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**REPORT ON**

# CORRECTIVE MEASURES ASSESSMENT
# F.B. CULLEY GENERATING STATION
# WEST ASH POND
# NEWBURGH, INDIANA

by
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for
Southern Indiana Gas and Electric Company
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## Overview

Southern Indiana Gas and Electric Company (SIGECO) retained Haley & Aldrich, Inc. (Haley & Aldrich) to prepare this Corrective Measures Assessment (CMA) for the Coal Combustion Residual (CCR) management unit, referred to as the West Ash Pond (WAP). The WAP is located at F.B. Culley Generating Station (FBC) in Newburgh, Indiana. FBC is a coal-fired power plant located on the Ohio River in Warrick County, Indiana. The CMA was completed in accordance with requirements stated in the United States Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (17 April 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (30 July 2018) (amending 40 CFR §257.61) (CCR Rule).

SIGECO implemented groundwater monitoring under the CCR Rule through a phased approach to allow for a graduated response and evaluation of steps to address groundwater quality. Assessment monitoring completed in 2020 evaluated the presence and concentration of Appendix IV constituents in groundwater specified in the CCR Rule. Two Appendix IV constituents, molybdenum and lithium, exceed the Groundwater Protection Standards (GWPS) established for the WAP thereby requiring the performance of this CMA.

In performing this CMA, Haley & Aldrich considered the following: presence and distribution of molybdenum and lithium, WAP configuration, hydrogeologic setting, and the results of the risk evaluation. Within the WAP, CCR was excavated from the southern and eastern areas for consolidation under the geomembrane cap system in the northwest portion of the WAP. These excavation areas resulted in the removal of CCR from contact with groundwater to the maximum extent feasible for consolidation into a reduced area that is above the seasonal high water table, as determined by data gathered during 2018 water level monitoring events. The remaining CCR is managed in a closed and capped impoundment at depths that range from 0 feet to approximately 50 feet. The alluvial aquifer beneath the WAP is approximately 65 feet in thickness. Although flow within the alluvial aquifer is influenced by the river stages of the Ohio River, groundwater flow is generally from the upland area north of the WAP toward the Ohio River.

To provide a comprehensive CMA, the evaluation described herein included surface impoundment closure options and groundwater remediation alternatives that were combined to constitute comprehensive groundwater remedies, including:

- <u>Alternative 1</u>: Hybrid closure in place (CIP) with monitored natural attenuation (MNA) and remediation performance monitoring
- <u>Alternative 2</u>: Hybrid CIP with hydraulic containment using pumping with no treatment of the extracted groundwater prior to discharge (hereafter referred to as "Hydraulic Containment and No Treatment")
- <u>Alternative 3</u>: Hybrid CIP with hydraulic containment and no treatment with a barrier wall
- <u>Alternative 4</u>: Hybrid CIP with hydraulic containment and ex-situ treatment
- <u>Alternative 5</u>: Hybrid CIP with hydraulic containment and ex-situ treatment with a barrier wall
- <u>Alternative 6</u>: Closure by removal with MNA and remediation performance monitoring

These six alternatives were developed to meet the threshold criteria provided in the CCR rule at § 257.97. These threshold criteria are discussed in **Section 4**, and include:

- Be protective of human health and the environment;
- Attain the groundwater protection standard as specified pursuant to §257.95(h);
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part into the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;
- Comply with standards for management of wastes as specified in §257.98(d).

The alternatives were then compared to three of the four balancing criteria stated in the CCR Rule at §257.97. The four balancing criteria consider:

1. The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy; and
4. The degree to which community concerns are addressed by a potential remedy.

Balancing criteria four, which considers community concerns, will be evaluated following a public information session to be conducted at least 30 days prior to remedy selection by SIGECO.

The following observations are made regarding closure scenarios and groundwater remedial alternatives for the WAP and are described more fully in this report:

- **Cap Integrity and Hydrogeologic Conditions:** All CIP alternatives consider the existing as-built hybrid closure condition that included consolidation of CCR into a reduced area that is above the seasonal high water table, as determined by data gathered during 2018 water level monitoring events, and is under a geomembrane cap and cover system that meets or exceeds the performance criteria set forth in the CCR Rule and is referred to in this CMA as a "low permeability cap" that virtually eliminates vertical infiltration via precipitation.

- **No Risk:** Risk assessment evaluations confirm that the WAP presents no unacceptable risk to human health or the environment. Therefore, because no adverse risk currently exists, implementation of any of the remedies considered herein will not result in a meaningful reduction in risk to groundwater-related exposures.

In accordance with §257.98, SIGECO will implement a groundwater monitoring program to document the effectiveness of the selected remedial alternative. Corrective measures are considered complete when monitoring reflects groundwater downgradient of the WAP does not exceed Appendix IV GWPS for three consecutive years.

USEPA is in the process of modifying certain CCR Rule requirements and, depending upon the nature of such changes, assessments made herein could be modified or supplemented to reflect such future regulatory revisions. See *Federal Register (15 March 2018; 83 FR 11584*).

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## List of Acronyms and Abbreviations

| Abbreviation | Definition |
|---|---|
| CBR | Closure by Removal |
| CCR | Coal Combustion Residual |
| CIP | Closure in Place |
| cm/sec | Centimeter per Second |
| CMA | Corrective Measures Assessment |
| COC | Constituent of Concern |
| CSM | Conceptual Site Model |
| EAP | East Ash Pond |
| FBC | F.B. Culley Generating Station |
| FEMA | Federal Emergency Management Agency |
| GMP | Groundwater Monitoring Plan |
| GWPS | Groundwater Protection Standards |
| Haley & Aldrich | Haley & Aldrich, Inc. |
| IDEM | Indiana Department of Environmental Management |
| IDNR | Indiana Department of Natural Resources |
| MNA | Monitored Natural Attenuation |
| Msl | Mean Sea Level |
| N&E | Nature and Extent |
| NPDES | National Pollutant Discharge Elimination System |
| RO | Reverse Osmosis |
| SIGECO | Southern Indiana Gas and Electric Company |
| SSI | Statistically Significant Increase |
| SSL | Statistically Significant Level |
| USEPA | United States Environmental Protection Agency |
| WAP | West Ash Pond |

# 1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) was retained by Southern Indiana Gas and Electric Company (SIGECO) to prepare this Corrective Measures Assessment (CMA) for the Coal Combustion Residual (CCR) management unit (West Ash Pond [WAP]) located at the F.B. Culley Generating Station (FBC), herein referred to as the "Site", in Warrick County, Indiana. SIGECO has conducted detailed geologic and hydrogeologic investigations under the United States Environmental Protection Agency (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (17 April 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (30 July 2018) (amending 40 CFR §257.61) (CCR Rule). These investigations were, in part, related to the groundwater monitoring and corrective action requirements in the CCR Rule.

This CMA includes a summary of the evaluation of the Appendix III constituents for statistically significant increases (SSI) compared to background, and a comparison of the Appendix IV constituents detected in assessment monitoring to the Groundwater Protection Standards (GWPS). These evaluations identified statistically significant levels (SSL) of molybdenum and lithium in groundwater downgradient of the WAP. This report evaluates potential corrective measures to remediate groundwater for the exceedances of the GWPS.

## 1.1 FACILITY DESCRIPTION/BACKGROUND

The WAP at FBC is located adjacent to the northern bank of the Ohio River approximately three miles east of the town of Newburgh. Topography surrounding the WAP varies in elevation with ground surface elevations varying from 430 to 359-feet above mean sea level (msl) (**Figure 1-1**). Higher ground surface elevations are northeast of the WAP with surface topography generally sloping to the west and south towards the Ohio River. The WAP is situated outside of the 100-year floodplain established by the Federal Emergency Management Agency (FEMA). Surface water runoff across the site occurs via sheet flow into low lying areas flowing towards the Ohio River and Little Pigeon Creek.

