration observed in ground water could not have resulted from the unit given the waste constituents and concentrations in the unit leachate and wastes, and site hydrogeologic conditions.
6. The data supporting conclusions regarding the alternative source are historically consistent with the hydrogeologic conditions and findings of the monitoring program.

This ASD Report addresses each of these lines of evidence for the SSIs detected in the groundwater beneath the BAC.

## 1.2 Background

The Plant is a coal-fired generating station located in Gallia County in Cheshire, Ohio, along the Ohio River (Figure 1-1). The BAC is one of three CCR management units at the Plant that are subject to regulation under the CCR Rule and is located adjacent to and immediately south of the main Plant area along the Ohio River (Figure 1-2). The BAC consists of two ponds: the larger pond is the Bottom Ash Pond (BAP) and the smaller pond is the Reclaim Pond (Figure 1-3). These ponds are used to manage the Plant's bottom ash and other miscellaneous Plant wastewaters.

The groundwater monitoring well network consists of three upgradient monitoring wells (BAC-01, MW-1, and MW-6) and four downgradient monitoring wells (BAC-02, BAC-03, BAC-04, and BAC-05) positioned around the perimeter of the BAC (Figure 1-3). In addition, monitoring well B-0904 is located to the south of the BAC and is used in this report to evaluate the quality of groundwater migrating from the Kyger Creek North Fly Ash Pond (NFAP) and under the BAC. All of the monitoring wells are screened in the uppermost aquifer beneath the BAP and Reclaim Pond units. The uppermost aquifer has the following characteristics (Geosyntec 2016):

- Consists of fine to coarse sand with some gravel that gets progressively finer with decreasing depth;
- Approximately 25 feet to 35 feet thick; and
- Located below an approximately 20-foot-thick silty clay confining layer, and above a shale bedrock unit.

The 2017 Annual Groundwater Monitoring and Corrective Action Report was prepared to document the status of the groundwater monitoring program for the BAC (ERM 2018a), and included results from eight rounds of sampling performed from August 2016 to August 2017. The report compared upper and lower prediction limits that were based on the upgradient data to the most recent results from the downgradient wells. Also, the following ASD Reports were previously submitted with regards to SSIs above the upper prediction limits or below the lower prediction limits in the BAC:

- The SSIs associated with the August 2016 to August 2017 period were addressed in the Gavin BAC ASD Report (ERM 2018b).
- The SSIs associated with the May 2018 sampling event were addressed in the *Gavin BAC First Semiannual Sampling Event of 2018 ASD Report* (ERM 2018c)

More recently, and relevant to this report, a comparison of results collected in the second semiannual groundwater sampling event, which occurred in September 2018, identified SSIs in downgradient wells for Appendix III analytes as summarized in Table 1-1.

## Table 1-1: SSIs in Groundwater beneath the BAC

| Analyte | BAC-02 | BAC-03 | BAC-04 | BAC-05 |
|---|---|---|---|---|
| Boron | X | X | X | X |
| Calcium | X | ϕ | ϕ | ϕ |
| Chloride | X | X | X | X |
| Fluoride | X | ϕ | ϕ | ϕ |
| pH | X | X | X | X |
| Sulfate | X | X | X | X |
| Total Dissolved Solids | X | ϕ | ϕ | ϕ |

*Notes: ϕ = No SSI, X = SSI*

Results are for the downgradient wells sampled on 18 September 2018.

Consistent with the previous ASD Reports for the BAC, this ASD Report identifies the mixing of upgradient groundwater and Ohio River surface water as the key factor controlling groundwater pH between the BAC and the Ohio River; regional discharge of groundwater as the source of calcium, chloride, fluoride, sulfate, and total dissolved solids (TDS); and the Kyger Creek NFAP as the source of boron. Supporting information and additional discussion of each of the lines of evidence discussed in Section 1.1 are presented in subsequent sections of this report.

# 2. DESCRIPTION OF ALTERNATE SOURCES

The ASD Report for the BAC (ERM 2018b) identified and described in detail three alternate sources for the Appendix III constituents: the Ohio River, the regional geology, and the neighboring Kyger Creek Generating Station. A summary of each of these alternate sources is provided below.

## 2.1 Ohio River

The Ohio River extends approximately 981 river miles from Pittsburgh, Pennsylvania to Cairo, Illinois, and drains an area of approximately 205,000 square miles (ORSANCO 2018). The Ohio River is approximately 700 feet east of the BAC and the alluvial aquifer beneath the BAC is hydraulically connected to the river. When the Ohio River floods, water from the river mixes with groundwater within the alluvial aquifer (ERM 2018b). The mixing of groundwater and river water is discussed in Section 3, and the quality of the Ohio River water that mixes with groundwater is discussed in Section 4.

## 2.2 Regional Background

The regional bedrock geology near the Plant includes Pennsylvanian-age sedimentary rocks from the Monongahela and Conemaugh Groups. These sedimentary rocks consist primarily of shale and siltstone, with minor amounts of mudstone, sandstone, and incidental amounts of limestone and coal (USGS 2005). Overlying the Pennsylvanian-age rocks are Quaternary-age alluvium that consists primarily of sand, silt, clay, and gravel (OEPA 2018). These sedimentary rocks form the ridges and valleys west of the Ohio River, and the unconsolidated sand, silt, clay, and gravel is located along the Ohio River. The consolidated sedimentary rocks and the unconsolidated alluvium (sand, silt, clay, and gravel) form the two major aquifers near the Plant (Figure 2-1). The interaction of groundwater with rocks and minerals within these aquifers can influence the concentration of Appendix III constituents (ORSANCO 1984).

Naturally-occurring brine, which is known to be rich in calcium, chloride, sulfate, fluoride and other trace elements, exists in the subsurface and at the land surface in the Ohio River Valley (Geological Survey of Ohio 1932; ORSANCO 1984; ODNR 1995). Some of the brines also exist close to the land surface. For example, brine was discovered at the land surface approximately 10 miles southwest of the Plant in Gallipolis, Ohio, and was utilized for the commercial production of salt starting in 1807 (Geological Survey of Ohio 1932). Naturally occurring brine was also identified at the land surface in Jackson, Ohio, approximately 30 miles west of the Plant (ODNR 1995). The presence of brine in the region indicates the potential for naturally occurring brine to contribute Appendix III constituents to shallow groundwater at the Plant.

To account for natural and anthropogenic influences on Appendix III constituents on a regional scale, background groundwater data were obtained from United States Geological Survey (USGS) databases. The background groundwater data set is discussed further in Section 4.

## 2.3 Kyger Creek Generating Station

The Kyger Creek Generating Station is located along the Ohio River in Gallia County, south of the Plant (Figure 2-2). The Kyger Creek fly ash pond complex consists of the 110-acre NFAP and 60-acre South Fly Ash Pond (SFAP). The construction history and groundwater monitoring results of these ponds are summarized in the first ASD Report for the BAC (ERM 2018b). The NFAP is located less than 300 feet from the BAC, and the units share an approximately 2,000-foot-long border (Figure 2-2). The NFAP has a higher potential to impact groundwater than the BAC because the NFAP contains fly ash, which, when compared to bottom ash, has a greater tendency to leach CCR constituents (Cox et al. 1978; Jones et al. 2012). This is described further in Section 7.

# 3. HYDRAULIC CONNECTIONS TO THE ALTERNATE SOURCES

Detailed explanations of the hydraulic connections between the alternate sources and the downgradient wells of the BAC were previously provided in the ASD Report for the BAC (ERM 2018b). A summary of each of these connections is provided below.

## 3.1 Ohio River

Both the Gavin BAC and the Kyger Creek NFAP are located above the alluvial aquifer (Geosyntec 2016; AGES 2016; ERM 2018b). Groundwater in the alluvial aquifer typically flows from the BAC and NFAP toward the Ohio River (ERM 2018b). Exceptions to this flow direction occur when the river stage (elevation of the surface water in the river) exceeds approximately 540 feet above mean sea level (ERM 2018b). When this occurs, groundwater flow reverses and flows generally westward from the Ohio River toward the BAC and NFAP (ERM 2018b). The correlation of the flow reversals with Ohio River flooding is strong evidence that the alluvial aquifer is hydraulically connected to the Ohio River (ERM 2018b).

## 3.2 Regional Background

Regional groundwater within the fractured sedimentary bedrock flows from northwest to southeast toward the Ohio River. Precipitation that falls in areas of higher topographic elevation northwest of the Plant infiltrates the land surface and recharges the underlying aquifers. Groundwater then flows from areas of higher hydraulic head (i.e., high topographic elevation) to areas of lower hydraulic head (i.e., low topographic elevation). As groundwater flows from northwest to southeast, it migrates both horizontally and vertically through the fracture network within the sedimentary bedrock. Near the Plant, groundwater in the bedrock aquifer mixes with groundwater in the alluvial aquifer, which then discharges to the Ohio River (Figure 3-1). Thus, regional groundwater is hydraulically connected to the downgradient BAC monitoring wells (ERM 2018b).

## 3.3 Kyger Creek Generating Station

The Ohio River stage elevation records were used to identify the frequency and duration of flow reversals, and were combined with the groundwater velocity estimates to develop groundwater flow paths under the BAC (ERM 2018b). There are three key points associated with the interpreted groundwater flow paths:

- The Kyger Creek NFAP is hydraulically upgradient of the four monitoring wells (BAC-02, BAC-03, BAC-04 and BAC-05) that are downgradient of the Gavin BAC.
- Due to the northeast flow direction, the Kyger Creek NFAP is not upgradient of the western edge of the BAC, where upgradient monitoring wells MW-1, BAC-01, and MW-6 are located.
- State monitoring well B-0904 is directly downgradient of the NFAP and upgradient of the BAC.

Based on the presence of the same alluvial aquifer beneath both the Kyger Creek NFAP and the Gavin BAC, and the average north-eastern direction of groundwater flow, it is evident that the Kyger Creek NFAP is hydraulically connected to the downgradient BAC monitoring wells (ERM 2018b).

# 4. CONSTITUENTS ARE PRESENT AT THE ALTERNATE SOURCES OR ALONG THE FLOW PATHWAYS

## 4.1 Ohio River

The pH of the Ohio River is near neutral and the pH of groundwater emanating from the Kyger Creek NFAP is slightly acidic (ERM 2018b). As described in Section 3, the hydrogeologic data indicate that water from the Ohio River mixes with groundwater from the alluvium underlying the BAC. When these waters mix under the BAC, the result is an intermediate pH (i.e., between the pH of the Ohio River and the pH of the NFAP). This pattern was observed in the September 2018 data, as summarized in Table 4-1 and on Figure 4-1.

**Table 4-1: Groundwater and Surface Water pH Values**

| Location | pH |
|---|---:|
| Kyger Creek NFAP Groundwater (B-0904, September 2018) | 5.08 |
| BAC Downgradient Groundwater (BAC-02 through BAC-05, September 2018) | 6.09–6.24 |
| Ohio River (September 2018) | 7.63 |

The September 2018 results are consistent with the 2017 results presented in the first ASD Report for the BAC (ERM, 2018b) and the May 2018 results presented in the *Gavin BAC First Semiannual Sampling Event of 2018 ASD Report* (ERM 2018c), and demonstrate that elevated pH is present at the Ohio River.

## 4.2 Regional Background

Regional background groundwater quality data were obtained from the USGS National Water Information System database. Groundwater results were selected for monitoring wells constructed within the alluvial, Conemaugh Group, and Monongahela Group aquifers located within 50 miles of the Plant (Figure 4-2). The USGS background data were compared to downgradient BAC data (wells BAC-02, BAC-03, BAC-04, and BAC-05) and Ohio River data collected in September 2018. As shown in Table 4-2, the concentrations of calcium, chloride, fluoride, sulfate, and TDS in groundwater downgradient of the BAC are between the concentrations in USGS background groundwater and the Ohio River. These results are consistent with the 2017 results presented in the first ASD Report for the BAC (ERM 2018b) and demonstrate that calcium, chloride, fluoride, sulfate, and TDS are present along flow pathways from the sedimentary bedrock aquifers to the alluvial aquifer beneath the BAC.

**Table 4-2: Comparison of USGS Regional Background to BAC and Ohio River**

| Analyte | Units | USGS Background (Max) | Downgradient BAC[a] | Ohio River[a] |
|---|:---:|---:|---:|---:|
| Calcium | mg/L | 520 | 76–160 | 32 |
| Chloride | mg/L | 9,900 | 37–100 | 15 |
| Fluoride | mg/L | 8.8 | 0.073–0.20 | 0.11 |
| Sulfate | mg/L | 2,700 | 200–400 | 52 |
| TDS | mg/L | 9,910 | 480–980 | 180 |

*[a] Results from samples collected in September 2018*
*mg/L = milligrams per liter*

## 4.3 Kyger Creek Generating Station

The concentration of boron in groundwater downgradient of the BAC (Figure 4-3) ranges from 2.2 milligrams per liter (mg/L) to 2.80 mg/L in the September 2018 samples. Figure 4-4 shows the distribution of boron at the northern boundary of the Kyger Creek NFAP and along the flow pathways as summarized below:

- The highest boron concentrations were measured in wells B-0904, BAC-05, and BAC-04, which are located closest to and downgradient of the Kyger Creek NFAP. Notably, monitoring well B-0904 is upgradient of the BAC.
- Concentrations decrease with distance downgradient from the NFAP along the northeastern flow path.

In addition to the Ohio Environmental Protection Agency (OEPA) correspondence that concluded that groundwater below the NFAP appears to be impacted by a release from the NFAP (Appendix A of the first ASD Report for the BAC [ERM 2018b]), the SFAP data also suggest boron is present in groundwater below both Kyger Creek fly ash ponds. Boron results from eight rounds of groundwater sampling conducted between October 2015 and September 2017 at SFAP downgradient monitoring wells (AEG 2018) are summarized in Table 4-3.

**Table 4-3: Kyger Creek SFAP Boron Results**

| Analyte | Units | Maximum | Average |
|---|---|---:|---:|
| Boron | mg/L | 17.7 | 6.8 |

The average concentration of boron (6.8 mg/L) in the SFAP is higher than the highest concentration of boron measured in groundwater beneath the BAC (2.8 mg/L). The SFAP and the NFAP both manage fly ash generated at the Kyger Creek Generating Station so it is reasonable to expect that the chemical characteristics of the landfilled fly ash are similar in both units. Given the elevated boron concentrations in groundwater downgradient of the SFAP, and considering that both units are unlined, elevated concentrations of boron in groundwater downgradient of the Kyger Creek NFAP are expected. Thus, this evidence demonstrates that boron is present at the Kyger Creek Generating Station.

# 5. LINKAGES OF CONSTITUENT CONCENTRATIONS AND DISTRIBUTIONS BETWEEN ALTERNATE SOURCES AND DOWNGRADIENT WELLS

## 5.1 Ohio River

As described in Section 3 and in detail in the first ASD Report for the BAC (ERM 2018b), the groundwater elevation and flow directions provide strong evidence of groundwater flow reversals and the mixing of Ohio River surface water and groundwater. The intermediate pH of groundwater downgradient of the BAC (i.e., the value between the pH of Kyger Creek groundwater and the pH of the Ohio River) is consistent with the mixing of surface water and groundwater. This evidence shows there is a linkage between groundwater downgradient of the BAC and the Ohio River.

## 5.2 Regional Background

As described in Section 3.2 and illustrated on Figure 3-1, groundwater flowing in the sedimentary bedrock aquifers discharges to the alluvial aquifer along the Ohio River, including the portion beneath the BAC. As described in Section 4.2, regional concentrations of calcium, chloride, fluoride, sulfate, and TDS are higher than respective groundwater concentrations downgradient of the BAC. Based on these observations, it is likely that the discharge of groundwater from the sedimentary bedrock aquifers to the alluvial aquifer under the BAC (Figure 5-1 and Figure 5-2) is an alternate source for these constituents. This evidence shows that there is a linkage between groundwater downgradient of the BAC and regional background.

## 5.3 Kyger Creek Generating Station

When the river stage is low (Figure 5-1), groundwater in the alluvial aquifer moves in a north-easterly direction from the NFAP, under the BAC, and eventually discharges to the Ohio River. During times of higher river stage (Figure 5-2), groundwater in the alluvial aquifer temporarily reverses direction and river water flows into the alluvial aquifer. Despite the temporary reversals of groundwater flow caused by flooding of the Ohio River, the overall, long-term flow direction is to the northeast, indicating that the source of boron detected in the monitoring wells downgradient of the BAC is connected with the Kyger Creek NFAP.

# 6. RELEASES FROM THE BAC ARE NOT SUPPORTED AS THE SOURCES

## 6.1 BAC Surface Water Concentrations are Lower than Groundwater Concentrations

The concentrations of boron, calcium, chloride, and TDS in BAC surface water (i.e., the water impounded in the BAC) are lower than the maximum concentrations of these constituents in groundwater downgradient of the BAC (Table 6-1).

### Table 6-1: BAC Surface Water and Groundwater Concentrations

| Analyte | BAC Surface Water (mg/L)[a] | Downgradient BAC Groundwater (mg/L)[b] |
|---|---:|---:|
| Boron | 0.32 | 2.80 |
| Calcium | 120 | 160 |
| Chloride | 79 | 100 |
| Fluoride | 0.35 | 0.2 |
| Sulfate | 520 | 400 |
| TDS | 580 | 980 |

[a] *Results from September 2018*
[b] *Maximum detections in September 2018 at downgradient wells BAC-02, BAC-03, BAC-04, BAC-05*

If the BAC were the source, the concentrations of boron, calcium, chloride, and TDS in BAC surface water would need to be higher to produce the concentrations measured in groundwater (e.g., it is unlikely that a release of surface water with 0.32 mg/L boron would result in a groundwater boron concentration greater than 0.32 mg/L). Sulfate and fluoride were higher in the BAC surface water compared to groundwater, but it is not possible that the BAC would be the source of sulfate and fluoride in groundwater, and not the source of the other constituents. Thus, on the whole, these results support the conclusion that the BAC is not the source of the SSIs observed in the BAC downgradient wells.

## 6.2 Chemical Fingerprints

The geochemical fingerprints of surface water from the BAC, groundwater from the BAC, groundwater from the NFAP, and surface water from the Ohio River were determined using a piper diagram. The piper diagram is a graphical procedure commonly used to interpret sources of dissolved constituents in water, and evaluate the potential for mixing of waters from different sources (Piper 1944). The samples presented on the diagram were collected from 2012 through 2018. The primary observations and conclusions based on the BAC piper diagram (Figure 6-1) are the following:

- Multiple samples collected from a single location (e.g., the Ohio River, or well B-0904) tended to be tightly clustered, which indicates the chemical signatures of individual locations were consistent over time.
- Groundwater from BAC upgradient wells MW-1, BAC-01, and MW-6 has a unique geochemical signature dominated by calcium and bicarbonate. This groundwater flows under the west-northwest portion of the BAC and does not appear to be influenced by the Ohio River or Kyger Creek NFAP.
- Groundwater from well B-0904, which is downgradient of the Kyger Creek NFAP and upgradient of the BAC, is dominated by calcium and sulfate, and has a signature that is distinct from all other chemical signatures on the diagram.
- Surface water from the Ohio River also has a distinct signature that plots closer to the center of the piper diagram.

- Groundwater from BAC downgradient wells BAC-02, BAC-03, BAC-04, and BAC-05 plots between the Ohio River and NFAP groundwater, which is an independent line of evidence that groundwater under a majority of the BAC is a mixture of groundwater from the NFAP (represented by well B-0904, which is upgradient of the BAC) and the Ohio River.
- Surface water from the BAP has a different signature than downgradient groundwater, and thus is not likely the source of impacts to BAC groundwater.

Thus, the chemical fingerprints of the waters at issue indicate that the BAC is not the source of the SSIs.

# 7. ALTERNATE SOURCE DATA ARE HISTORICALLY CONSISTENT WITH HYDROGEOLOGIC CONDITIONS

## 7.1 Ohio River

The hydraulic connection of the Ohio River to the alluvial aquifer was established after the last deglaciation (USGS 2004). Seasonal flooding of the Ohio River, which has occurred regularly over the period that the Plant has existed, is the driving force behind the mixing of surface water and groundwater. Thus, source data for the Ohio River are historically consistent with hydrogeologic conditions and findings of the monitoring program.

## 7.2 Regional Background

This report provides background groundwater quality data for the fractured sedimentary bedrock aquifers found within and beyond the boundary of the Plant. The patterns of regional groundwater flow through fractured bedrock near the BAC were established after the last deglaciation, which occurred approximately 14,000 years ago (Hansen 2017). Assuming a conservatively high effective porosity of 1 percent results in an estimated groundwater velocity for the Morgantown Sandstone and Cow Run Sandstone of 50 feet per year and 80 feet per year[1], respectively, which would allow ample time for groundwater to migrate from upgradient regional sources onto Plant property since the end of the last glaciation. The data supporting these conclusions are historically consistent with hydrogeologic conditions and findings of the BAC monitoring program.

## 7.3 Kyger Creek Generating Station

The Kyger Creek NFAP was constructed in 1955 with its base on native soil, without an engineered liner to contain leachate. The unit was used to manage fly ash until it was drained and closed in 1997, although dewatered ash is still present within the NFAP. Groundwater flows under the NFAP in a northeasterly direction toward and under the Gavin BAC. Given the six decades that this unit has contained fly ash, and the alluvial aquifer groundwater velocity estimates of 5 to 19 feet per day, ample time has passed for groundwater to migrate from the Kyger Creek NFAP beneath the BAC. The following evidence supports the NFAP as the alternate source of boron:

- The distribution of boron in groundwater beneath the BAC (Section 4);
- Analytical results from groundwater samples collected below the Kyger Creek SFAP suggest boron is present in Kyger Creek groundwater, and given the similarity in construction and types of CCR managed, it is reasonable to interpret SFAP groundwater data as representative of NFAP groundwater quality (Section 4);
- The chemical fingerprinting evidence shows groundwater from Kyger Creek mixes with Ohio River water under the BAC (Section 6);
- The concentration of boron in BAC surface water is significantly lower than the concentration in groundwater below the BAC (Section 6); and
- The OEPA concluded that groundwater appears to be impacted by a release from the NFAP (Appendix A of the first ASD Report for the BAC [ERM 2018b]).

---

[1] The groundwater velocities presented in the ASD prepared for the first semiannual sampling event of 2018 were based on an estimated porosity of 30 percent. Based on observations of additional bedrock cores advanced in 2018, ERM has revised downward the estimated porosity, which has resulted in higher estimated groundwater velocities within the fractured bedrock aquifers.

In addition, a comparison of the materials managed provides evidence that the BAC is not the source, and the NFAP is a more likely source of boron. The NFAP has contained fly ash since 1955, while the BAC has been used primarily for the management of bottom ash since 1974. Bottom ash and fly ash have different physical and chemical properties, and laboratory investigations have shown elements (including Appendix III constituents) have a much greater potential to leach from fly ash compared to bottom ash (Cox et al. 1978; Jones et al. 2012). The higher concentrations of boron observed in Kyger Creek SFAP groundwater compared to the lower concentration of boron observed in BAC surface water are consistent with the known leaching properties of fly ash and bottom ash. These observations support the conclusion that the NFAP, and not the BAC, is the source of boron in groundwater under the BAC. Thus, the data supporting these conclusions are historically consistent with hydrogeologic conditions and findings of the BAC monitoring program.

# 8. CONCLUSIONS

The SSIs identified in this report for samples from monitoring wells downgradient of the BAC were detected on 15 November 2018. In response to the SSIs, this ASD Report was prepared within the required 90-day period in accordance with 40 CFR § 257.94(e)(2).

All SSIs in the downgradient BAC monitoring wells have been determined to result from alternate sources: mixing with the Ohio River, regional groundwater discharge, and the Kyger Creek Power Plant. Table 8-1 summarizes the six lines of evidence for each of the SSIs:

**Table 8-1: BAC ASD Summary**

| | | Six Lines of Evidence from USEPA Guidance | | | | | |
|---|---|---|---|---|---|---|---|
| **Analyte** | **SSI Location** | **Alternate Source** | **Hydraulic Connection** | **Constituent Present at Source or Along Flow Path** | **Constituent Distribution More Strongly Linked to Alternate Source** | **Constituent Could Not Have Resulted from the BAC** | **Data Are Historically Consistent with Hydrogeologic Conditions** |
| Boron | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Kyger Creek NFAP | X | X | X | X | X |
| Calcium | BAC-02 | Regional Groundwater Discharge | X | X | X | X | X |
| Chloride | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Regional Groundwater Discharge | X | X | X | X | X |
| Fluoride | BAC-02 | Regional Groundwater Discharge | X | X | X | X | X |
| pH | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Mixing with Ohio River | X | X | X | X | X |
| Sulfate | BAC-02<br>BAC-03<br>BAC-04<br>BAC-05 | Regional Groundwater Discharge | X | X | X | X | X |
| TDS | BAC-02 | Regional Groundwater Discharge | X | X | X | X | X |

In conclusion, the BAC was not the source of the SSIs associated with the second semiannual sampling event groundwater results for 2018. Thus, Gavin will continue detection monitoring at the BAC in accordance with 40 CFR § 257.94(e)(2). The first semiannual BAC sampling event for 2019 is planned to be performed before 31 May 2019.

## PROFESSIONAL ENGINEER CERTIFICATION

I hereby certify that I or an agent under my review has prepared this Alternate Source Demonstration Report for the Bottom Ash Complex in accordance with 40 CFR § 257.94(e)(2). To the best of my knowledge, the information contained in this Report is true, complete, and accurate.

______________________________

**James A. Hemme, P.E.**
*State of Ohio License No.: 72851*

Date: ____1/31/2019___________

JAMES
HEMME
72851
1/31/19

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# FIGURES

Figure 1-1: Gavin Plant Location
Bottom Ash Complex Second Semi-Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMM\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\2nd_SemiAnnual_ASD\Figure1_1_GavinPowerPlantLocation_20181220mxd.mxd - Dana.Heusinkveld - 12/21/2018

Figure 1-2: Bottom Ash Complex Location

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\2nd_SemiAnnual_ASD\Figure1_2_BACLocation_20181221.mxd - Dana.Heusinkveld - 12/28/2018

Legend

⊕ Federal Sampling Program Groundwater Monitoring Well

⊕ Monitoring Well (Not in Federal Program)

NOTES:

1. Locations are approximate
2. Aerial Imagery: ESRI World Imagery Reproduced under license in ArcGIS 10.4

## Figure 1-3: Existing Monitoring Well Network

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

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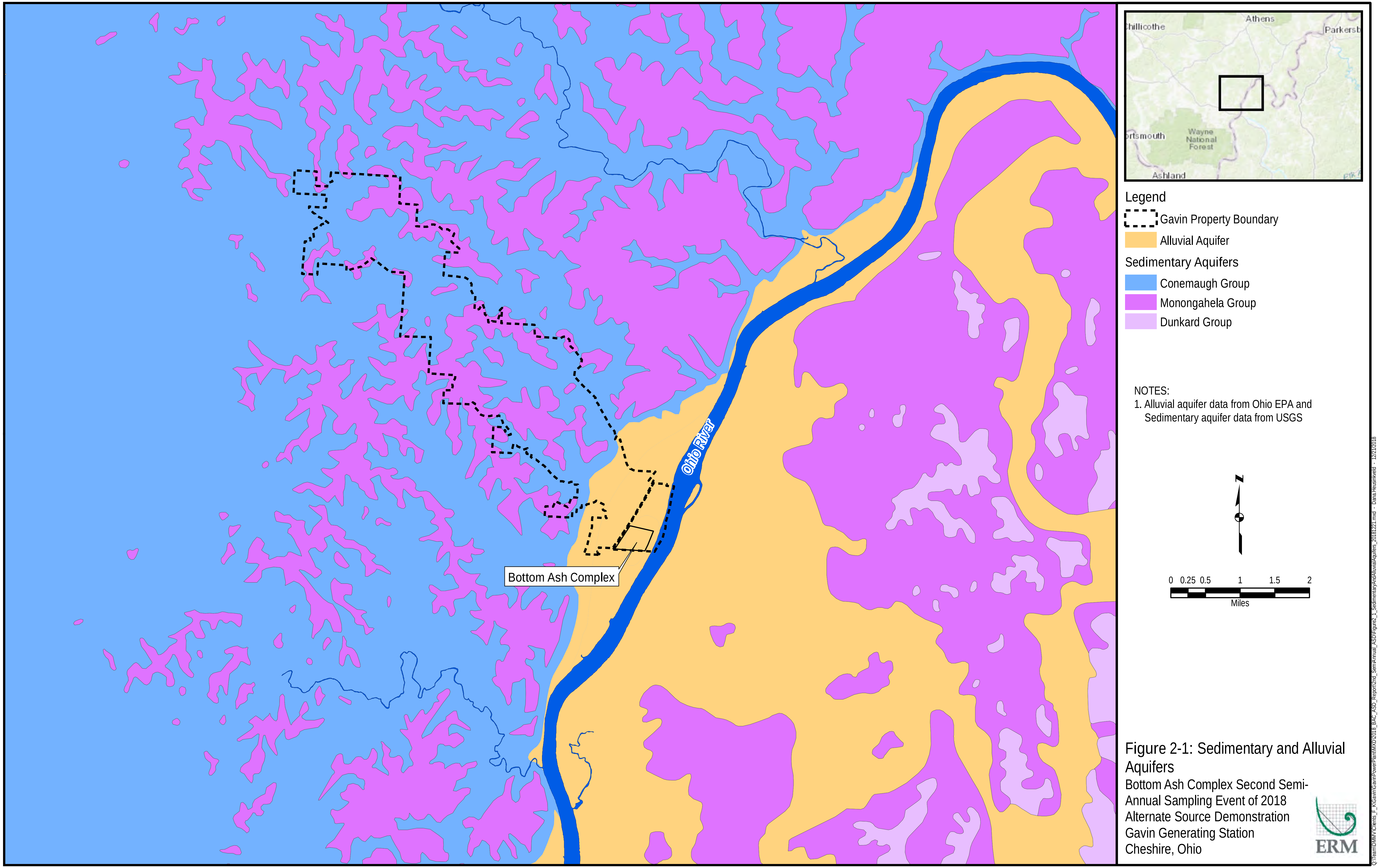