FBC is an active energy production facility that generates electricity through the combustion of coal. The CCR are products of the combustion process and include bottom ash, fly ash, and flue gas desulfurization sludge. CCR is currently managed on the Site in a 10-acre impoundment known as the East Ash Pond (EAP). Because the WAP was "inactive" as defined by 40 CFR §257.53 in the 2015 CCR Rule, it was not considered to be subject to the compliance and schedule requirements in the CCR Rule. However, due to subsequent CCR Rule changes related to a partial vacatur ordered by the District of Columbia Circuit Court on 14 June 2016 and the subsequent 5 August 2016 "Direct Final Rule" (effective on 4 October 2016), the WAP must meet the requirements of the CCR Rule for existing CCR surface impoundments. The CCR Rule changes extend the deadlines to comply with the groundwater monitoring requirements. While complying with the CCR Rule groundwater monitoring and corrective action requirement SIGECO continued to work with the Indiana Department of Environmental Management (IDEM) to gain approval of a Closure/Post-Closure Plan (Plan) for the WAP under 329 IAC 10-9-1(c). The approval was issued in December 2019. The Plan established a partial removal and consolidation of CCR herein referred to as a hybrid Closure-in-Place (CIP) closure of the WAP and established post-closure monitoring requirements. The hybrid CIP closure construction included excavation of CCR material from approximately 15.6+/- acres of the original 32+/- acre WAP footprint, resulting in the removal of ash from areas that were determined to be, or have the potential to remain, in contact with groundwater to the maximum extent feasible. The consolidated 16.4+/- acre CIP area included a low permeability final cover (cap) system consisting of the following elements from bottom to top: 40 mil LLDPE geomembrane, a geocomposite drainage layer, a 24-inch infiltration soil layer and a 6-inch vegetative cover soil layer. The WAP hybrid CIP construction was completed in December 2020.

With respect to the groundwater monitoring requirements outlined in the CCR Rule, nine rounds of groundwater sampling were completed by 17 April 2019. A Site Index Map showing the location of the CCR monitoring network and the post-closure groundwater monitoring system is provided as **Figure 1-2**. Several drinking water wells are located proximate to the WAP. These wells are described in **Section 3** of this report.

The Site was constructed in 1953 by excavating a portion of the hills located just north of the plant and diverting Little Pigeon Creek from its previous flow east-to-west across the plant area, to flow southeast to the Ohio River east of the EAP. The WAP was commissioned in the mid-1960s with an earthen berm constructed along the southern and western boundaries. It was used to store the various residuals from plant operations, plant storm water, and direct precipitation. In 1999, fly ash generated on the Site was stored in a silo and shipped to an offsite cement kiln. The WAP also received fly ash from a neighboring industrial site until 2007 when the CCR input was stopped. Some process residuals contained in the WAP were removed in 2008.

## 1.2 GROUNDWATER MONITORING

Groundwater monitoring under the CCR Rule occurred through an iterative process to allow for a graduated response based on site conditions (i.e., baseline, detection, and assessment monitoring as applicable) and evaluation of steps to address groundwater quality. Haley & Aldrich prepared a *Groundwater Monitoring Plan* (GMP) as required by the CCR Rule. The GMP presents the design of the groundwater monitoring system as well as groundwater sampling and analytical procedures. Groundwater statistical analysis methods were presented in a companion document entitled *Statistical Analysis Plan*.

Monitoring wells were installed in December 2015, March 2016, February 2017 and September 2020. The original CCR monitoring well network for the WAP included two background wells (WAP-1 and CCR-AP-7) and four downgradient monitoring wells (WAP-2R, WAP-3S, WAP-4S, and WAP-5S) located around the perimeter of the WAP. In addition, 13 new wells have been added to satisfy IDEM's post-closure groundwater monitoring requirements. These additional wells are shown on **Figure 1-2** and include WAP-3D, WAP-4I, WAP-4D, WAP-5I, WAP-5D, WAP-6S, WAP-6I, WAP-6D, WAP-7S, WAP-7D, WAP-8S, WAP-8I and WAP-8D installed in nested well clusters.

Detection monitoring events occurred in 2019. The Appendix III constituent results from the detection sampling events were compared to background concentrations using statistical methods to determine if SSIs of the Appendix III constituents above background were present downgradient of the WAP. The result of the statistical analysis identified SSIs thereby triggering Assessment Monitoring and notification of the same.

During the Assessment Monitoring phase, CCR groundwater samples were collected from the CCR monitoring well network in October 2019, and March 2020 and subsequently analyzed for the Appendix III and Appendix IV constituents as required by 40 CFR §257.95(b) and 40 CFR §257.95(d)(1). Appendix IV analytical results are summarized in **Table I**. Concurrent with the second assessment sampling round, and as required by 40 CFR §257.95(h), GWPS were established for the detected Appendix IV constituents. The assessment monitoring results were compared to the GWPS to determine if SSLs of Appendix IV constituents were present downgradient of the WAP. The results of this evaluation indicated that SSLs of molybdenum and lithium were present in one or more groundwater monitoring well downgradient of the WAP.

As a result of this determination and in accordance with 40 CFR §257.95(g)(3)(i) SIGECO initiated this assessment of corrective measures.

## 1.3 CORRECTIVE MEASURES ASSESSMENT PROCESS

The CMA process described in this document involves an evaluation of groundwater remediation technologies that will result in meeting the following threshold criteria: protection of human health and the environment, attainment of GWPS, source control, constituent removal, and compliance with standards for waste management. Once the evaluation demonstrates the remediation technologies meet these criteria, they are then compared to one another with respect to the following balancing criteria: long- and short-term effectiveness, source control, and ease or difficulty of implementation. Input from the community on such proposed measures will occur as part of a public meeting to be conducted at least 30 days prior to remedy selection by SIGECO.

## 1.4 RISK REDUCTION AND REMEDY

The CCR Rule (§257.97(b)(1) - Selection of Remedy) requires that remedies must be protective of human health and the environment. Further, §257.97(c) of the CCR Rule requires that in selecting a remedy, the owner or operator of the CCR unit must consider specific evaluation factors, including the risk reduction achieved by each of the proposed corrective measures. Each of the following evaluation factors listed here from §257.97 and discussed in **Section 4** are those that are directly related to human health and environmental risk:

- (c)(1)(i) Magnitude of reduction of existing risks;
- (c)(1)(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;
- (c)(1)(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;
- (c)(1)(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;

The following are additional factors related to risk that are considered when developing the schedule for implementing and completing remedial activities once a remedy is selected (§257.97(d)):

- (d)(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy[1];
- (d)(5)(i) Current and future uses of the aquifer;
- (d)(5)(ii) Proximity and withdrawal rate of users; and
- (d)(5)(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents.

[1] Factors (d)(4) and (d)(5) are not part of the CMA evaluation process as described in §257.97(d)(4), §257.97(d)(5)(i)(ii)(iv); rather they are factors the owner or operator must consider as part of the schedule for remedy implementation.

# 2. Groundwater Conceptual Site Model

The Site geology and hydrogeology was initially described in the *Groundwater Monitoring Plan* prepared by Haley & Aldrich in April 2019. The conceptual site model (CSM) presented in this section of the CMA has been updated to reflect information gathered to comply with the CCR Rule and to satisfy IDEMs post-closure groundwater monitoring requirements.

## 2.1 SITE SETTING

The WAP at FBC is located adjacent the northern bank of the Ohio River approximately three miles east of the town of Newburgh. Topography surrounding the WAP varies in elevation with ground surface elevations varying from 430 to 359-feet above msl. Higher ground surface elevations are northeast of the WAP with surface topography generally sloping to the west and south towards the Ohio River. As shown on **Figure 2-1**, the WAP is situated outside of the 100-year floodplain established by FEMA. Surface water runoff across the site occurs via sheet flow into low lying areas flowing towards the Ohio River and Little Pigeon Creek.

## 2.2 GEOLOGY AND HYDROGEOLOGY

The WAP at FBC is located within the Ohio River valley which contains naturally occurring alluvial (stream) and loess (windblown) deposits derived indirectly from continental ice sheets. These sediments were transported in meltwater heavily loaded with entrained sediments that accumulated on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited silty sediments in the upland areas adjacent to the stream valley. As a result, base levels of the valley floor increased in elevation and created natural levees and terraces. These natural levees produced slackwater lakes which deposited thick sequences of silt and clay adjacent to the river channel. When the ice sheets retreated, the sediment load in the Ohio River diminished and lowered base levels. Consequently, the river incised the slackwater lake sediments, sculpted fluvial terraces, and deposited sand and gravel stream alluvium.