NOTES:
1. Alluvial aquifer data from Ohio EPA and Sedimentary aquifer data from USGS

## Figure 2-1: Sedimentary and Alluvial Aquifers

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

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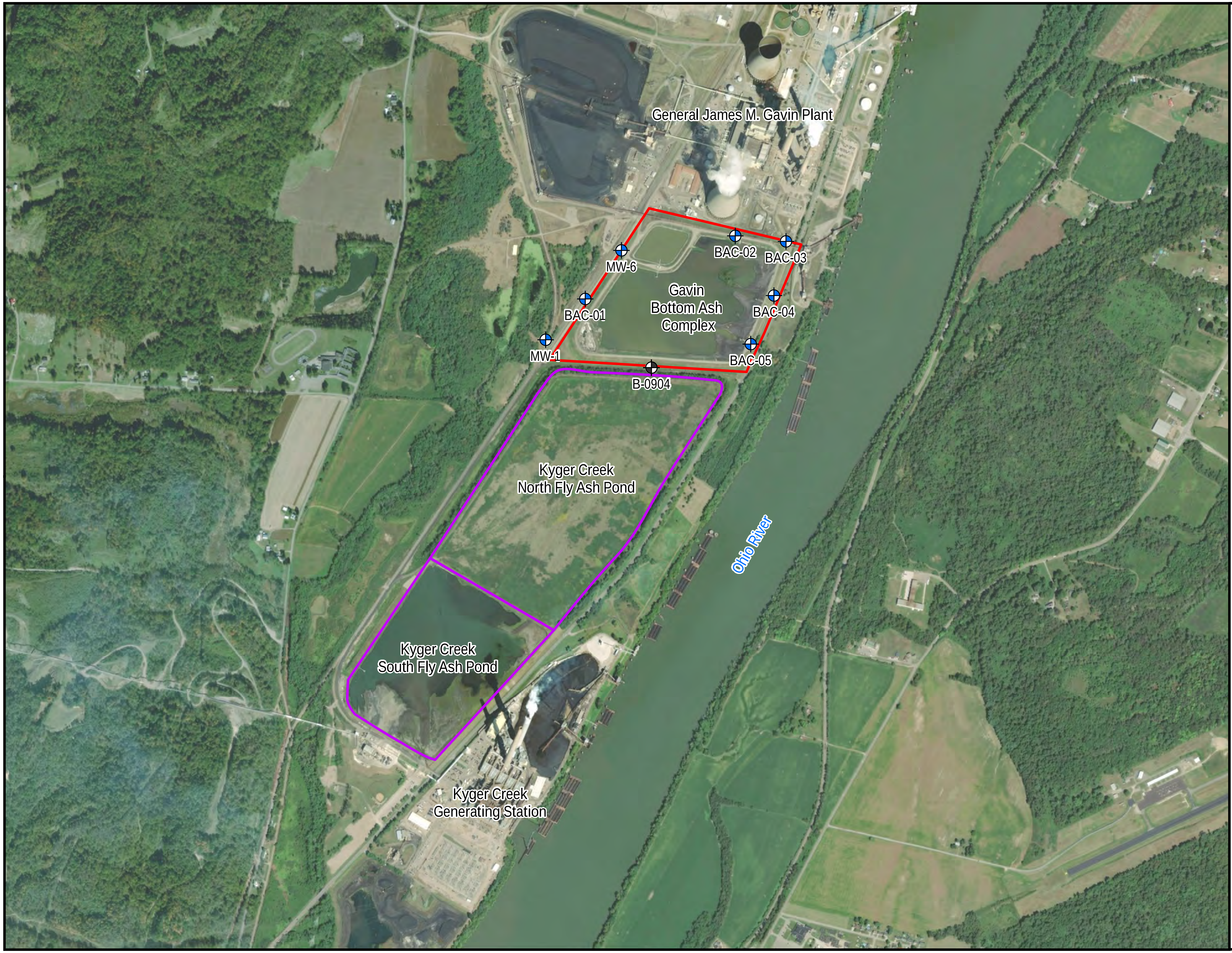

Legend

⊕ Federal Sampling Program Groundwater Monitoring Well

⊕ Monitoring Well (Not in Federal Program)

🟥 Gavin Bottom Ash Complex

🟪 Kyger Creek Fly Ash Ponds

NOTES:
1. Kyger Creek features are from AEP. 1994. Hydrogeologic Site Investigation Plan for the Proposed North Fly Ash Pond Closure, Kyger Creek Station, Ohio Valley Electric Corporation, Gallia County, Ohio.

Figure 2-2: Location of Kyger Creek Generating Station

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

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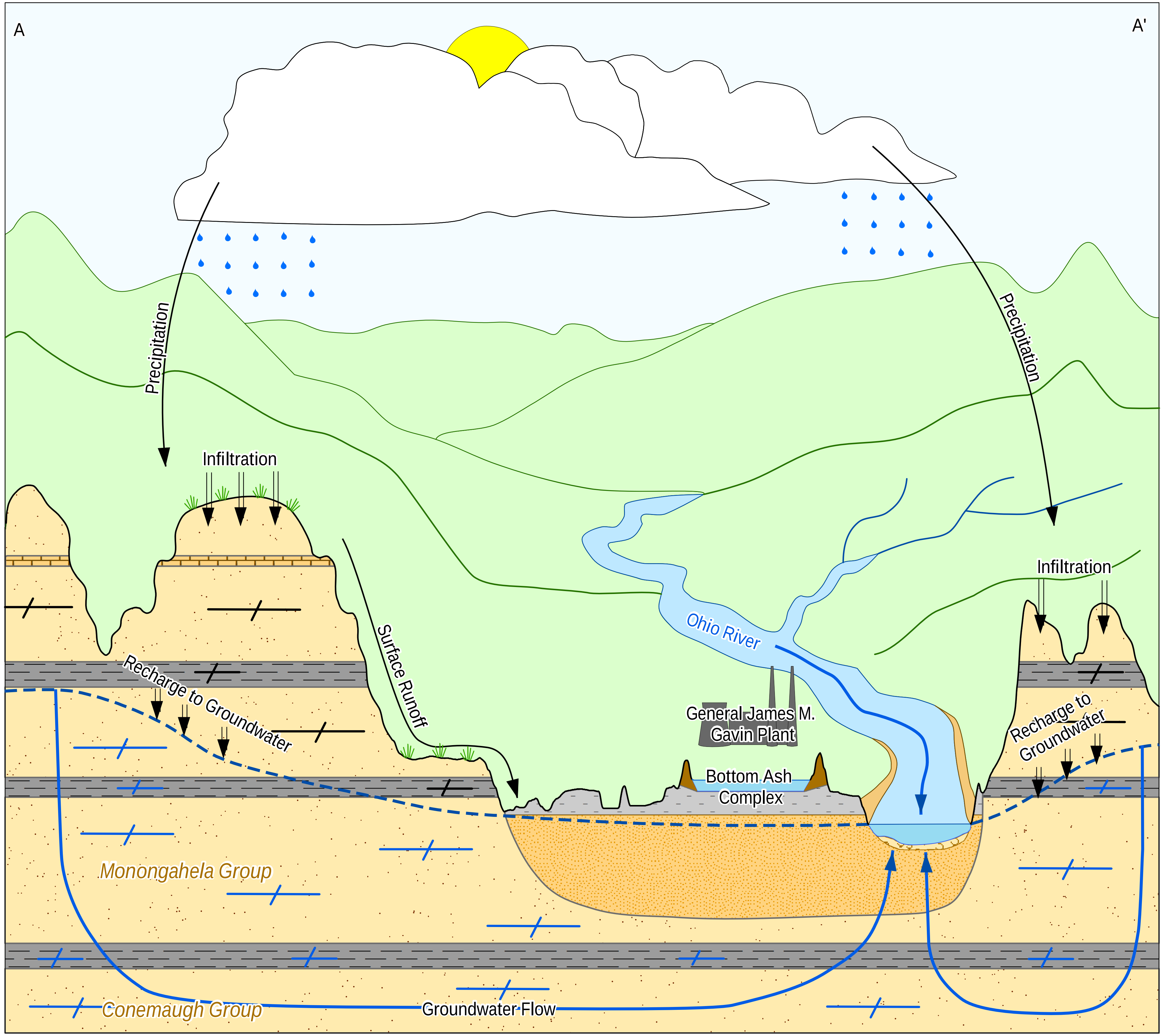
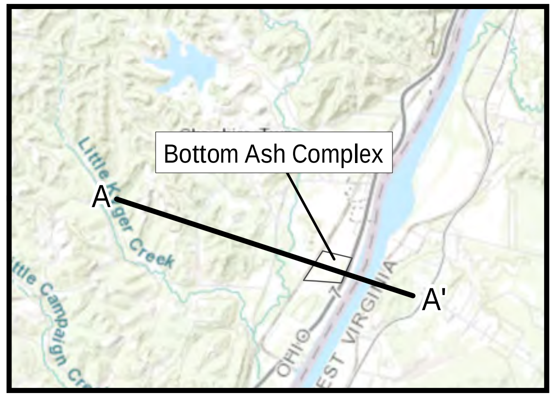




## Legend

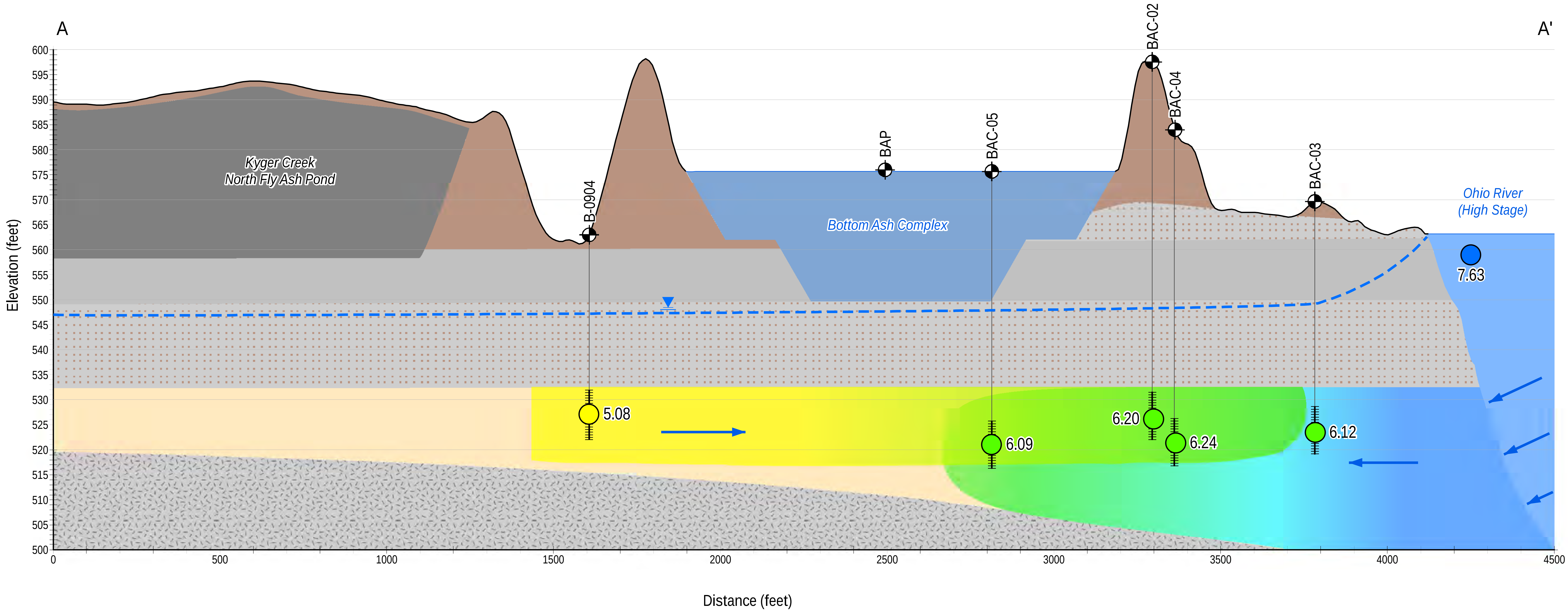
- → Groundwater Flow Direction
- - - Water Table
- — Saturated Fractures
- — Unsaturated Fractures
- ▨ Fill
- ▨ Interbedded Silt/Clay
- ▨ Sand
- ▨ Coarse Sand Deposits
- ▨ Sandstone
- ▨ Fractured Limestone
- ▨ Fractured Shale

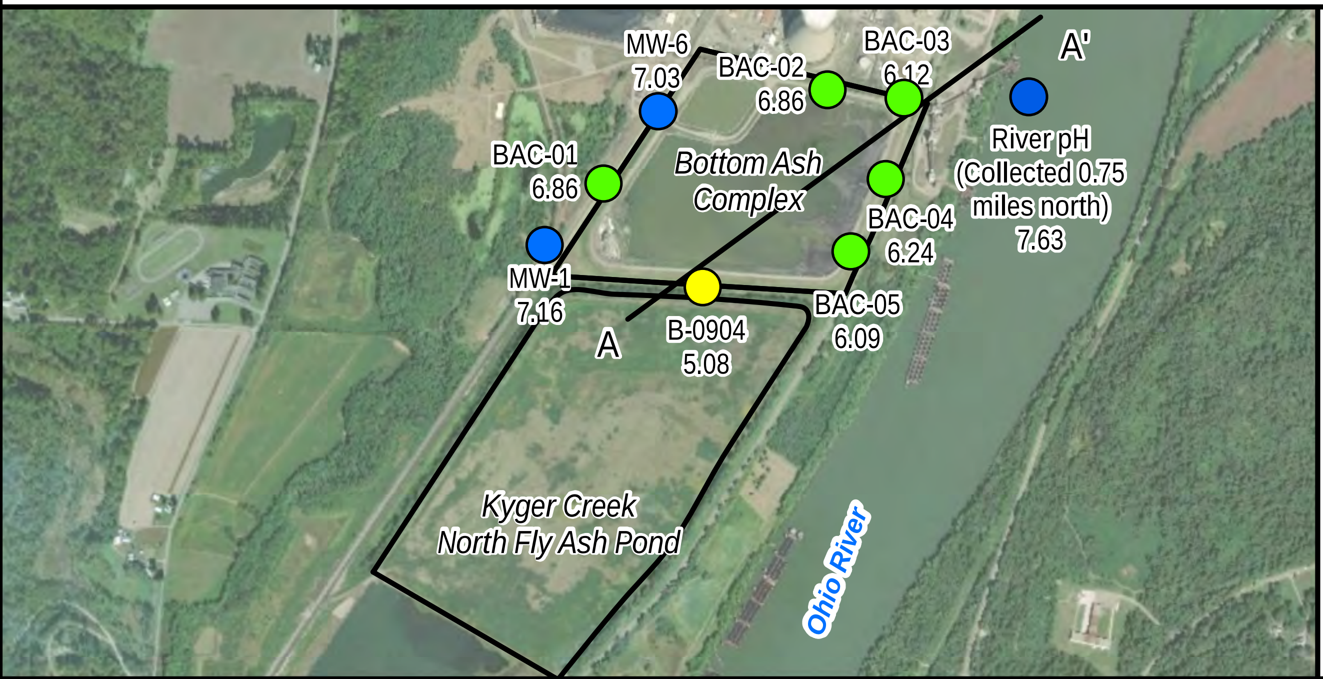
NOTES:
1. Sandstone bedrock units represent the Conemaugh Group and Monongahela Group Sedimentary Aquifers

0 250 500 1,000 1,500 2,000 2,500 3,000
Feet

## Figure 3-1: Regional Groundwater Flow Patterns

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio





Legend

- ⊕ Monitoring Well
- ▬ Cross Section Location
- ― Borehole
- ╫╫╫ Well Screen
- ‒ ‒ Interpreted High River Potentiometric Surface
- → Interpreted Groundwater Flow Direction

pH (Standard Units)

- ● <6
- ● 6-7
- ● >7

Interpreted Geology

- ▆ Sandy Clayey Gravel with Bottom Ash
- ▆ Silt/Clay
- ▨ Silt/Clay Interbedded with Fine Sand
- ▆ Sand
- ▨ Bedrock

Figure 4-1: pH of the Oiho River and BAC Groundwater
Bottom Ash Complex Second Semi- Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

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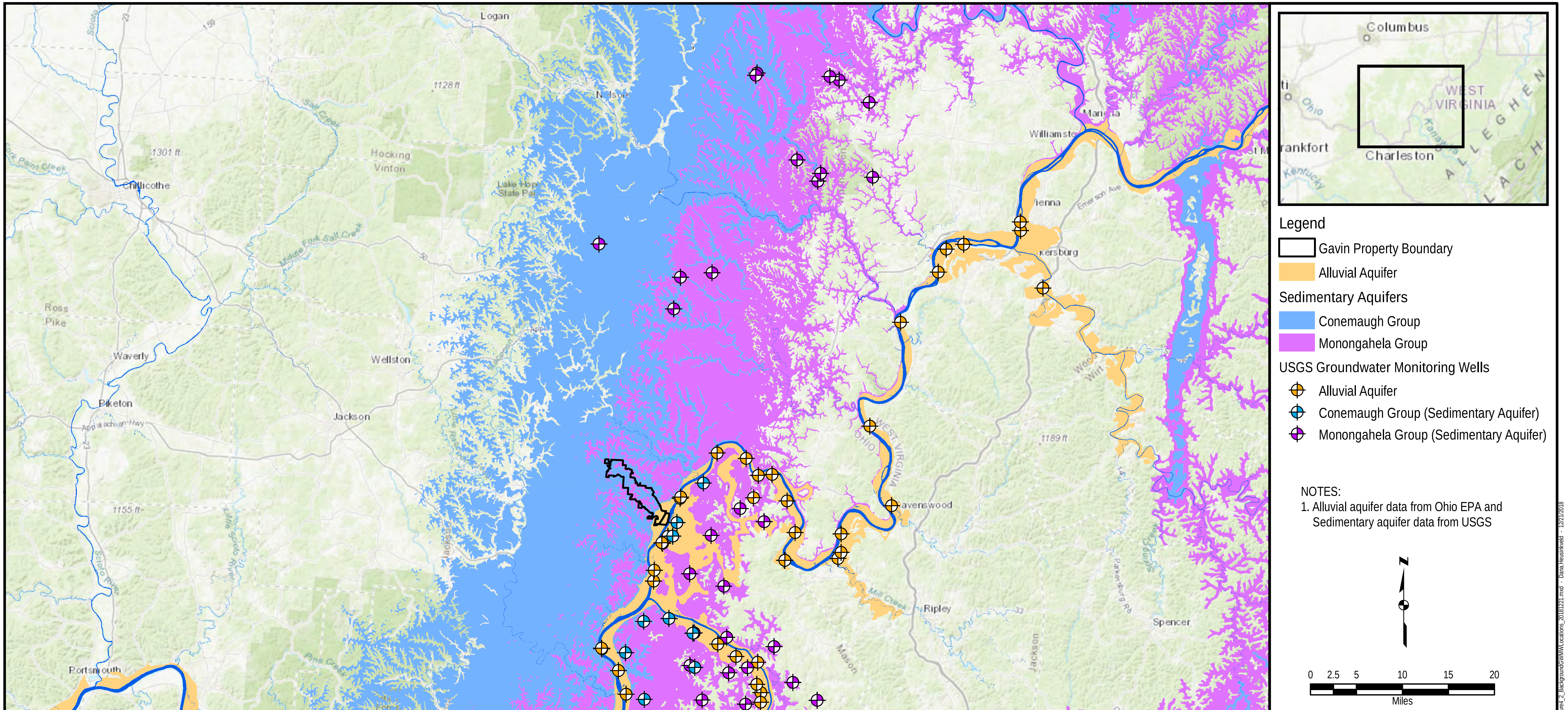

NOTES:
1. Alluvial aquifer data from Ohio EPA and Sedimentary aquifer data from USGS

## Figure 4-2: Locations of Background Groundwater Monitoring Wells

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

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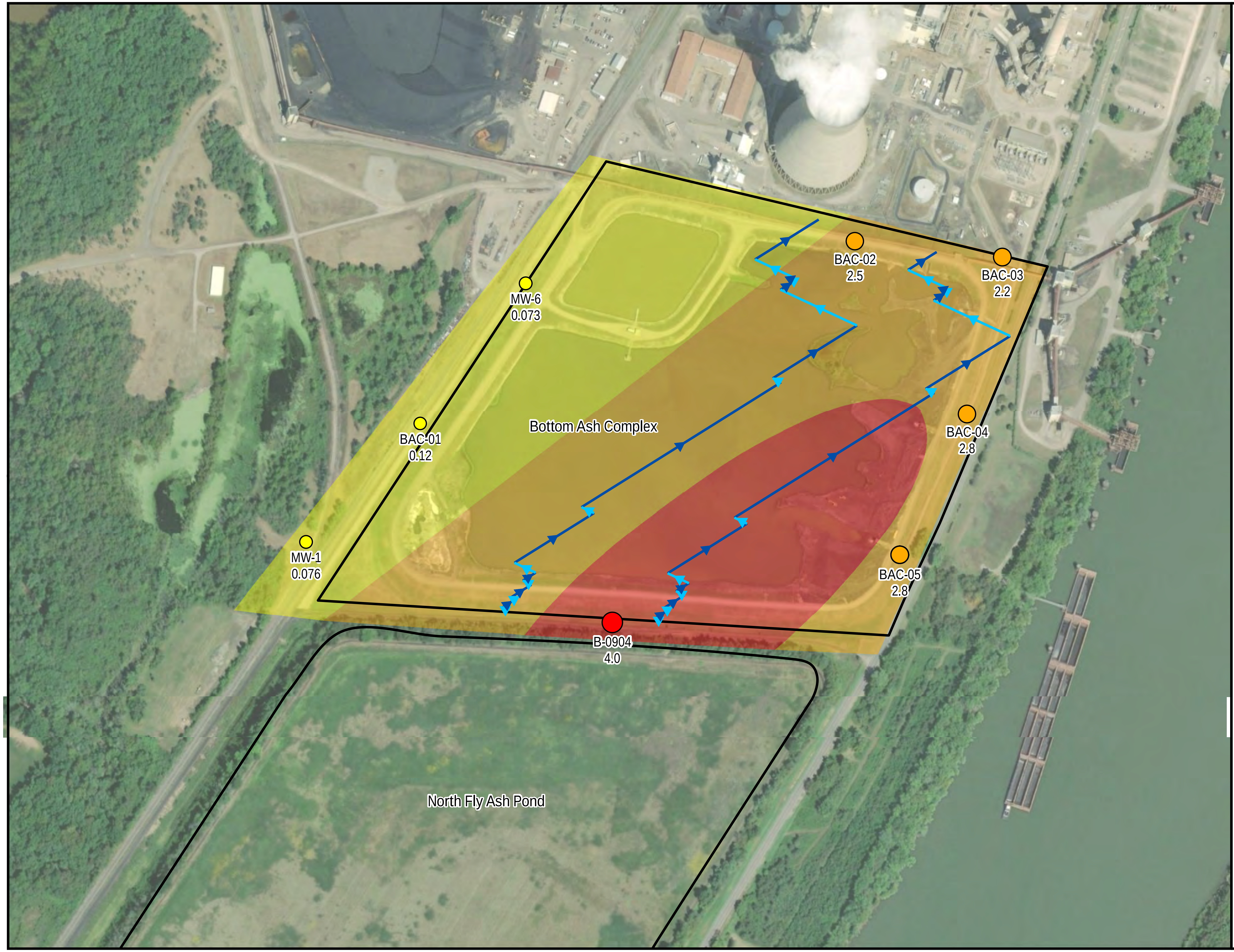

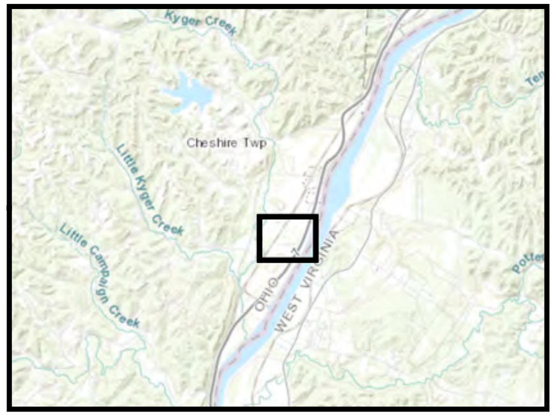

Legend

| | |
|---|---|
| 0.076 | Boron Concentration (mg/L) |
| → | Low (Typical) River State Groundwater Flow Direction to the Northeast* |
| → | High River Stage Groundwater Flow Direction to the Northwest* |
| ▭ | Coal Combustion Residuals Unit |

Boron Concentration in Groundwater

| | |
|---|---|
| 🟨 | <2 mg/L |
| 🟧 | 2-3 mg/L |
| 🟥 | >3 mg/L |

NOTES:
1. Groundwater and surface water data is from September 2018
2. * Arrow length is relative to duration of low, high river stage

N

0 100 200 300 400 500
Feet

## Figure 4-3: Boron Distribution in Groundwater in September 2018

Bottom Ash Complex Second Semi-Annual Sampling Event of 2018
Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