Soil types described in boring logs from monitoring wells installed around the WAP, as well as boring logs generated from geotechnical explorations conducted by AECOM through the WAP indicate that the uppermost aquifer is comprised of a layered sequence of unconsolidated deposits consisting primarily of alluvial sand deposits overlain by silty sand and clay associated with the slackwater lakes. This unconsolidated overburden overlies Pennsylvanian age sandstone and shale.

As shown on the geologic cross sections A-A', B-B', C-C', and D-D', presented in **Figures 2-3 through 2-6,** the WAP was constructed on unconsolidated silty clay and clay deposited adjacent to the Ohio River. The top of these fine-grained deposits represents the original land surface prior to constructing the WAP. These slackwater lake deposits are laterally continuous and competent beneath the WAP with thickness varying from 2.5 feet beneath the former Little Pigeon Creek bed to more than 30-feet north of the old creek bed. The competency of the fine-grained deposits was confirmed by AECOM. Hydraulic conductivity testing of undisturbed Shelby tube samples showed that the average hydraulic conductivity of the material is $1 \times 10^{-7}$ centimeters per second (cm/sec). This low permeability material likely impedes the upward and downward movement of groundwater and may serve as a semi-confining layer. The former Little Pigeon Creek, which generally paralleled the Ohio River and flowed from east to west, bisected the WAP area until the creek was diverted prior to construction of the WAP.

The location of the former little Pigeon Creek is shown on historical topographic maps. This feature was delineated by AECOM in 2017 by advancing a series of north-south oriented transects across the former creek bed. The original land surface, prior to constructing the WAP, was defined by the top of the native silty clay and clay deposits. Little Pigeon Creek cut approximately 20-feet into the fine-grained silty clay and clay deposits but within the footprint of the WAP did not breach the clay layer. Beneath the silty clay and clay are Ohio River sand and gravel deposits. This wedge of clastic sediments coarsens downward, thickens to the south toward the Ohio River, and directly overlies bedrock. As shown on the north-south oriented cross sections, the alluvial sand units located beneath the WAP thin and pinch out against the upland area located along the northern boundary of the WAP.

Bedrock around FBC belongs to the Carbondale Group. The Carbondale Group consists of Pennsylvanian age sandstone, limestone, shale and coal. The Carbondale Group ranges from 260 to 470 feet thick but on average is approximately 300 feet thick. The Carbondale Group includes laterally persistent limestone units and four of Indiana's commercially important coal seams. Laterally continuous shale beds are associated with the coal formations. As shown on the geologic cross sections, presented in **Figures 2-3 through 2-6** and the contour map showing the top of bedrock, presented in **Figure 2-7**, bedrock beneath the WAP dips to the south and south west toward the Ohio River and the Warrick Power Plant. In the upland area to the northeast of the WAP, the top of bedrock is represented by sandstone. The sandstone unit is not present along the Ohio River where the bedrock is more deeply eroded, and the top of bedrock is represented by gray shale.

The Site is located in the vicinity of the Wabash Valley and New Madrid seismic zones. The largest earthquake recorded (magnitude 5.2) proximal to the Site occurred on 18 April 2008 approximately fifty miles northwest of the facility.

Water table mapping consistently shows that the direction of groundwater flow in the vicinity of the WAP is to the southwest toward the Ohio River with a component of flow to the west. While the water levels vary in response to the Ohio River stages the interpreted groundwater flow directions do not change. The most recent water table map has been provided as **Figure 2-8**. There is a correlation between the water table configuration and bedrock surface suggesting that groundwater flow in the north and eastern portion of the WAP is partially controlled by the bedrock surface with a steep hydraulic gradient (0.065 feet per foot) being maintained across the fine-grained lake deposits. Under base flow conditions, groundwater elevations in the western and southern berms are below the elevation of the Ohio River.

In general, hydraulic conductivity values are consistent with the expected values for the materials that the wells are screened across. For example, the hydraulic conductivity in well WAP-1, screened in the fine-grained silty clay and clay was estimated to be $1.6\text{x}10^{-6}$ cm/sec. Higher hydraulic conductivities were measured at WAP-2R, WAP-5I and WAP-5D, which are screened across sand and gravel deposits, range from $7.7\text{x}10^{-3}$ cm/sec in well WAP-2R to $2.3\text{x}10^{-1}$ cm/sec in WAP-5D. The newly installed monitoring wells (WAP-6, WAP-7 and WAP-8 clusters) which are screened across the sand and gravel deposits range from $8.1\text{x}10^{-3}$ cm/sec in well WAP-6S to $1.3\text{x}10^{-1}$ cm/sec in WAP-6D.

Groundwater flow velocity in the uppermost aquifer beneath the WAP was estimated using site-specific hydraulic conductivity, measured hydraulic gradients, and assumes an effective porosity of 20 percent for the fine-grained material and 30 percent for the sand and gravel. Hydraulic conductivity varied from 1.6E-6 cm/sec adjacent to the northern boundary of the WAP to 9.4E-2 cm/sec beneath and downgradient of the WAP. The hydraulic gradient north of the WAP is 0.065 feet per foot. South of the WAP the hydraulic gradient flattens to 6.8E-4 feet/foot down to the Ohio River. Using the site-

specific hydraulic conductivity and hydraulic gradients, and assuming an effective porosity of 20 percent the groundwater flow north of the WAP is estimated to be 0.54 feet/year. Beneath and downgradient of the Ash Pond groundwater flow is estimated to be 220 feet/year.
In general, the vertical groundwater flow potential is negative, or downward, between the shallow and intermediate wells and between the intermediate and deep wells. While the magnitude of the gradient lessens during high river stages, the flow potential remains negative. The magnitude of the vertical gradient is greater in well cluster WAP-6 located along the western side of the south berm.

## 2.3 GROUNDWATER PROTECTION STANDARDS

Haley & Aldrich completed a statistical evaluation of groundwater samples using the methods and procedures outlined in §257.93(f)) to develop site-specific GWPS for each Appendix IV constituent detected during assessment monitoring.

Groundwater results were compared to the site-specific GWPS. Exceedances above the GWPS are limited to two CCR monitoring wells (WAP-3S, and WAP-4S). SIGECO is in the process of establishing baseline conditions at the newly installed post-closure monitoring points that were installed at the request of IDEM. Exceedances of GWPS will be evaluated at these new locations after baseline sampling is complete. Monitoring well locations with SSLs above the GWPS are illustrated on **Figure 2-9**.

## 2.4 NATURE AND EXTENT OF GROUNDWATER IMPACTS

The CCR Rule requires that an investigation be performed to identify the horizontal and vertical nature and extent (N&E) of Appendix IV SSLs. The N&E investigation is currently underway. Results of initial sampling from the newly installed post-closure monitoring points are being used to aid in the establishment of down-gradient N&E investigation monitoring points.

# 3. Risk Assessment and Exposure Evaluation

A "Groundwater Risk Evaluation" report has been prepared by Haley & Aldrich, as a companion to this CMA document, and is presented in **Appendix A**. The purpose of the risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for the FBC WAP under the CCR Rule. In addition, SIGECO has voluntarily taken the additional step of evaluating potential groundwater-to-surface water transport and exposure pathways in the risk evaluation. An evaluation of the nature and extent of contamination is underway for the Site and based on the outcome of those evaluations may result in changes to this section of the report.

The risk evaluation was initiated by developing a CSM to identify the potential for human or ecological exposure to constituents that may have been released to the environment. Although CCR source removal from contact with groundwater to the maximum extent feasible was performed, and CCR is capped in an area above the seasonal high water table as determined by data gathered during 2018 water level monitoring events, constituents remaining in the subsurface soils of the WAP could be dissolved into infiltrating water (from precipitation) and those constituents may move through the subsurface and could then be present in shallow groundwater. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction. The general direction of groundwater flow at the Site is to the southwest toward the Ohio River with a component of flow to the west towards the production wells located adjacent to the Ohio River on the south side of the Warrick Power Plant.

Groundwater moves slowly through the rock and unconsolidated deposits beneath the ground. Like surface water, groundwater moves from areas of high elevation to areas of low elevation and typically discharges into adjacent surface water. Potential releases of constituents to groundwater from the WAP will be limited in extent by the direction of groundwater flow (southwest toward the river and west) and will not impact surrounding upgradient areas to the east and north.