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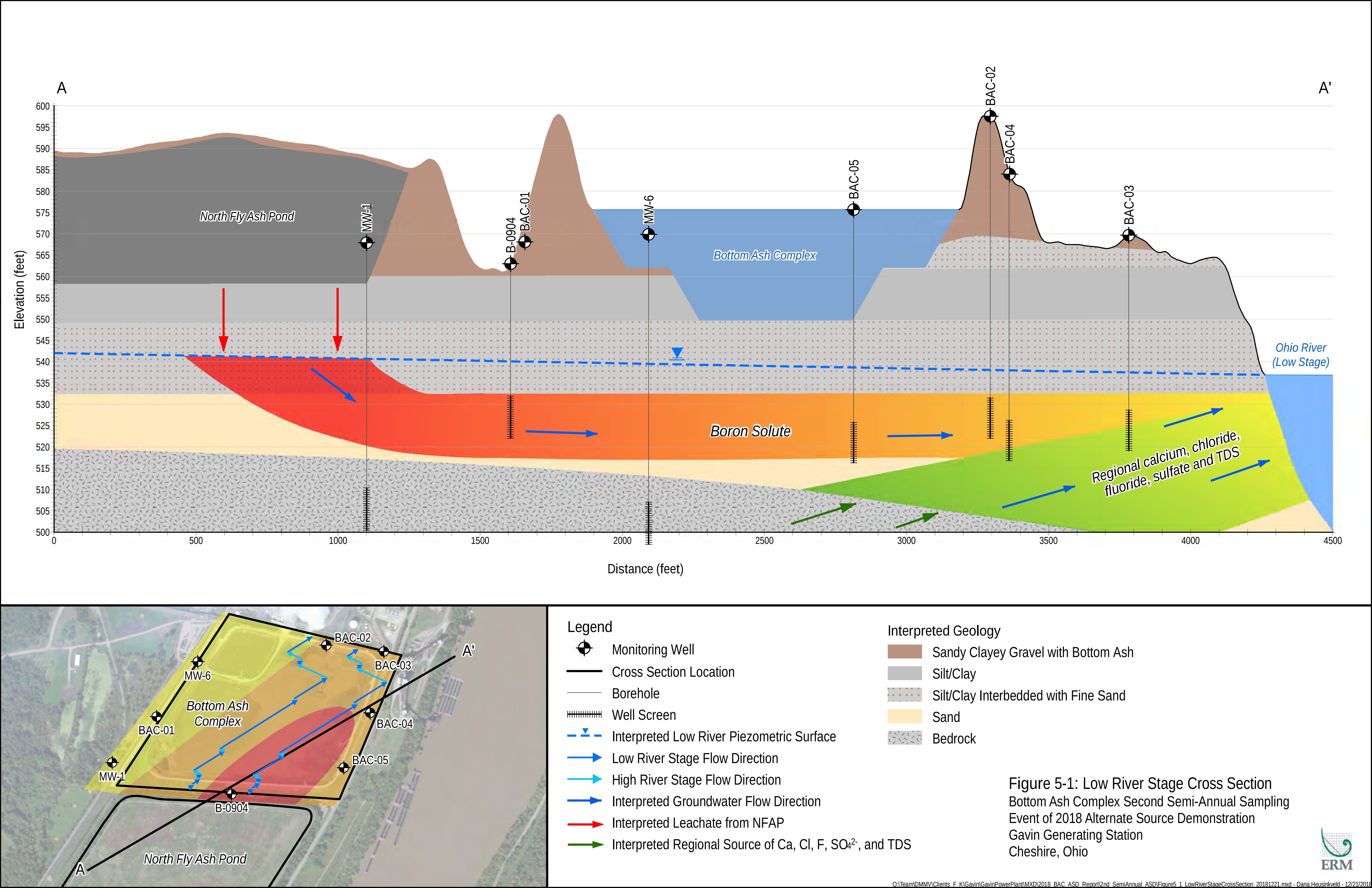

Figure 5-1: Low River Stage Cross Section
Bottom Ash Complex Second Semi-Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

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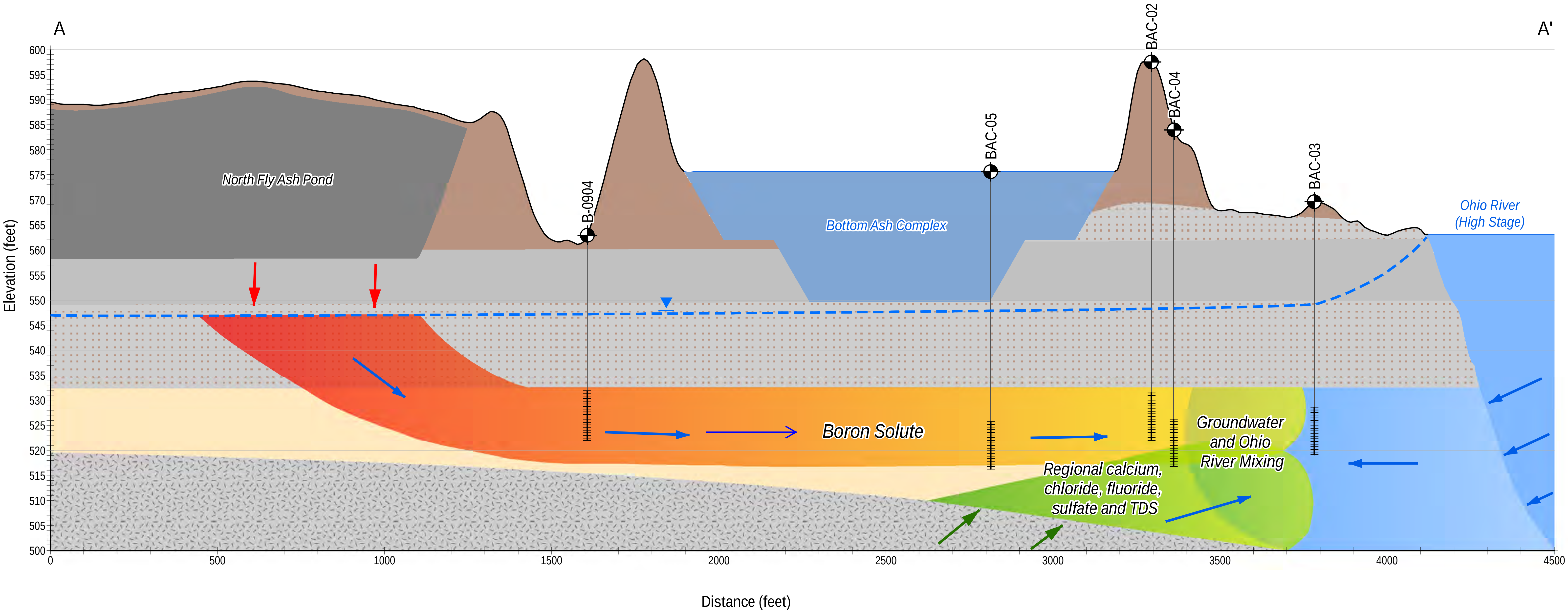
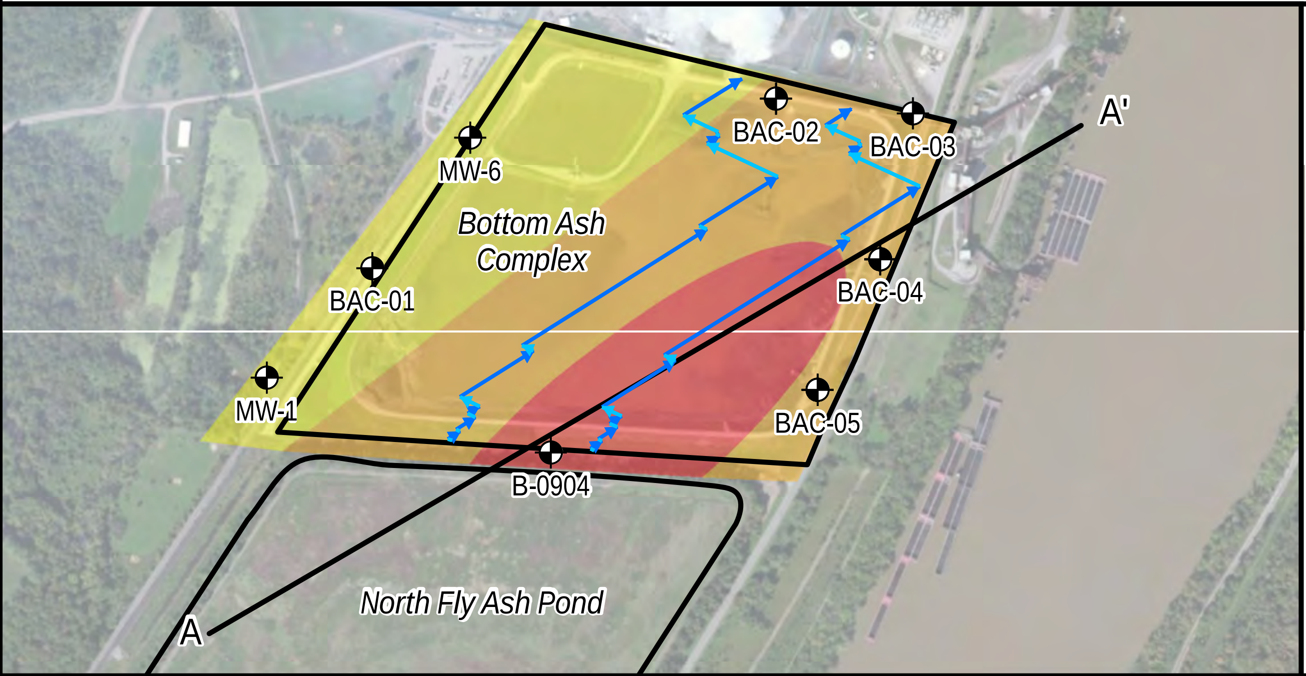




Legend

- ⌖ Monitoring Well
- — Cross Section Location
- — Borehole
- ▥ Well Screen
- ‒ ‒ Interpreted High River Potentiometric Surface
- → Low River Stage Flow Direction
- → High River Stage Flow Direction
- → Interpreted Groundwater Flow Vector
- → Interpreted Leachate from NFAP
- → Interpreted Regional Source of Ca, Cl, F, $SO_4$, and TDS

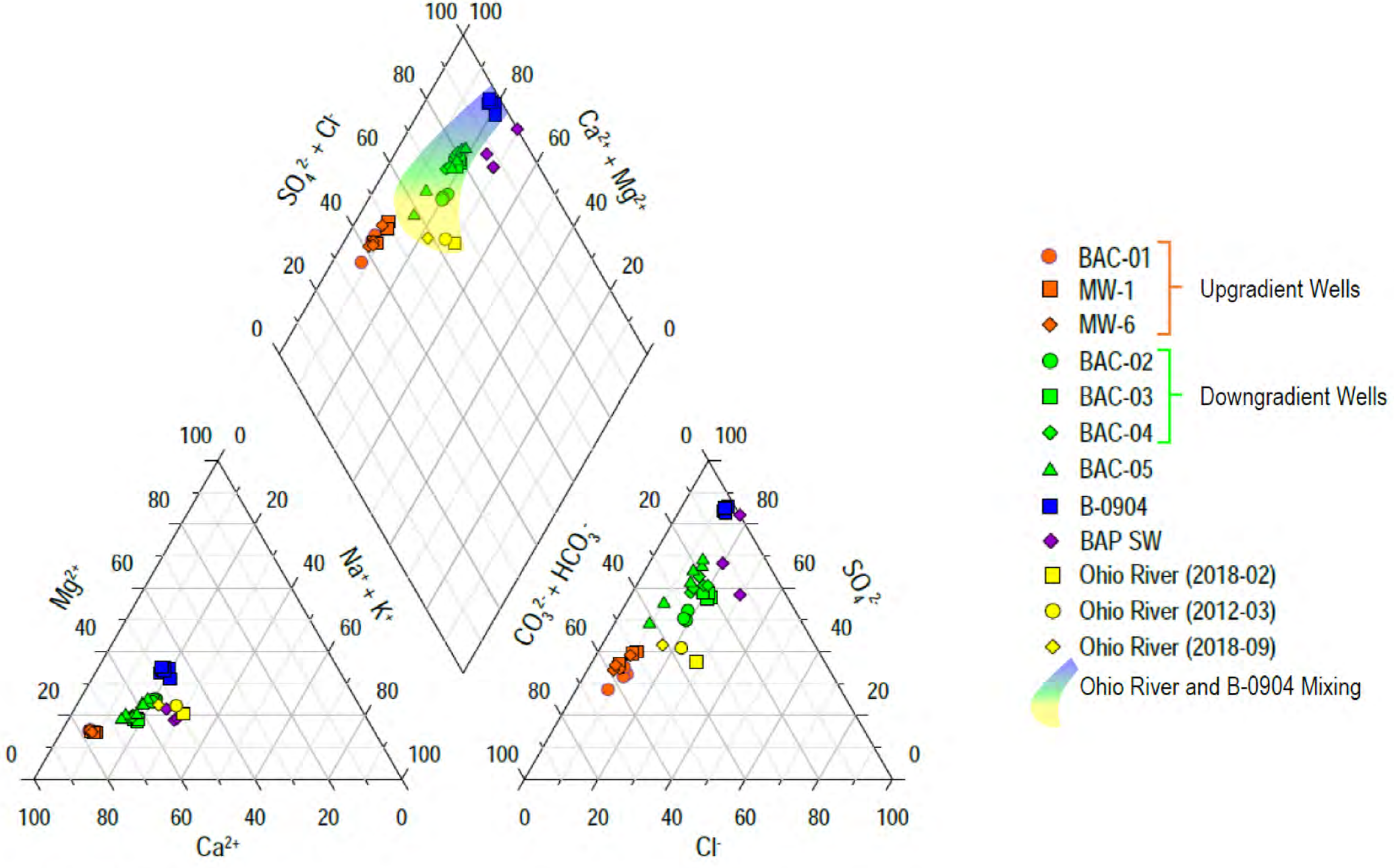
Interpreted Geology

- ■ Sandy Clayey Gravel with Bottom Ash
- ■ Silt/Clay
- ▨ Silt/Clay Interbedded with Fine Sand
- ■ Sand
- ▨ Bedrock

Figure 5-2: High River Stage Cross Section
Bottom Ash Complex Second Semi- Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients F K\Gavin\GavinPowerPlant\MXD\2018 BAC ASD Report\2nd SemiAnnual ASD\Figure5 2 HighRiverStageCrossSection 20181221.mxd - Dana.Heusinkveld - 12/21/2018



NOTES:
1. Date Range: 3/12/2012 to 9/18/2018
2. Only Samples including all 8 piper diagram analytes are presented

Figure 6-1: BAC Water Geochemistry

Bottom Ash Complex Second Semi-Annual Sampling
Event of 2018 Alternate Source Demonstration
Gavin Generating Station
Cheshire, Ohio

ERM

Q:\Team\DMMV\Clients_F_K\Gavin\GavinPowerPlant\MXD\2018_BAC_ASD_Report\2nd_SemiAnnual_ASD\Figure6_1_BACPiperDiagram_20181228.mxd - Dana.Heusinkveld - 1/16/2019

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# APPENDIX D ANALYTICAL SUMMARY

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 8/25/2016 | 8/25/2016 | 8/26/2016 | 8/26/2016 | 8/26/2016 | 8/26/2016 | 8/26/2016 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | BAC-02 | MW-1 | BAC-01 | BAC-03 | BAC-04 | BAC-05 | MW-6 |
| Sample ID | | BAC-02-20160825-01 | MW-1-20160825-01 | BAC-01-20160826-01 | BAC-03-20160826-01 | BAC-04-20160826-01 | BAC-05-20160826-01 | MW-6-20160826-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 6E-05 | 2E-05 | 2E-05 | 5E-05 | 9E-05 | 0.00023 | 2E-05 |
| Arsenic | mg/L | 0.00159 | 0.00102 | 0.00078 | 0.00027 | 0.00183 | 0.00298 | 0.00029 |
| Barium | mg/L | 0.0515 | 0.0982 | 0.0725 | 0.0469 | 0.0624 | 0.0585 | 0.148 |
| Beryllium | mg/L | 3.5E-05 | 2E-05 | 1E-05 | 1E-05 | 2E-05 | 0.000118 | 2E-05 |
| Boron | mg/L | 1.72 | 0.053 | 0.104 | 2.14 | 2.56 | 3.32 | 0.045 |
| Cadmium | mg/L | 0.0003 | 2E-05 | 2E-05 | 0.00015 | 0.00011 | 0.00033 | 4E-05 |
| Calcium | mg/L | 149 | 114 | 113 | 97.8 | 99.1 | 93.4 | 123 |
| Chloride | mg/L | 82.8 | 19.4 | 20.4 | 52.1 | 42.6 | 31.6 | 17.1 |
| Chromium | mg/L | 0.0013 | 0.0007 | 0.0004 | 0.0007 | 0.0006 | 0.0048 | 0.0005 |
| Cobalt | mg/L | 0.00333 | 0.000964 | 0.00052 | 0.000468 | 0.00807 | 0.0111 | 0.000403 |
| Dissolved Solids, Total | mg/L | 824 | 466 | 434 | 528 | 516 | 522 | 476 |
| Fluoride | mg/L | 0.19 | 0.09 | 0.1 | 0.07 | 0.08 | 0.1 | 0.08 |
| Lead | mg/L | 0.00284 | 0.000495 | 0.00244 | 0.00184 | 0.00106 | 0.0066 | 3.9E-05 |
| Lithium | mg/L | 0.01 | 0.008 | 0.008 | 0.009 | 0.007 | 0.015 | 0.007 |
| Mercury | mg/L | 3E-06 | 5E-06 | 5E-06 | 5E-06 | 5E-06 | 3E-06 | 5E-06 |
| Molybdenum | mg/L | 0.00109 | 0.00045 | 0.00037 | 0.00031 | 0.00057 | 0.00147 | 0.00073 |
| pH, Field | SU | 6.2 | 7.21 | 6.82 | 6.12 | 6.41 | 6.58 | 7 |
| Radium-226/228 | pCi/L | 1.073 | 2.081 | 0.549 | 0.2129 | 0.8152 | 0.127 | 1.663 |
| Selenium | mg/L | 0.0003 | 0.0001 | 0.0002 | 7E-05 | 0.0001 | 0.0004 | 3E-05 |
| Sulfate | mg/L | 288 | 125 | 112 | 211 | 215 | 200 | 131 |
| Thallium | mg/L | 0.000128 | 3E-05 | 1E-05 | 3E-05 | 7.2E-05 | 7.3E-05 | 2E-05 |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L  = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 10/3/2016 | 10/3/2016 | 10/3/2016 | 10/3/2016 | 10/3/2016 | 10/3/2016 | 10/3/2016 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | BAC-01 | BAC-02 | BAC-03 | BAC-04 | BAC-05 | MW-1 | MW-6 |
| Sample ID | | BAC-01-20161003-01 | BAC-02-20161003-01 | BAC-03-20161003-01 | BAC-04-20161003-01 | BAC-05-20161003-01 | MW-1-20161003-01 | MW-6-20161003-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 2E-05 | 3E-05 | 2E-05 | 7E-05 | 7E-05 | 2E-05 | 5E-05 |
| Arsenic | mg/L | 0.00042 | 0.00124 | 0.00024 | 0.00134 | 0.00143 | 0.00087 | 0.00035 |
| Barium | mg/L | 0.0611 | 0.0489 | 0.045 | 0.0583 | 0.0478 | 0.0914 | 0.138 |
| Beryllium | mg/L | 2E-05 | 2.3E-05 | 2E-05 | 6E-06 | 4.7E-05 | 1E-05 | 2E-05 |
| Boron | mg/L | 0.095 | 1.92 | 2.06 | 2.53 | 3.72 | 0.044 | 0.054 |
| Cadmium | mg/L | 2E-05 | 0.00031 | 9E-05 | 4E-05 | 9E-05 | 1E-05 | 3E-05 |
| Calcium | mg/L | 105 | 156 | 93.7 | 98.2 | 90.8 | 113 | 116 |
| Chloride | mg/L | 21.5 | 91.8 | 52.8 | 44.5 | 28.5 | 19.9 | 17.8 |
| Chromium | mg/L | 0.0002 | 0.0008 | 0.0006 | 0.0009 | 0.0018 | 0.0003 | 0.0001 |
| Cobalt | mg/L | 0.000168 | 0.00257 | 0.00026 | 0.00627 | 0.00814 | 0.000769 | 0.000377 |
| Dissolved Solids, Total | mg/L | 402 | 858 | 476 | 488 | 468 | 440 | 434 |
| Fluoride | mg/L | 0.1 | 0.1 | 0.09 | 0.09 | 0.15 | 0.09 | 0.09 |
| Lead | mg/L | 0.000255 | 0.00184 | 0.000641 | 0.000367 | 0.00248 | 0.000355 | 2E-05 |
| Lithium | mg/L | 0.0009 | 0.004 | 0.006 | 0.006 | 0.007 | 0.004 | 0.003 |
| Mercury | mg/L | 5E-06 | 7E-06 | 1.6E-05 | 1.9E-05 | 1.4E-05 | 1.3E-05 | 2E-06 |
| Molybdenum | mg/L | 0.00071 | 0.00044 | 0.00138 | 0.00465 | 0.00118 | 0.00023 | 0.00069 |
| pH, Field | SU | 6.83 | 6.19 | 6.03 | 6.17 | 6.63 | 7.2 | 7.04 |
| Radium-226/228 | pCi/L | 0.526 | 0.855 | -0.14 | 0.467 | 2.056 | 2.045 | 1.32 |
| Selenium | mg/L | 0.0002 | 0.0002 | 6E-05 | 6E-05 | 0.0002 | 7E-05 | 0.0001 |
| Sulfate | mg/L | 105 | 341 | 204 | 214 | 190 | 126 | 123 |
| Thallium | mg/L | 8.4E-05 | 3E-05 | 2E-05 | 4E-05 | 5E-05 | 2E-05 | 4E-05 |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| | Sample Date | 11/28/2016 | 11/28/2016 | 11/28/2016 | 11/28/2016 | 11/28/2016 | 11/28/2016 | 11/28/2016 |
| | Sample Type | N | N | N | N | N | N | N |
| | Location ID | BAC-01 | BAC-02 | BAC-03 | BAC-04 | BAC-05 | MW-1 | MW-6 |
| | Sample ID | BAC-01-20161128-01 | BAC-02-20161128-01 | BAC-03-20161128-01 | BAC-04-20161128-01 | BAC-05-20161128-01 | MW-1-20161128-01 | MW-6-20161128-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 1E-05 | 4E-05 | 2E-05 | 4E-05 | 9E-05 | 2E-05 | 5E-05 |
| Arsenic | mg/L | 0.0004 | 0.00146 | 0.00016 | 0.00212 | 0.00177 | 0.00073 | 0.00031 |
| Barium | mg/L | 0.0641 | 0.0492 | 0.0422 | 0.059 | 0.0459 | 0.0985 | 0.141 |
| Beryllium | mg/L | 2E-05 | 2.6E-05 | 2E-05 | 9E-06 | 5.9E-05 | 6E-06 | 2E-05 |
| Boron | mg/L | 0.11 | 2.17 | 2.07 | 2.61 | 3.99 | 0.058 | 0.045 |
| Cadmium | mg/L | 2E-05 | 0.0003 | 8E-05 | 2E-05 | 5E-05 | 5E-06 | 3E-05 |
| Calcium | mg/L | 114 | 168 | 90.4 | 96.7 | 97.7 | 124 | 123 |
| Chloride | mg/L | 22.2 | 95 | 48.2 | 40.9 | 24.6 | 19.5 | 18 |
| Chromium | mg/L | 0.000207 | 0.00129 | 0.000458 | 0.000238 | 0.00208 | 0.000175 | 0.000822 |
| Cobalt | mg/L | 0.000164 | 0.00266 | 0.000169 | 0.00577 | 0.00536 | 0.000672 | 0.000383 |
| Dissolved Solids, Total | mg/L | 380 | 896 | 416 | 448 | 452 | 447 | 456 |
| Fluoride | mg/L | 0.1 | 0.08 | 0.07 | 0.08 | 0.17 | 0.01 | 0.09 |
| Lead | mg/L | 0.000283 | 0.00158 | 0.00048 | 0.000277 | 0.0021 | 0.000124 | 2E-05 |
| Lithium | mg/L | 0.006 | 0.005 | 0.007 | 0.01 | 0.01 | 0.006 | 0.005 |
| Mercury | mg/L | 5E-06 | 5E-06 | 5E-06 | 5E-06 | 3E-06 | 5E-06 | 5E-06 |
| Molybdenum | mg/L | 0.00055 | 0.00081 | 0.0005 | 0.00037 | 0.00139 | 0.00022 | 0.00064 |
| pH, Field | SU | 6.85 | 6.14 | 6.04 | 6.19 | 6.64 | 7.16 | 7 |
| Radium-226/228 | pCi/L | 1.114 | 0.0347 | 0.3818 | 0.34 | 0.554 | 0.2551 | 1.032 |
| Selenium | mg/L | 0.0001 | 0.0002 | 0.0001 | 8E-05 | 0.0002 | 4E-05 | 4E-05 |
| Sulfate | mg/L | 111 | 359 | 200 | 209 | 184 | 127 | 127 |
| Thallium | mg/L | 2E-05 | 9.3E-05 | 1E-05 | 3E-05 | 4E-05 | 1E-05 | 2E-05 |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 2/7/2017 | 2/7/2017 | 2/7/2017 | 2/7/2017 | 2/7/2017 | 2/7/2017 | 2/7/2017 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | BAC-01 | BAC-02 | BAC-03 | BAC-04 | BAC-05 | MW-1 | MW-6 |
| Sample ID | | BAC-01-20170207-01 | BAC-02-20170207-01 | BAC-03-20170207-01 | BAC-04-20170207-01 | BAC-05-20170207-01 | MW-1-20170207-01 | MW-6-20170207-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 2E-05 | 2E-05 | 3E-05 | 7E-05 | 3E-05 | 2E-05 | 1E-05 |
| Arsenic | mg/L | 0.00106 | 0.00067 | 0.00031 | 0.0017 | 0.00065 | 0.00087 | 0.00031 |
| Barium | mg/L | 0.0625 | 0.0358 | 0.0426 | 0.0597 | 0.0495 | 0.0899 | 0.123 |
| Beryllium | mg/L | 9E-06 | 7E-06 | 8E-06 | 2.1E-05 | 1E-05 | 7E-06 | 2E-05 |
| Boron | mg/L | 0.162 | 2.08 | 2.24 | 2.7 | 2.78 | 0.048 | 0.122 |
| Cadmium | mg/L | 2E-05 | 0.00025 | 8E-05 | 9E-05 | 8E-05 | 8E-06 | 3E-05 |
| Calcium | mg/L | 107 | 161 | 95.7 | 99.6 | 89 | 121 | 106 |
| Chloride | mg/L | 23.4 | 97.3 | 52.2 | 40 | 36.2 | 20 | 17.9 |