IDNR Division of Water Well Records database lists 28 wells within a half-mile radius of the facility (IN.gov, 2020a). Of these, 18 are located upgradient (north or east) of the WAP, meaning that groundwater does not flow from the WAP toward those wells. There are nine wells located to the west of the WAP at the Warrick Power Plant, including six production wells. The production wells at the Warrick Power Plant are permitted for potable purposes (IDEM regulated Public Water Supply System Number IN2870801). It is currently unknown if workers at the Warrick Power Plant facility use water from the facility for drinking water, however, use of groundwater as drinking water and for showering by workers at the Warrick Power Plant facility is evaluated as a potentially complete exposure pathway in this evaluation. The remaining well is reported as being located on FBC facility property within the WAP footprint. According to SIGECO personnel familiar with the WAP, this well does not exist.

There are three additional water wells on facility property that are used to supply water to the FBC. These wells are located cross-gradient and east of the WAP and, therefore, would not be impacted by groundwater from the WAP (i.e., users of the water from the wells would not have complete exposure pathways to groundwater potentially affected by the WAP). These wells are used for grey water (handwashing and other non-drinking uses) at the facility and bottled water is provided for drinking water.

To answer the question, "Are the constituent concentrations high enough to potentially exert a toxic effect?", human health risk-based screening levels were used for comparison to the data. Of the groundwater data collected, the majority (95 percent) are below GWPS (i.e., below drinking water standards).

The potential for groundwater containing constituents associated with the WAP to have migrated onto the Warrick Power Plant property or to their production wells is currently being assessed. However, an evaluation of potential risks to a Warrick Power Plant facility worker from groundwater used for drinking water and for showering was included in this risk assessment. This evaluation demonstrates that if the adjacent off-site Warrick Power Plant facility production wells had groundwater quality represented by the nearest WAP downgradient wells (WAP-6S or WAP-3S), there would not be an unacceptable risk posed to the off-site workers.

Due to the influence of the production wells at the Warrick Power Plant, groundwater along the southern boundary of the WAP does not currently discharge into the Ohio River. Therefore, under current conditions, groundwater is evaluated for potential exposure to Warrick Power Plant users, and no potential exposure to groundwater via migration to the Ohio River is evaluated. However, in the event that pumping from the Warrick production wells is discontinued, groundwater would flow toward the Ohio River. For that scenario, a surface water dilution and attenuation factor (SW-DAF) was derived for groundwater that may flow to the Ohio River. This value was derived by calculating the ratio of the groundwater flux compared to the river flux. The groundwater flux was obtained from the CMA model developed for the Culley East Ash Pond utilizing the mass balance tool. The river flux was determined from the 7Q10 low flow of the Ohio River near the Site, derived from nearby USGS gauging stations.; the conservatively calculated SW-DAF is 83,000 (a unitless value) as detailed in Appendix A. When the SW-DAF is applied to the lowest conservative risk-based screening level for surface water (including screening levels for both human health and ecological receptors) the results indicate that groundwater concentrations at the WAP would need to be at least three orders of magnitude higher than current concentrations before groundwater could hypothetically cause a CCR-related constituent in Ohio River surface water to be above a screening level protective of people who use the Ohio River as a source of drinking water and for recreational purposes, and for ecological receptors that live in or use the Ohio River.

This comprehensive evaluation demonstrates that there are no adverse impacts on human health or ecological receptors from constituents present in groundwater resulting from coal ash management practices at the FBC WAP. Therefore, because no adverse risk currently exists, any of the remedies considered in this CMA are all protective of human health and the environment, and implementation of any of the remedial alternatives will not result in a meaningful reduction in risk to groundwater-related exposures or risk.

# 4. Corrective Measures Alternatives

## 4.1 CORRECTIVE MEASURES ASSESSMENT GOALS

The overall goal of this CMA is to identify and evaluate the appropriateness of potential corrective measures to prevent further releases of Appendix IV constituents to groundwater above their GWPS, to remediate releases of Appendix IV constituents detected during groundwater monitoring above their GWPS that have already occurred, and to restore groundwater in the affected area to conditions where Appendix IV constituents, if present, are at concentrations below the GWPS. The corrective measures evaluation that is discussed below and in subsequent sections provides an analysis of the effectiveness of six potential corrective measures in meeting the requirements and objectives of remedies as described under §257.97 (also shown graphically on **Figure 4-1**). Additional remedial alternatives were considered but were determined to not be viable for remediating groundwater at this site. By meeting these requirements, this assessment also meets the requirements promulgated in §257.96 which include an evaluation of:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to complete the remedy; and
- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

The criteria listed above are included in the balancing criteria considered during the corrective measures evaluation, described in **Section 5**.

## 4.2 GROUNDWATER FATE AND TRANSPORT MODELING

Groundwater at the Site was modeled utilizing Groundwater Vista Version 7 for flow and solute transport. The model was constructed, calibrated, and subsequent simulations run to evaluate remedy alternatives for Appendix IV constituents above the GWPS. Site-specific parameters (i.e., geology, groundwater elevations, and hydraulic conductivity) were utilized for model preparation. MODFLOW 2005, a finite difference three-dimensional solver, was utilized for groundwater flow estimation. Modeled groundwater elevations were compared to observed values from the on-site well network (November 2020) to achieve a calibration of less than 10 percent scaled root mean squared of measured water levels. Once groundwater flow was calibrated in the model, solute transport was completed using MT3DMS, a three-dimensional solute transport modeling program. Parameters affecting transport such as advection, diffusion, dispersion, and adsorption are utilized within the MT3DMS package to estimate solute transport within the model domain.

The calibrated flow models were used to simulate the different remediation alternatives and the effects they have on groundwater quality through time. These simulations are incorporated into the discussion on remediation alternatives provided below.

### 4.3 CORRECTIVE MEASURES ALTERNATIVES

Corrective measures are considered complete when groundwater impacted by the WAP does not exceed the Appendix IV GWPS for three consecutive years of groundwater monitoring. In accordance with §257.97, the groundwater corrective measures being considered must meet, at a minimum, the following threshold criteria:

1. Be protective of human health and the environment;
2. Attain the GWPS;
3. Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents of concern (COCs) to the environment;
4. Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5. Comply with standards (regulations) for waste management.

Each of the corrective measures assembled in this CMA meet the requirements of the threshold criteria listed above.

Both CIP and closure by removal (CBR) closure methods are expressly authorized under the CCR Rule. As stated previously, closure of the WAP has already been completed via hybrid CIP that included removal of ash from areas that were determined to be, or had the potential to be in contact with groundwater, to the maximum extent feasible. In this instance, five of the six corrective measures alternatives presented below include CIP, and specifically the as-constructed hybrid CIP of the WAP. The sixth corrective measure alternative includes CBR.

#### 4.3.1 Alternative 1 – Hybrid Closure in Place with Monitored Natural Attenuation and Remediation Performance Monitoring

The WAP would remain closed in place with CCR, including, to the maximum extent feasible, CCR previously below the water table as determined by data gathered during 2018 water level monitoring events, relocated to the northeastern portion of the ash pond and covered with a cap system that reduces infiltration of surface water to groundwater thereby isolating source material. This low permeability cap selection as described in **Section 1.1** meets or exceed the performance criteria set forth in the CCR Rule.

Over time, depletion of COCs in CCR will allow the concentration of COCs in downgradient groundwater to decline and overall groundwater concentrations of COCs to attenuate through the processes of natural attenuation. With material from below the water table relocated and the presence of a low-permeability cap, the isolated CCR will allow the concentrations of COCs in downgradient groundwater to decline and overall groundwater concentrations of COCs to attenuate naturally.

Hybrid CIP was completed safely, in compliance with applicable federal and state regulations, and is protective of public health and the environment. For the WAP, CIP consisted of removing CCR below the water table and adjacent to the southern berm and consolidating CCR to one area and installing a cap/cover designed to significantly reduce infiltration from groundwater, surface water, or rainwater, resist erosion, contain CCR materials, and prevent exposures to CCR. CIP at the WAP included mounding of the remaining CCR within the northeastern portion of the pond in order to create a surface with adequate slope to construct a cap and prevent the mounding and ponding of stormwater. This included excavation and transferring of the material within the pond.