| Chromium | mg/L | 0.000312 | 0.00432 | 0.00115 | 0.00081 | 0.000652 | 0.000219 | 0.00476 |
| Cobalt | mg/L | 0.000439 | 0.00178 | 0.000317 | 0.00553 | 0.00852 | 0.000763 | 0.000376 |
| Dissolved Solids, Total | mg/L | 360 | 860 | 514 | 498 | 494 | 455 | 454 |
| Fluoride | mg/L | 0.1 | 0.17 | 0.07 | 0.09 | 0.1 | 0.1 | 0.3 |
| Lead | mg/L | 0.00058 | 0.000589 | 0.00168 | 0.00102 | 0.000631 | 0.000214 | 2.1E-05 |
| Lithium | mg/L | 0.004 | 0.001 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Mercury | mg/L | 5E-06 | 3E-06 | 5E-06 | 5E-06 | 5E-06 | 5E-06 | 5E-06 |
| Molybdenum | mg/L | 0.00147 | 0.00201 | 0.0006 | 0.00365 | 0.00237 | 0.00042 | 0.00128 |
| pH, Field | SU | 6.75 | 6.1 | 6.05 | 6.23 | 6.2 | 7.09 | 6.96 |
| Radium-226/228 | pCi/L | 0.449 | 0.1452 | 0.17 | 0.017 | 0.2258 | 0.918 | 0.249 |
| Selenium | mg/L | 0.0001 | 6E-05 | 4E-05 | 0.0001 | 4E-05 | 5E-05 | 5E-05 |
| Sulfate | mg/L | 95.3 | 346 | 196 | 200 | 216 | 119 | 118 |
| Thallium | mg/L | 1E-05 | 3E-05 | 3E-05 | 5.3E-05 | 5.4E-05 | 3E-05 | 8.7E-05 |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 |
| Sample Type | | FD | N | N | N | N | N | N |
| Location ID | | MW-1 | BAC-01 | BAC-02 | BAC-03 | BAC-04 | BAC-05 | MW-1 |
| Sample ID | | DUPE BAC032817 | BAC-01-20170328-02 | BAC-02-20170328-02 | BAC-03-20170328-02 | BAC-04-20170328-02 | BAC-05-20170328-02 | MW-1-20170328-02 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 0.00063 JB | | | | | | |
| Arsenic | mg/L | 0.00061 J | | | | | | |
| Barium | mg/L | 0.1 B | | | | | | |
| Beryllium | mg/L | 0.001 U | | | | | | |
| Boron | mg/L | 0.074 J | | | | | | |
| Cadmium | mg/L | 0.001 U | | | | | | |
| Calcium | mg/L | 120 JB | | | | | | |
| Chloride | mg/L | 20 | | | | | | |
| Chromium | mg/L | 0.00027 JB | | | | | | |
| Cobalt | mg/L | 0.0007 J | | | | | | |
| Dissolved Solids, Total | mg/L | 460 | | | | | | |
| Fluoride | mg/L | 0.11 | | | | | | |
| Lead | mg/L | 0.00031 J | | | | | | |
| Lithium | mg/L | 0.0041 J | | | | | | |
| Mercury | mg/L | 0.0002 U | | | | | | |
| Molybdenum | mg/L | 0.01 U | | | | | | |
| pH, Field | SU | | 6.82 | 6.18 | 6.07 | 6.18 | 6.72 | 7.16 |
| Radium-226/228 | pCi/L | 0.567 | | | | | | |
| Selenium | mg/L | 0.005 U | | | | | | |
| Sulfate | mg/L | 120 | | | | | | |
| Thallium | mg/L | 0.001 U | | | | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 | 3/28/2017 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | MW-6 | MW-1 | BAC-01 | MW-6 | BAC-02 | BAC-05 | BAC-04 |
| Sample ID | | MW-6-20170328-02 | MW1-20170328-01 | BAC-01-20170328-01 | MW-6-20170328-01 | BAC-02-20170328-01 | BAC-05-20170328-01 | BAC-04-20170328-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | | 0.0006 JB | 0.002 B | 0.00059 JB | 0.00035 JB | 0.00048 JB | 0.00046 JB |
| Arsenic | mg/L | | 0.00064 J | 0.0022 J | 0.00042 J | 0.00072 J | 0.00086 J | 0.002 J |
| Barium | mg/L | | 0.1 B | 0.075 B | 0.15 B | 0.05 B | 0.04 B | 0.06 B |
| Beryllium | mg/L | | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Boron | mg/L | | 0.081 J | 0.11 J | 0.065 J | 2.5 J | 4.5 J | 2.7 J |
| Cadmium | mg/L | | 0.001 U | 0.001 U | 0.001 U | 0.00035 J | 0.001 U | 0.001 U |
| Calcium | mg/L | | 120 JB | 110 JB | 120 JB | 170 JB | 94 JB | 94 JB |
| Chloride | mg/L | | 20 | 23 | 19 | 100 | 24 | |
| Chromium | mg/L | | 0.00049 JB | 0.0013 JB | 0.001 JB | 0.0012 JB | 0.0016 JB | 0.00034 JB |
| Cobalt | mg/L | | 0.00072 J | 0.00095 J | 0.00052 J | 0.0019 | 0.004 | 0.0066 |
| Dissolved Solids, Total | mg/L | | 470 | 420 | 480 | 1000 | 480 | |
| Fluoride | mg/L | | 0.11 | 0.14 | 0.098 | 0.17 | 0.21 | |
| Lead | mg/L | | 0.00035 J | 0.001 J | 0.00028 J | 0.0008 J | 0.0008 J | 0.00037 J |
| Lithium | mg/L | | 0.004 J | 0.0034 J | 0.0042 J | 0.0022 J | 0.0042 J | 0.0067 J |
| Mercury | mg/L | | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U |
| Molybdenum | mg/L | | 0.01 U | 0.0014 J | 0.00078 J | 0.01 U | 0.0011 J | 0.00061 J |
| pH, Field | SU | 7.03 | | | | | | |
| Radium-226/228 | pCi/L | | 0.537 | 0.316 | 0.283 U | 0.298 U | 0.241 U | |
| Selenium | mg/L | | 0.005 U | 0.0011 J | 0.005 U | 0.00048 J | 0.005 U | 0.005 U |
| Sulfate | mg/L | | 120 | 92 | 120 | 410 | 170 | |
| Thallium | mg/L | | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|
| Sample Date | | 3/28/2017 | 5/2/2017 | 5/2/2017 | 5/2/2017 | 5/2/2017 | 5/2/2017 |
| Sample Type | | N | FD | N | N | N | N |
| Location ID | | BAC-03 | BAC-03 | BAC-03 | BAC-04 | BAC-04 | BAC-03 |
| Sample ID | | BAC-03-20170328-01 | BAC DUPE 1-20170502-01 | BAC-03-20170502-02 | BAC-04-20170502-02 | BAC-04-20170502-01 | BAC-03-20170502-01 |
| Analyte | Unit | | | | | | |
| Antimony | mg/L | 0.00048 JB | 0.002 U | | | 0.002 U | 0.002 U |
| Arsenic | mg/L | 0.005 U | 0.005 U | | | 0.0033 J | 0.005 U |
| Barium | mg/L | 0.05 B | 0.048 | | | 0.07 | 0.048 |
| Beryllium | mg/L | 0.001 U | 0.001 U | | | 0.001 U | 0.001 U |
| Boron | mg/L | 2.3 J | 2.1 | | | 2.5 | 2.1 |
| Cadmium | mg/L | 0.001 U | 0.001 U | | | 0.001 U | 0.001 U |
| Calcium | mg/L | 97 JB | 96 | | | 94 | 96 |
| Chloride | mg/L | 68 | 72 | | | 48 | 72 |
| Chromium | mg/L | 0.00054 JB | 0.002 U | | | 0.005 | 0.002 U |
| Cobalt | mg/L | 0.00027 J | 0.00024 J | | | 0.0083 | 0.00025 J |
| Dissolved Solids, Total | mg/L | 520 | 510 | | | 530 | 510 |
| Fluoride | mg/L | 0.071 | 0.071 | | | 0.11 | 0.071 |
| Lead | mg/L | 0.00093 J | 0.00096 J | | | 0.0035 | 0.00083 J |
| Lithium | mg/L | 0.0056 J | 0.0049 J | | | 0.0068 J | 0.0049 J |
| Mercury | mg/L | 0.0002 U | 0.0002 U | | | 0.0002 U | 0.0002 U |
| Molybdenum | mg/L | 0.01 U | 0.01 U | | | 0.01 U | 0.01 U |
| pH, Field | SU | | | 6.05 | 6.2 | | |
| Radium-226/228 | pCi/L | 0.102 U | 0.345 | | | 0.641 | 0.271 U |
| Selenium | mg/L | 0.005 U | 0.005 U | | | 0.005 U | 0.005 U |
| Sulfate | mg/L | 180 | 180 | | | 220 J | 180 |
| Thallium | mg/L | 0.001 U | 0.001 U | | | 0.001 U | 0.001 U |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 5/3/2017 | 5/3/2017 | 5/3/2017 | 5/3/2017 | 5/3/2017 | 5/3/2017 | 5/3/2017 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | BAC-01 | BAC-02 | BAC-05 | MW-1 | MW-6 | BAC-05 | BAC-02 |
| Sample ID | | BAC-01-20170503-02 | BAC-02-20170503-02 | BAC-05-20170503-02 | MW-1-20170503-02 | MW-6-20170503-02 | BAC-05-20170503-01 | BAC-02-20170503-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | | | | | | 0.00057 J | 0.002 U |
| Arsenic | mg/L | | | | | | 0.00097 J | 0.00075 J |
| Barium | mg/L | | | | | | 0.052 | 0.048 |
| Beryllium | mg/L | | | | | | 0.001 U | 0.001 U |
| Boron | mg/L | | | | | | 3.2 | 2.4 |
| Cadmium | mg/L | | | | | | 0.001 U | 0.00032 J |
| Calcium | mg/L | | | | | | 100 | 180 |
| Chloride | mg/L | | | | | | 34 | 21 |
| Chromium | mg/L | | | | | | 0.0013 J | 0.0015 J |
| Cobalt | mg/L | | | | | | 0.0078 | 0.0018 |
| Dissolved Solids, Total | mg/L | | | | | | 540 | 1000 |
| Fluoride | mg/L | | | | | | 0.17 | 0.032 J |
| Lead | mg/L | | | | | | 0.0012 | 0.00068 J |
| Lithium | mg/L | | | | | | 0.0048 J | 0.008 U |
| Mercury | mg/L | | | | | | 0.0002 U | 0.0002 U |
| Molybdenum | mg/L | | | | | | 0.01 U | 0.01 U |
| pH, Field | SU | 6.79 | 6.13 | 6.47 | 7.15 | 6.96 | | |
| Radium-226/228 | pCi/L | | | | | | 0.253 U | 0.375 U |
| Selenium | mg/L | | | | | | 0.0011 J | 0.005 U |
| Sulfate | mg/L | | | | | | 220 J | 80 |
| Thallium | mg/L | | | | | | 0.001 U | 0.001 U |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