Monitored natural attenuation (MNA) is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. The USEPA defines MNA as "the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods". The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes may include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants (USEPA, 2015). When combined with a low-permeability cap to address the source by limiting the infiltration of precipitation into and through the CCR, MNA can reduce concentrations of molybdenum and lithium in groundwater at the boundary of the WAP.

Following the installation of the cap system, SIGECO implemented post-closure care activities. Post-closure care includes cap system maintenance and long-term groundwater monitoring until such time that groundwater conditions return to below GWPS.

### 4.3.2 Alternative 2 – Hybrid Closure in Place with Hydraulic Containment and No Treatment

Using this alternative, the WAP would remain closed in-place as described in **Section 4.3.1** to reduce infiltration of surface water to groundwater, with CCR material removed from below the water table to the maximum extent feasible as determined by data gathered during 2018 water level monitoring events and relocated beneath the cap. Molybdenum and lithium in groundwater would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. Pumping would be undertaken in the alluvial aquifer and the pumping well effluent is assumed to be discharged directly to surface water under existing or future discharge permits. Under this alternative, no treatment would be used prior to discharge. Verification that the effluent could be discharged under current permits or application for and approval of a new permit would be required.

Implementation of a large-scale hydraulic containment system will require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling will be needed to verify the hydraulic capture zone.

The pumping well effluent would be discharged directly to a receiving water body (i.e., the Ohio River) in accordance with a National Pollutant Discharge Elimination System (NPDES) Permit. No treatment would be used prior to discharge. The construction of water discharge piping from the WAP to the receiving water body will require engineering design, permitting, and site construction. For the effluent to be discharged to a receiving water body, the existing FBC NPDES Permit may need to be modified or a new permit issued. Either option would likely require effluent testing or modeling to support a permit application. The anticipated timeline for permitting and construction of this option is 3 years.

Following the installation of the groundwater pumping well network, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic control system performance, and cap and cover system maintenance.

### 4.3.3 Alternative 3 – Hybrid Closure in Place with Hydraulic Containment and No Treatment with a Barrier Wall

Using this alternative, the WAP would remain closed in-place as described in **Section 4.3.1** to reduce infiltration of surface water to groundwater, with CCR material removed from below the water table to the maximum extent feasible as determined by data gathered during 2018 water level monitoring events and relocated beneath the cap. Molybdenum and lithium in groundwater would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. A partially penetrating low-permeability barrier wall would be installed on the western and southern margin of the capped area to reduce groundwater flux and improve pumping well performance. Pumping would be undertaken in the alluvial aquifer on the upgradient side of the barrier wall and the pumping well effluent is assumed to be discharged directly to surface water under existing or future discharge permits. Under this alternative no treatment would be used prior to discharge. Verification that the effluent could be discharged under current permits or application for and approval of a new permit would be required.

Implementation of a large-scale hydraulic containment system will require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling will be needed to verify the hydraulic capture zone. Design and installation of a subsurface barrier wall will require a detailed design effort and permitting and would include extensive construction to be completed by a specialty contractor.

The pumping well effluent would be discharged directly to a receiving water body (i.e., the Ohio River) in accordance with a NPDES Permit. No treatment would be used prior to discharge. The construction of water discharge piping from the WAP to the receiving water body will require engineering design, permitting, and site construction. For the effluent to be discharged to a receiving water body, the existing FBC NPDES Permit may need to be modified or a new permit issued. Either option would likely require effluent testing or modeling to support a permit application. The anticipated timeline for permitting and construction of this option is 5 years.

Following the installation of the barrier wall and groundwater pumping well network, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system and treatment system, long-term groundwater sampling to monitor hydraulic control system performance, and cap and cover system maintenance.

### 4.3.4 Alternative 4 – Hybrid Closure in Place with Hydraulic Containment and Ex-Situ Treatment

The WAP would remain closed in-place as described in **Section 4.3.1** with reduced infiltration of surface water to groundwater. Molybdenum and lithium detected at the boundary of the unit at concentrations above the GWPS would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. Pumping would be limited to the uppermost aquifer. Pumping well effluent would be treated ex-situ, likely with an ion exchange or a reverse osmosis (RO) treatment system. Both systems would have ongoing operation and maintenance and would generate a secondary waste stream – including regeneration/replacement of the ion exchange media or accumulation of reject water from the RO system.

The design and construction of an ion exchange or RO system would require additional development of a treatment system enclosure, equipment and space that adds complexity to this alternative. As noted in the previous option, implementation of a large-scale hydraulic containment system would require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling, will be needed to verify the hydraulic capture zone. The timeline for engineering, procurement, permit modification and construction of this option is estimated to be 3 years.

Following the installation of the low-permeability cap, groundwater pumping well network, and ex-situ treatment system, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic containment system performance, and cover system maintenance. Over time, concentrations of molybdenum and lithium would decrease to less than the GWPS and operation of the hydraulic containment system would cease.

### 4.3.5 Alternative 5 – Hybrid Closure in Place with Hydraulic Containment and Ex-Situ Treatment with a Barrier Wall

The WAP would remain closed in-place as described in **Section 4.3.1** with reduced infiltration of surface water to groundwater. Molybdenum and lithium detected at the boundary of the unit at concentrations above the GWPS would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. A partially penetrating, low-permeability barrier wall would be installed on the western and southern margin of the capped area to reduce groundwater flux and improve pumping well performance. Pumping would be limited to the uppermost aquifer. Pumping well effluent would be treated ex-situ, likely with an ion exchange or a RO treatment system. Both systems would have ongoing operation and maintenance and would generate a secondary waste stream – including regeneration/replacement of the ion exchange media or accumulation of reject water from the RO system.

The design and construction of an ion exchange or RO system would require additional development of a treatment system enclosure, equipment and space that adds complexity to this alternative. As noted in the previous option, implementation of a large-scale hydraulic containment system would require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling, will be needed to verify the hydraulic capture zone. Similar to Alternative 3, design and installation of a subsurface barrier wall will require a detailed design effort and permitting and would include extensive construction to be completed by a specialty contractor. The timeline for engineering, procurement, permit modification and construction of this option is estimated to be 5 years.

Following the installation of the low-permeability cap, groundwater pumping well network, ex-situ treatment system, and barrier wall, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system and treatment system, long-term groundwater sampling to monitor hydraulic containment system performance, and cover system maintenance. Over time, concentrations of molybdenum and lithium would decrease to less than the GWPS and operation of the hydraulic containment system would cease.

### 4.3.6 Alternative 6 – Closure by Removal with Monitored Natural Attenuation and Remediation Performance Monitoring

This alternative evaluates the removal of CCR from the WAP at FBC followed by natural attenuation of molybdenum and lithium in groundwater. Because the WAP is moderate in size (approximately 1,008,000 cubic yards), excavation and off-site disposal is expected to take as much as 3 years to complete. As with Alternative 1, concentrations of molybdenum and lithium in downgradient groundwater would decline via natural attenuation processes.

Potential community impacts, safety concerns, and construction challenges associated with the CBR alternative are anticipated to be moderate. Removal activities require temporary staging/stockpiling of material prior to transportation, which may affect productivity and extend the timeframe to complete removal. During periods of rain and inclement weather, the removal schedule will be negatively impacted. Excavation and construction safety during the removal duration is another concern due to heavy equipment (e.g., bulldozers, excavators, front end loaders, and off-road trucks) and dump truck operation within the active FBC site. Lastly, transportation of CCR to an off-site landfill will increase truck traffic on public roads increasing risks of traffic accidents and increasing vehicle emissions.

Groundwater would be addressed through MNA. MNA is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. The USEPA defines MNA as "the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods". The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants" (USEPA, 2015). MNA can reduce concentrations of molybdenum and lithium in groundwater at the boundary of the WAP. Long-term, SIGECO would implement post-closure care activities that includes groundwater sampling.

# 5. Comparison of Corrective Measures Alternatives

The purpose of this section is to evaluate, compare, and rank the six corrective measures alternatives using the balancing criteria described in §257.97.

## 5.1 EVALUATION CRITERIA

In accordance with §257.97, remedial alternatives that satisfy the threshold criteria are then compared to four balancing (evaluation) criteria. The balancing criteria allow a comparative analysis for each corrective measure, thereby providing the basis for final corrective measure selection. The four balancing criteria include the following:

1. The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy; and
4. The degree to which community concerns are addressed by a potential remedy.

Public input and feedback will be considered following a public information session to be conducted at least 30 days prior to remedy selection by SIGECO.

## 5.2 COMPARISON OF ALTERNATIVES

This section compares the alternatives to each other based on evaluation of the balancing criteria listed above. Each of the balancing criteria consists of several sub criteria listed in the CCR Rule which have been considered in this assessment. The goal of this analysis is to identify the alternative that is technologically feasible, relevant and readily implementable, provides adequate protection to human health and the environment, and minimizes impacts to the community.

A color-coded graphic which is part of a comprehensive visual comparison tool (see **Table II**) is presented within each subsection below. These graphics provide a visual snapshot of the favorability of each alternative compared to the other alternatives, where green represents “most favorable”, yellow represents “less favorable”, and red represents “least favorable”.

### 5.2.1 Balancing Criterion 1 – The Long- and Short-Term Effectiveness and Protectiveness of the Potential Remedy, along with the Degree of Certainty that the Remedy Will Prove Successful

This balancing criterion takes into consideration the following sub criteria relative to the long-term and short-term effectiveness of the remedy, along with the anticipated success of the remedy.

#### *5.2.1.1 Magnitude of reduction of existing risks*

As indicated by the most recent groundwater sampling results, and the risk evaluation presented in **Section 3**, no unacceptable risk to human health and the environment exists with respect to the FBC WAP. Therefore, none of the remedial alternatives are necessary to reduce risks because no such unacceptable risk from molybdenum or lithium in groundwater currently exists. However, other types of impacts may be posed by the various remedial alternatives considered herein. Alternative 6 (CBR with MNA) is considered the least favorable since the CCR material has been removed from groundwater to the maximum extent feasible and consolidated above the seasonal high water table, as determined by data gathered during 2018 water level monitoring events, with a geomembrane cover system. The CCR material is currently contained, versus CBR, which would result in excavation, transportation over public roadways, and disposal off-site which would create potential risks for exposure. Alternatives 3 and 5, which incorporate hydraulic containment and barrier wall installation have a greater potential for remediation risk due to the installation of pumping wells, construction of the barrier wall, long-term operation and maintenance, and the removal of soils and potential CCR material during trench construction. Alternatives 1, 2, and 4 are considered the most favorable since additional disturbance and handling of CCR material is minimal.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria i)* Magnitude of reduction of risks | | | | | | |

### 5.2.1.2 Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy

Alternatives 1 through 5 have equal magnitude of residual risks in terms of likelihood of further releases due to CCR remaining because full implementation of all of the remedies will result in meeting the GWPS (as a proxy for risk). Alternative 6 is considered the most favorable since the CCR material would be removed from the WAP completely.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria ii)* Magnitude of residual risk in terms of likelihood of further release | | | | | | |

### 5.2.1.3 The type and degree of long-term management required, including monitoring, operation, and maintenance

Alternative 6 (CBR with MNA) is the most favorable alternative with respect to this criterion because it requires the least amount of long-term management and involves no mechanical systems as part of the remedy. Alternative 1 (Hybrid CIP with capping and MNA) is also favorable because it only requires maintenance of the already installed cap and cover system. Alternatives 2 and 3, which both include hydraulic containment with direct discharge, require long-term O&M of the hydraulic containment system and are therefore considered less favorable. Alternatives 4 and 5, which include ex-situ treatment, are the least favorable due to the O&M of groundwater treatment systems and the generation of secondary waste streams.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria iii)* Type and degree of long-term management required | | | | | | |

#### 5.2.1.4 *Short-term risks that might be posed to the community or the environment during implementation of such a remedy*

Community impacts include general impacts to the community due to increased truck traffic on public roads during construction and operation of the remedies, along with generation of secondary waste streams with transportation and off-site disposal of waste streams. Alternative 6 is considered the least favorable since CCR material would need to be transported over public roadways for off-site landfill disposal. Alternatives 3 and 5 are considered less favorable since excess material created during subsurface barrier construction would likely need to be transported and disposed off-site and low-permeability material would need to be transported on-site via public roadways to construct the wall. Alternatives 1, 2, and 4 are considered the most favorable since the short-term risks to the community during implementation would be minimal.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria iv)* Short term risk to community or environment during implementation | | | | | | |

#### 5.2.1.5 *Time until full protection is achieved*

As previously stated, there is currently no unacceptable exposure to groundwater impacted by molybdenum and lithium associated with the WAP; therefore, protection is already achieved. The timeframes to achieve GWPS were evaluated using a predictive model as described above. Based upon predictive modeling, Alternatives 2, 3, 4, and 5, which include hydraulic containment are predicted to achieve the GWPS in the shortest amount of time. Closure by removal with MNA (Alternative 6) and closure in place (Alternative 1) with MNA are predicted to take slightly more time to achieve GWPS due to the longer period of time required for MNA to reduce molybdenum and lithium concentrations and are therefore less favorable. Alternative 6 (CBR with MNA) is considered the least favorable since molybdenum and lithium concentration reductions in groundwater through MNA would not begin until construction is complete.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria v)* Time until full protection is achieved | | | | | | |

#### 5.2.1.6 *Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment*

Because the extent of groundwater impacted by the WAP is limited to the alluvial aquifer, Alternatives 1 (Hybrid CIP with MNA), 2 (CIP with HC), and 4 (Hybrid CIP with HC and treatment) have the lowest potential for exposure to human and environmental receptors and are considered most favorable with respect to this criterion. Alternatives 3 and 5 which rely on a subsurface barrier wall are slightly less favorable because they involve the construction of a low permeability barrier; however, exposures to remaining wastes during construction are still quite low. Alternative 6 (CBR with MNA), which includes excavation, transportation, and disposal of CCR material with off-site disposal has a potential risk for exposure to humans and environmental receptors due to construction and transportation. Therefore, Alternative 6 is considered the least favorable alternative.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria vi)* Potential for exposure of humans and environmental receptors to remaining wastes | | | | | | |

### *5.2.1.7 Long-term reliability of the engineering and institutional controls*

Alternative 6 (CBR with MNA) is expected to have high long-term reliability and is favorable with respect to this criterion. Alternative 1 (Hybrid CIP with MNA) is slightly less reliable due to the long-term maintenance of the cap and cover system, however, is still favorable when compared to alternatives that include active remediation. Hydraulic containment (Alternatives 2, 3, 4 and 5) are considered reliable, proven technologies and would have high long-term reliability, but require field pilot studies and bench scale testing and rely on mechanical systems (groundwater pumping and/or treatment systems) to operate and maintain. Therefore, Alternatives 2, 3, 4, and 5 are considered less favorable.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria vii)* Long-term reliability of engineering and institutional controls | | | | | | |

### *5.2.1.8 Potential need for replacement of the remedy*

Alternative 6, which incorporates closure by removal with MNA is considered the remedy with the lowest likelihood of requiring replacement because source removal is permanent and natural processes will remedy groundwater. Alternative 1 (Hybrid CIP with MNA) is also considered reliable but relies on the cap and cover system to reduce infiltration and control the source and natural processes to reduce the concentrations of molybdenum and lithium in groundwater. Therefore, Alternative 1 is considered less favorable when compared to Alternative 6. From the perspective of needing to replace the remedy, the alternatives that rely on operating systems (Alternatives 2, 3, 4, and 5) are considered more likely to require replacement and are therefore also considered less favorable when compared to Alternative 6.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 1 - Subcriteria viii)* Potential need for replacement of the remedy | | | | | | |

### *5.2.1.9 Long- and short-term effectiveness and protectiveness criterion summary*

The following graphic provides a summary of the long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful.

| | Alternative 1 Hybrid CIP with MNA and Remediation Performance Monitoring | Alternative 2 Hybrid CIP with HC and No Treatment | Alternative 3 Hybrid CIP with HC and No Treatment with a Barrier Wall | Alternative 4 Hybrid CIP with HC and Ex-Situ Treatment | Alternative 5 Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | Alternative 6 CBR with MNA |
|---|---|---|---|---|---|---|
| CATEGORY 1 Long- and Short Term Effectiveness, Protectiveness, and Certainty of Success | | | | | | |

### 5.2.2 Balancing Criterion 2 – The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases

This balancing criterion takes into consideration the ability of the remedy to control a future release, and the degree of complexity of treatment technologies that would be required.