**Appendix D**
**Analytical Data Summary**
**Bottom Ash Complex**
**Gavin Power Plant**

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 5/3/2017 | 5/3/2017 | 5/3/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 |
| Sample Type | | N | N | N | FD | N | N | N |
| Location ID | | BAC-01 | MW-6 | MW-1 | BAC-02 | BAC-01 | BAC-02 | BAC-03 |
| Sample ID | | BAC-01-20170503-01 | MW-6-20170503-01 | MW-1-20170503-01 | BAC-DUP-1-20170613-01 | BAC-01-20170613-02 | BAC-02-20170613-02 | BAC-03-20170613-02 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 0.002 U | 0.002 U | 0.002 U | 0.002 U | | | |
| Arsenic | mg/L | 0.005 U | 0.005 U | 0.005 U | 0.005 U | | | |
| Barium | mg/L | 0.063 | 0.15 | 0.1 | 0.049 | | | |
| Beryllium | mg/L | 0.001 U | 0.001 U | 0.001 U | 0.001 U | | | |
| Boron | mg/L | 0.12 | 0.06 J | 0.06 J | 2.6 J | | | |
| Cadmium | mg/L | 0.001 U | 0.001 U | 0.001 U | 0.00043 J | | | |
| Calcium | mg/L | 100 | 120 | 120 | 180 | | | |
| Chloride | mg/L | 22 | 20 | 21 | 110 | | | |
| Chromium | mg/L | 0.002 U | 0.002 U | 0.002 U | 0.0016 J | | | |
| Cobalt | mg/L | 0.0002 J | 0.00044 J | 0.00072 J | 0.0018 | | | |
| Dissolved Solids, Total | mg/L | 400 | 460 | 470 | 1100 J | | | |
| Fluoride | mg/L | 0.14 | 0.095 | 0.11 | 0.17 | | | |
| Lead | mg/L | 0.001 U | 0.001 U | 0.001 U | 0.0006 J | | | |
| Lithium | mg/L | 0.0024 J | 0.0033 J | 0.0033 J | 0.008 U | | | |
| Mercury | mg/L | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | | | |
| Molybdenum | mg/L | 0.01 U | 0.01 U | 0.01 U | 0.01 U | | | |
| pH, Field | SU | | | | | 6.76 | 6.08 | 5.89 |
| Radium-226/228 | pCi/L | 0.0267 U | 0.159 U | 0.527 | 0.29 U | | | |
| Selenium | mg/L | 0.005 U | 0.005 U | 0.005 U | 0.005 U | | | |
| Sulfate | mg/L | 92 | 130 | 130 | 430 | | | |
| Thallium | mg/L | 0.001 U | 0.001 U | 0.001 U | 0.001 U | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
| Sample Date | | 6/13/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | BAC-04 | BAC-05 | MW-1 | MW-6 | BAC-03 | BAC-04 | BAC-05 |
| Sample ID | | BAC-04-20170613-02 | BAC-05-20170613-02 | MW-1-20170613-02 | MW-6-20170613-02 | BAC-03-20170613-01 | BAC-04-20170613-01 | BAC-05-20170613-01 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | | | | | 0.002 U | 0.00071 J | 0.002 U |
| Arsenic | mg/L | | | | | 0.005 U | 0.0045 J | 0.0013 J |
| Barium | mg/L | | | | | 0.045 | 0.065 | 0.039 |
| Beryllium | mg/L | | | | | 0.001 U | 0.00059 J | 0.001 U |
| Boron | mg/L | | | | | 2 J | 2.7 J | 4.5 J |
| Cadmium | mg/L | | | | | 0.001 U | 0.00036 J | 0.001 U |
| Calcium | mg/L | | | | | 89 | 83 | 90 |
| Chloride | mg/L | | | | | 62 | 47 | 21 |
| Chromium | mg/L | | | | | 0.002 U | 0.0029 | 0.0027 |
| Cobalt | mg/L | | | | | 0.001 U | 0.0087 | 0.0042 |
| Dissolved Solids, Total | mg/L | | | | | 500 J | 520 J | 460 J |
| Fluoride | mg/L | | | | | 0.071 | 0.079 | 0.22 |
| Lead | mg/L | | | | | 0.00055 J | 0.0037 | 0.0019 |
| Lithium | mg/L | | | | | 0.0033 J | 0.0048 J | 0.0021 J |
| Mercury | mg/L | | | | | 0.0002 U | 0.0002 U | 0.0002 U |
| Molybdenum | mg/L | | | | | 0.01 U | 0.01 U | 0.01 U |
| pH, Field | SU | 6.04 | 6.63 | 7.13 | 6.95 | | | |
| Radium-226/228 | pCi/L | | | | | 0.0882 U | 0.178 U | 0.0636 U |
| Selenium | mg/L | | | | | 0.005 U | 0.005 U | 0.005 U |
| Sulfate | mg/L | | | | | 190 | 230 | 170 |
| Thallium | mg/L | | | | | 0.001 U | 0.001 U | 0.001 U |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 6/13/2017 | 6/13/2017 | 6/13/2017 | 6/13/2017 | 7/14/2017 | 7/14/2017 | 7/14/2017 |
| Sample Type | | N | N | N | N | FD | N | N |
| Location ID | | BAC-02 | BAC-01 | MW-6 | MW-1 | MW-1 | BAC-01 | BAC-03 |
| Sample ID | | BAC-02-20170613-01 | BAC-01-20170613-01 | MW-6-20170613-01 | MW-1-20170613-01 | BAC-DUP-1-20170714-01 | BAC-01-20170714-02 | BAC-03-20170714-02 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | | |
| Arsenic | mg/L | 0.00075 J | 0.005 U | 0.005 U | 0.005 U | 0.005 U | | |
| Barium | mg/L | 0.051 | 0.064 | 0.14 | 0.11 | 0.1 | | |
| Beryllium | mg/L | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | | |
| Boron | mg/L | 2.7 J | 0.13 J | 0.067 J | 0.066 J | 0.067 JB | | |
| Cadmium | mg/L | 0.00041 J | 0.001 U | 0.001 U | 0.001 U | 0.001 U | | |
| Calcium | mg/L | 180 | 110 | 120 | 120 | 120 | | |
| Chloride | mg/L | 110 | 22 | 20 | 22 | 22 | | |
| Chromium | mg/L | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | | |
| Cobalt | mg/L | 0.0017 | 0.001 U | 0.00047 J | 0.0007 J | 0.00069 J | | |
| Dissolved Solids, Total | mg/L | 1000 J | 420 J | 480 J | 490 J | 470 J | | |
| Fluoride | mg/L | 0.17 | 0.14 | 0.096 | 0.11 | 0.11 | | |
| Lead | mg/L | 0.00068 J | 0.001 U | 0.001 U | 0.001 U | 0.001 U | | |
| Lithium | mg/L | 0.008 U | 0.0035 J | 0.0049 J | 0.0046 J | 0.0052 J | | |
| Mercury | mg/L | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | | |
| Molybdenum | mg/L | 0.01 U | 0.01 U | 0.01 U | 0.01 U | 0.01 U | | |
| pH, Field | SU | | | | | | 6.67 | 5.93 |
| Radium-226/228 | pCi/L | 0.305 U | 0.559 | 0.665 | 0.525 | 0.342 | | |
| Selenium | mg/L | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | | |
| Sulfate | mg/L | 420 | 95 | 130 | 130 | 130 | | |
| Thallium | mg/L | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 7/14/2017 | 7/14/2017 | 7/14/2017 | 7/14/2017 | 7/14/2017 | 7/14/2017 | 7/19/2017 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | MW-1 | MW-6 | MW-1 | BAC-01 | MW-6 | BAC-03 | BAC-02 |
| Sample ID | | MW-1-20170714-02 | MW-6-20170714-02 | MW-1-20170714-01 | BAC-01-20170714-01 | MW-6-20170714-01 | BAC-03-20170714-01 | BAC-02-20170719-02 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | | | 0.002 U | 0.002 U | 0.002 U | 0.002 U | |
| Arsenic | mg/L | | | 0.00094 J | 0.005 U | 0.005 U | 0.005 U | |
| Barium | mg/L | | | 0.1 | 0.062 | 0.14 | 0.044 | |
| Beryllium | mg/L | | | 0.001 U | 0.001 U | 0.001 U | 0.001 U | |
| Boron | mg/L | | | 0.068 JB | 0.13 JB | 0.064 JB | 2 JB | |
| Cadmium | mg/L | | | 0.001 U | 0.001 U | 0.001 U | 0.001 U | |
| Calcium | mg/L | | | 120 | 110 | 120 | 88 | |
| Chloride | mg/L | | | 22 | 23 | 20 | 61 | |
| Chromium | mg/L | | | 0.002 U | 0.002 U | 0.002 U | 0.002 U | |
| Cobalt | mg/L | | | 0.00078 J | 0.001 U | 0.00053 J | 0.001 U | |
| Dissolved Solids, Total | mg/L | | | 480 J | 420 J | 470 J | 500 J | |
| Fluoride | mg/L | | | 0.11 | 0.14 | 0.095 | 0.07 | |
| Lead | mg/L | | | 0.00076 J | 0.001 U | 0.001 U | 0.001 U | |
| Lithium | mg/L | | | 0.0051 J | 0.0038 J | 0.0053 J | 0.0067 J | |
| Mercury | mg/L | | | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | |
| Molybdenum | mg/L | | | 0.01 U | 0.01 U | 0.01 U | 0.01 U | |
| pH, Field | SU | 6.98 | 6.89 | | | | | 6.02 |
| Radium-226/228 | pCi/L | | | 0.518 | 0.195 U | 0.259 U | 0.506 | |
| Selenium | mg/L | | | 0.0012 JB | 0.005 U | 0.005 U | 0.0011 JB | |
| Sulfate | mg/L | | | 130 | 95 | 130 | 190 J | |
| Thallium | mg/L | | | 0.001 U | 0.001 U | 0.001 U | 0.001 U | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|---|
| Sample Date | | 7/19/2017 | 7/19/2017 | 7/19/2017 | 7/19/2017 | 7/19/2017 | 5/15/2018 | 5/15/2018 |
| Sample Type | | N | N | N | N | N | N | N |
| Location ID | | BAC-04 | BAC-05 | BAC-02 | BAC-05 | BAC-04 | MW-1 | MW-1 |
| Sample ID | | BAC-04-20170719-02 | BAC-05-20170719-02 | BAC-02-20170719-01 | BAC-05-20170719-01 | BAC-04-20170719-01 | MW-1-20180515-01 | MW-1-WG-20180515-02 |
| Analyte | Unit | | | | | | | |
| Antimony | mg/L | | | 0.002 U | 0.002 U | 0.002 U | | |
| Arsenic | mg/L | | | 0.00078 J | 0.00084 J | 0.0086 | | |
| Barium | mg/L | | | 0.052 | 0.041 | 0.077 | | |
| Beryllium | mg/L | | | 0.001 U | 0.001 U | 0.001 U | | |
| Boron | mg/L | | | 2.7 JB | 4.3 JB | 2.5 JB | 0.054 | |
| Cadmium | mg/L | | | 0.00036 J | 0.001 U | 0.00022 J | | |
| Calcium | mg/L | | | 190 | 87 | 86 | 120 | |
| Chloride | mg/L | | | 110 | 21 | 49 | 25 | |
| Chromium | mg/L | | | 0.0011 J | 0.0092 | 0.0039 | | |
| Cobalt | mg/L | | | 0.0025 | 0.0037 | 0.0095 | | |
| Dissolved Solids, Total | mg/L | | | 1100 J | 460 J | 520 J | 500 | |
| Fluoride | mg/L | | | 0.16 | 0.21 | 0.077 | 0.11 | |
| Lead | mg/L | | | 0.00089 J | 0.0015 | 0.0064 | | |
| Lithium | mg/L | | | 0.0025 J | 0.0045 J | 0.0082 | | |
| Mercury | mg/L | | | 0.0002 U | 0.0002 U | 0.0002 U | | |
| Molybdenum | mg/L | | | 0.01 U | 0.01 U | 0.01 U | | |
| pH, Field | SU | 5.94 | 6.53 | | | | | 7.14 |
| Radium-226/228 | pCi/L | | | -0.104 U | 0.13 U | 0.576 | | |
| Selenium | mg/L | | | 0.005 U | 0.005 U | 0.005 U | | |
| Sulfate | mg/L | | | 440 | 160 | 220 | 140 | |
| Thallium | mg/L | | | 0.001 U | 0.001 U | 0.001 U | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|
| Sample Date | | 5/15/2018 | 5/15/2018 | 5/15/2018 | 5/15/2018 | 5/15/2018 | 5/15/2018 |
| Sample Type | | FD | N | N | N | N | N |
| Location ID | | BAC-02 | BAC-02 | BAC-02 | BAC-03 | BAC-03 | BAC-04 |
| Sample ID | | DUPLICATE (BAC-02)-20180515-01 | BAC-02-20180515-01 | BAC-02-WG-20180515-02 | BAC-03-20180515-01 | BAC-03-WG-20180515-02 | BAC-04-20180515-01 |
| Analyte | Unit | | | | | | |
| Antimony | mg/L | | | | | | |
| Arsenic | mg/L | | | | | | |
| Barium | mg/L | | | | | | |
| Beryllium | mg/L | | | | | | |
| Boron | mg/L | 2.3 | 2.4 | | 2.5 | | 2.9 |
| Cadmium | mg/L | | | | | | |
| Calcium | mg/L | 160 | 170 | | 96 | | 95 |
| Chloride | mg/L | 110 | 110 | | 56 | | 49 |
| Chromium | mg/L | | | | | | |
| Cobalt | mg/L | | | | | | |
| Dissolved Solids, Total | mg/L | 950 | 980 | | 540 | | 540 |
| Fluoride | mg/L | 0.16 | 0.16 | | 0.085 | | 0.085 |
| Lead | mg/L | | | | | | |
| Lithium | mg/L | | | | | | |
| Mercury | mg/L | | | | | | |
| Molybdenum | mg/L | | | | | | |
| pH, Field | SU | | | 6.18 | | 6.16 | |
| Radium-226/228 | pCi/L | | | | | | |
| Selenium | mg/L | | | | | | |
| Sulfate | mg/L | 390 | 390 | | 200 | | 220 |
| Thallium | mg/L | | | | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|
| Sample Date | | 5/15/2018 | 5/16/2018 | 5/16/2018 | 5/16/2018 | 5/16/2018 | 5/16/2018 |
| Sample Type | | N | N | N | N | N | N |
| Location ID | | BAC-04 | BAC-05 | BAC-05 | MW-6 | MW-6 | BAC-01 |
| Sample ID | | BAC-04-WG-20180515-02 | BAC-05-20180516-01 | BAC-05-WG-20180516-02 | MW-6-20180516-01 | MW-6-WG-20180516-02 | BAC-01-20180516-01 |
| Analyte | Unit | | | | | | |
| Antimony | mg/L | | | | | | |
| Arsenic | mg/L | | | | | | |
| Barium | mg/L | | | | | | |
| Beryllium | mg/L | | | | | | |
| Boron | mg/L | | 2.9 | | 0.08 | | 0.12 |
| Cadmium | mg/L | | | | | | |
| Calcium | mg/L | | 74 | | 120 | | 100 |
| Chloride | mg/L | | 32 | | 22 | | 19 |
| Chromium | mg/L | | | | | | |
| Cobalt | mg/L | | | | | | |
| Dissolved Solids, Total | mg/L | | 470 | | 460 | | 380 |
| Fluoride | mg/L | | 0.11 | | 0.095 | | 0.13 |
| Lead | mg/L | | | | | | |
| Lithium | mg/L | | | | | | |
| Mercury | mg/L | | | | | | |
| Molybdenum | mg/L | | | | | | |
| pH, Field | SU | 6.17 | | 6.06 | | 7.01 | |
| Radium-226/228 | pCi/L | | | | | | |
| Selenium | mg/L | | | | | | |
| Sulfate | mg/L | | 220 | | 120 | | 84 |
| Thallium | mg/L | | | | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|---|---|---|
| Sample Date | | 5/16/2018 | 9/18/2018 | 9/18/2018 | 9/18/2018 | 9/18/2018 | 9/18/2018 |
| Sample Type | | N | N | N | N | N | N |
| Location ID | | BAC-01 | MW-6 | MW-6 | BAC-01 | BAC-01 | BAC-02 |
| Sample ID | | BAC-01-WG-20180516-02 | MW-6-20180918-01 | MW-6-WG-20180918-02 | BAC-01-20180918-01 | BAC-01-WG-20180918-02 | BAC-02-20180918-01 |
| Analyte | Unit | | | | | | |
| Antimony | mg/L | | | | | | |
| Arsenic | mg/L | | | | | | |
| Barium | mg/L | | | | | | |
| Beryllium | mg/L | | | | | | |
| Boron | mg/L | | 0.073 | | 0.12 | | 2.5 |
| Cadmium | mg/L | | | | | | |
| Calcium | mg/L | | 120 | | 100 | | 160 |
| Chloride | mg/L | | 23 | | 25 | | 100 |
| Chromium | mg/L | | | | | | |
| Cobalt | mg/L | | | | | | |
| Dissolved Solids, Total | mg/L | | 480 | | 410 | | 980 |
| Fluoride | mg/L | | 0.11 | | 0.12 | | 0.2 |
| Lead | mg/L | | | | | | |
| Lithium | mg/L | | | | | | |
| Mercury | mg/L | | | | | | |
| Molybdenum | mg/L | | | | | | |
| pH, Field | SU | 6.83 | | 7.03 | | 6.86 | |
| Radium-226/228 | pCi/L | | | | | | |
| Selenium | mg/L | | | | | | |
| Sulfate | mg/L | | 130 | | 98 | | 400 |
| Thallium | mg/L | | | | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L  = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL | FEDERAL |
| Sample Date | | 9/18/2018 | 9/18/2018 | 9/18/2018 | 9/18/2018 | 9/18/2018 | 9/18/2018 |
| Sample Type | | N | N | N | N | N | N |
| Location ID | | BAC-02 | BAC-05 | BAC-05 | BAC-04 | BAC-04 | BAC-03 |
| Sample ID | | BAC-02-WG-20180918-02 | BAC-05-20180918-01 | BAC-05-WG-20180918-02 | BAC-04-20180918-01 | BAC-04-WG-20180918-02 | BAC-03-20180918-01 |
| Analyte | Unit | | | | | | |
| Antimony | mg/L | | | | | | |
| Arsenic | mg/L | | | | | | |
| Barium | mg/L | | | | | | |
| Beryllium | mg/L | | | | | | |
| Boron | mg/L | | 2.8 | | 2.8 | | 2.2 |
| Cadmium | mg/L | | | | | | |
| Calcium | mg/L | | 76 | | 92 | | 92 |
| Chloride | mg/L | | 37 | | 40 | | 57 |
| Chromium | mg/L | | | | | | |
| Cobalt | mg/L | | | | | | |
| Dissolved Solids, Total | mg/L | | 480 | | 490 | | 500 |
| Fluoride | mg/L | | 0.092 | | 0.082 | | 0.073 |
| Lead | mg/L | | | | | | |
| Lithium | mg/L | | | | | | |
| Mercury | mg/L | | | | | | |
| Molybdenum | mg/L | | | | | | |
| pH, Field | SU | 6.2 | | 6.09 | | 6.24 | |
| Radium-226/228 | pCi/L | | | | | | |
| Selenium | mg/L | | | | | | |
| Sulfate | mg/L | | 230 | | 220 | | 200 |
| Thallium | mg/L | | | | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

***Appendix D***
***Analytical Data Summary***
***Bottom Ash Complex***
***Gavin Power Plant***

| | | FEDERAL | FEDERAL | FEDERAL |
|---|---|---|---|---|
| Sample Date | | 9/18/2018 | 9/18/2018 | 9/18/2018 |
| Sample Type | | N | N | N |
| Location ID | | BAC-03 | MW-1 | MW-1 |
| Sample ID | | BAC-03-WG-20180918-02 | MW-1-20180918-01 | MW-1-WG-20180918-02 |
| Analyte | Unit | | | |
| Antimony | mg/L | | | |
| Arsenic | mg/L | | | |
| Barium | mg/L | | | |
| Beryllium | mg/L | | | |
| Boron | mg/L | | 0.076 | |
| Cadmium | mg/L | | | |
| Calcium | mg/L | | 120 | |
| Chloride | mg/L | | 27 | |
| Chromium | mg/L | | | |
| Cobalt | mg/L | | | |
| Dissolved Solids, Total | mg/L | | 490 | |
| Fluoride | mg/L | | 0.1 | |
| Lead | mg/L | | | |
| Lithium | mg/L | | | |
| Mercury | mg/L | | | |
| Molybdenum | mg/L | | | |
| pH, Field | SU | 6.12 | | 7.16 |
| Radium-226/228 | pCi/L | | | |
| Selenium | mg/L | | | |
| Sulfate | mg/L | | 140 | |
| Thallium | mg/L | | | |

Notes
FD - Field Duplicate
N - Normal Sample
mg/L = milligrams per liter
SU = Standard Units
pCi/L = Picocuries per liter

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