#### *5.2.2.1 The extent to which containment practices will reduce further releases*

Alternative 6 (CBR with MNA) is considered least favorable since CCR material would need to be excavated and removed from the WAP, which creates a potential for further release at multiple stages (low permeability cap removal, excavation, loading, transportation, unloading at the off-site location). Reductions in the concentrations of molybdenum and lithium in groundwater would not begin until CBR is complete since the low permeability cap would need to be removed and releases would continue during the construction period due to precipitation infiltration. Alternatives 2 through 4, which include hydraulic containment with direct discharge or ex-situ treatment, are considered less favorable with respect to this criterion. Under Alternatives 2 and 3, which include hydraulic containment with no treatment, pumping system effluent would be discharged elsewhere on the property without treatment. Under Alternatives 4 and 5, which include hydraulic containment with ex-situ treatment, additional waste streams would be generated and would require management on- and off-site which creates the potential for a further release. Alternative 1 (Hybrid CIP with MNA) is considered the most favorable since the hybrid closure is already complete and there is little potential for a further release.

| | Alternative 1 Hybrid CIP with MNA and Remediation Performance Monitoring | Alternative 2 Hybrid CIP with HC and No Treatment | Alternative 3 Hybrid CIP with HC and No Treatment with a Barrier Wall | Alternative 4 Hybrid CIP with HC and Ex-Situ Treatment | Alternative 5 Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | Alternative 6 CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 2 - Subcriteria i)* Extent to which containment practices will reduce further releases | | | | | | |

#### *5.2.2.2 The extent to which treatment technologies may be used*

With respect to Alternative 1 (Hybrid CIP with MNA) and Alternative 6 (CBR with MNA), no groundwater treatment technologies other than natural attenuation will be used. Alternative 2 will rely on one technology (hydraulic containment) to address groundwater with the effluent being directly discharged to surface water under existing or future discharge permits(s), while Alternative 3 relies on hydraulic containment with the addition of a barrier wall (two technologies). Alternative 4 will also rely on hydraulic containment, with the addition of ex-situ treatment (two technologies). When compared to Alternatives 1 and 6, Alternatives 2, 3, and 4 are considered less favorable. Alternative 5 includes hydraulic containment with ex-situ treatment, plus a subsurface barrier wall, relying on the greatest number of technologies (three) technologies and therefore considered the least favorable when compared to the other five alternatives.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 2 - Subcriteria ii)* Extent to which treatment technologies may be used | | | | | | |

### *5.2.2.3 Effectiveness of the remedy in controlling the source to reduce further releases summary*

The graphic below provides a summary of the effectiveness of the remedial alternatives to control the source to reduce further releases.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| **CATEGORY 2** Effectiveness in controlling the source to reduce further releases | | | | | | |

## 5.2.3 Balancing Criterion 3 – The Ease or Difficulty of Implementing a Potential Remedy

This balancing criterion takes into consideration the following technical and logistical challenges required to implement a remedy:

1. Degree of difficulty associated with constructing the technology;
2. Expected operational reliability of the technologies;
3. Need to coordinate with and obtain necessary approvals and permits from other agencies;
4. Availability of necessary equipment and specialists; and
5. Available capacity and location of needed treatment, storage, and disposal services.

### *5.2.3.1 Degree of difficulty associated with constructing the technology*

Alternative 1 (Hybrid CIP with MNA) is considered favorable since the cover system is in place and implementation of long-term monitoring is straightforward. Alternatives 2 and 4, which include hydraulic containment with and without ex-situ treatment, are also considered favorable since installation of pumping wells is normally straightforward and routine. It is worth noting that in the case of the WAP, coordination with and approvals from IDEM will be required in accordance with the requirements of the Approval of Closure/Post-Closure Plan that was issued by IDEM in December 2019. Alternative 4 will be slightly more difficult to construct due to the ex-situ treatment system and will require additional treatability testing and field pilot studies but is still considered favorable. Alternatives 3 and 5, which combine hydraulic containment with a barrier wall, are both considered less favorable since barrier wall construction will require additional design and permitting and may be difficult to install due to the close proximity of the WAP to the property boundary, existing subsurface utilities, and a neighboring facility. Alternative 6 (CBR with MNA) is considered the least favorable since CCR material removal will require extensive design, permitting, and construction over a longer period of time.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 3 - Subcriteria i)* Degree of difficulty associated with constructing the technology | | | | | | |

### 5.2.3.2 *Expected operational reliability of the technologies*

Alternative 1 (Hybrid CIP with MNA) and Alternative 6 (CBR with MNA) are considered the most favorable from an operational perspective because isolation through capping or removal of the source followed by MNA has a proven track record and only requires long-term monitoring following implementation. While Alternatives 2, 3, 4, and 5 which include hydraulic containment are also expected to be reliable, these alternatives will utilize pumping wells and associated piping with ongoing operations and maintenance and therefore are considered less favorable when compared to Alternatives 1 and 6. Alternatives 4 and 5 will also include the long-term operation of an ex-situ treatment system and further rely on mechanical systems.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 3 - Subcriteria ii)* Expected operational reliability of the technologies | | | | | | |

### 5.2.3.3 *Need to coordinate with and obtain necessary approvals and permits from other agencies*

Alternative 1 is considered favorable since permitting is limited to hybrid CIP requirements and the WAP hybrid CIP has already been permitted and completed. Alternatives 2 and 4, which include hydraulic containment with and without groundwater treatment, are also considered favorable since these alternatives do not require large-scale construction, although permits will be required for effluent discharge and the ex-situ treatment system, and approval by IDEM for any modifications to the approved Closure/Post-Closure Plan. Alternatives 3 and 5 both include the installation of a subsurface barrier wall which will likely require extensive permitting and approvals prior to construction. Therefore, Alternatives 3 and 5 are both considered less favorable. Alternative 6 (CBR with MNA) is considered the least favorable since this alternative includes a large-scale, longer term construction project with associated permits and approvals for CCR material removal and off-site disposal.

| | **Alternative 1** Hybrid CIP with MNA and Remediation Performance Monitoring | **Alternative 2** Hybrid CIP with HC and No Treatment | **Alternative 3** Hybrid CIP with HC and No Treatment with a Barrier Wall | **Alternative 4** Hybrid CIP with HC and Ex-Situ Treatment | **Alternative 5** Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | **Alternative 6** CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 3 - Subcriteria iii)* Need to coordinate with and obtain necessary approvals and permits from other agencies | | | | | | |

### 5.2.3.4 *Availability of necessary equipment and specialists*

Alternative 1 (Hybrid CIP with MNA) is favorable since specialty equipment and technical specialists will not be required to implement the MNA remedy and hybrid capping of the CCR material is already complete. Alternatives 2 and 4 will require equipment for drilling, recovery well installation, construction of groundwater conveyance systems, and an ex-situ treatment system for Alternative 4, making Alternatives 2 and 4 also be considered favorable since qualified contractors and equipment required should not present a great challenge. In addition to hydraulic containment, Alternatives 3 and 5 incorporate a subsurface barrier wall, making these alternatives less favorable since specialty contractors and trenching equipment will be needed to complete the installation. Alternative 6 is also considered less favorable since specialty contractors may be required to complete the CCR material removal and extensive use of construction equipment and material transportation vehicles will be needed.

| | Alternative 1<br>Hybrid CIP with MNA and Remediation Performance Monitoring | Alternative 2<br>Hybrid CIP with HC and No Treatment | Alternative 3<br>Hybrid CIP with HC and No Treatment with a Barrier Wall | Alternative 4<br>Hybrid CIP with HC and Ex-Situ Treatment | Alternative 5<br>Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | Alternative 6<br>CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 3 - Subcriteria iv)*<br>Availability of necessary equipment and specialists | | | | | | |

### *5.2.3.5 Available capacity and location of needed treatment, storage, and disposal services*

Alternative 1 is considered favorable since a hybrid CIP is complete and no additional treatment, storage, or disposal services are anticipated. Alternatives 2 and 3 are also considered favorable since no treatment or disposal are included with the hydraulic containment system, and a limited duration and quantity for storage and disposal of material will be needed during subsurface barrier wall construction for Alternative 3. Alternatives 4 and 5 are less favorable since they both include ex-situ treatment which will generate a concentrated waste stream which would require off-site transportation and disposal during operation. Alternative 6 (CBR with MNA) requires adequate capacity, storage, and disposal service for off-site receiving facilities for over 1 million cubic yards of CCR material. Therefore, this alternative is considered the least favorable.

| | Alternative 1<br>Hybrid CIP with MNA and Remediation Performance Monitoring | Alternative 2<br>Hybrid CIP with HC and No Treatment | Alternative 3<br>Hybrid CIP with HC and No Treatment with a Barrier Wall | Alternative 4<br>Hybrid CIP with HC and Ex-Situ Treatment | Alternative 5<br>Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | Alternative 6<br>CBR with MNA |
|---|---|---|---|---|---|---|
| *Category 3 - Subcriteria v)*<br>Available capacity and location of needed treatment, storage, and disposal services | | | | | | |

### *5.2.3.6 Ease or difficulty of implementation summary*

The graphic below provides a summary of the ease or difficulty that will be needed to implement each alternative. Alternative 1 (Hybrid CIP with capping and MNA) and Alternative 2 (hybrid CIP with HC and no treatment)) are considered the most favorable, while the two remaining alternatives that include a hydraulic containment component (Alternatives 4 and 5) and the addition of ex-situ treatment or barrier wall are considered less favorable. Similarly, Alternative 3 is less favorable since this alternative includes a hydraulic containment component and a barrier wall. Alternative 6 (CBR with MNA) is considered the most difficult to implement and therefore the least favorable.

| | Alternative 1<br>Hybrid CIP with MNA and Remediation Performance Monitoring | Alternative 2<br>Hybrid CIP with HC and No Treatment | Alternative 3<br>Hybrid CIP with HC and No Treatment with a Barrier Wall | Alternative 4<br>Hybrid CIP with HC and Ex-Situ Treatment | Alternative 5<br>Hybrid CIP with HC and Ex-Situ Treatment with a Barrier Wall | Alternative 6<br>CBR with MNA |
|---|---|---|---|---|---|---|
| CATEGORY 3<br>Ease of implementation | | | | | | |

# 6. Summary

This Corrective Measures Assessment has evaluated the following alternatives:

- Alternative 1: Hybrid CIP with MNA and remediation performance monitoring
- Alternative 2: Hybrid CIP with hydraulic containment and no treatment
- Alternative 3: Hybrid CIP with hydraulic containment with no treatment with a barrier wall
- Alternative 4: Hybrid CIP with hydraulic containment and ex-situ treatment
- Alternative 5: Hybrid CIP with hydraulic containment and ex-situ treatment with a barrier wall
- Alternative 6: CBR with MNA and remediation performance monitoring

In accordance with §257.97, each of these alternatives has been confirmed to meet the following threshold criteria:

- Be protective of human health and the environment;
- Attain the GWPS;
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of COCs to the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards (regulations) for waste management.

In addition, in accordance with §257.96, each of the alternatives has been evaluated in the context of the following balancing criteria:

- The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
- The effectiveness of the remedy in controlling the source to reduce further releases;
- The ease or difficulty of implementing a potential remedy; and
- The degree to which community concerns are addressed by a potential remedy.

This Corrective Measures Assessment, and the input received during the public comment period, will be used to identify and select a final corrective measure for implementation at the WAP.

## References


1. USEPA. 2015a. Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities. 80 FR 21301-21501. United State Environmental Protection Agency, Washington, D.C. Available at: https://www.govinfo.gov/content/pkg/FR-2015-04-17/pdf/2015-00257.pdf

2. USEPA. 2015b. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites.

3. USEPA. 2018a. USEPA Regional Screening Levels. November 2018, values for tapwater. United States Environmental Protection Agency. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables


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# TABLES

**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name<br>Sample Name<br>Sample Date<br>Lab Sample ID | Maximum Contaminant Level/ Regional Screening Level | CCR-AP-7<br>CCR-AP-7-20160610<br>06/10/2016<br>180-55667-7 | CCR-AP-7<br>CCR-AP-7-20160812<br>08/12/2016<br>180-57631-7 | CCR-AP-7<br>CCR-AP-7-20161028<br>10/28/2016<br>180-60350-7 | CCR-AP-7<br>CCR-AP-7-20161207<br>12/07/2016<br>180-61530-7 | CCR-AP-7<br>CCR-AP-7-20170208<br>02/08/2017<br>180-63329-7 | CCR-AP-7<br>CCR-AP-7-20170406<br>04/06/2017<br>180-65041-9 | CCR-AP-7<br>CCR-AP-7-20170607<br>06/07/2017<br>180-67233-7 | CCR-AP-7<br>CCR-AP-7-20170928<br>09/28/2017<br>180-70838-3 | CCR-AP-7<br>CCR-AP-7-20171117<br>11/17/2017<br>180-72640-7 | CCR-AP-7<br>CCR-AP-7-20180611<br>06/11/2018<br>180-78672-7 | CCR-AP-7<br>CCR-AP-7-20180828<br>08/28/2018<br>180-81363-7 | CCR-AP-7<br>CCR-AP-7-20190528<br>05/28/2019<br>180-90609-7 | CCR-AP-7<br>CCR-AP-7/WAP-7-20191023<br>10/23/2019<br>180-97809-16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U | 0.002 U | **0.00016 J** | **0.00062 J** | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Arsenic, Total | 0.01 | **0.0025** | **0.0048** | **0.0084** | **0.0083** | **0.018** | **0.008** | **0.0075** | **0.0058** | **0.0034** | **0.0071** | **0.0064** | **0.0037** | **0.0075** |
| Barium, Total | 2 | **0.1** | **0.12** | **0.16** | **0.14** | **0.19** | **0.15** | **0.15** | **0.12** | **0.11** | **0.14** | **0.14** | **0.13** | **0.15** |
| Beryllium, Total | 0.004 | 0.001 U | 0.001 U | **0.00017 J** | **0.00012 J** | **0.00075 J** | **0.00022 J** | **0.00015 J** | 0.001 U | 0.001 U | 0.001 U | **0.000067 J** | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00032 J** | **0.00014 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Chromium, Total | 0.1 | **0.00048 J** | **0.00047 J** | **0.0026** | **0.0039** | **0.019** | **0.0048** | **0.0039 J+** | 0.002 U | 0.002 U | 0.0014 U | **0.0061 J+** | 0.002 U | **0.0018 J** |
| Cobalt, Total | 0.006 | **0.0012** | **0.0023** | **0.0053 J** | **0.0037** | **0.015** | **0.0054** | **0.0032** | **0.00054** | **0.0003 J** | **0.00065** | **0.0014** | **0.00047 J** | **0.001** |
| Fluoride | 4 | 0.11 R | **0.24** | **0.25** | **0.37 J+** | **0.28 J+** | **0.29** | **0.34** | **0.19** | **0.25** | **0.31** | **0.31** | **0.27 J+** | **0.14 J+** |
| Lead, Total | 0.015 | **0.00062 J** | **0.00099 J** | **0.0082 J** | **0.0036** | **0.02** | **0.0087 J+** | **0.0041** | 0.001 U | 0.001 U | **0.00041 J** | **0.0014** | 0.001 U | **0.0014 J+** |
| Lithium, Total | 0.04 | **0.01 J** | **0.011 J** | **0.02 J** | **0.012 J** | **0.039 J** | **0.019 J** | **0.019 J** | **0.01 J** | **0.012 J** | **0.011** | **0.013** | **0.011** | **0.02 J+** |
| Mercury, Total | 0.002 | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | - | 0.0002 U | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.0082** | **0.0054** | **0.0044 J** | **0.0088** | **0.013** | **0.0058** | **0.0069** | **0.0036 J** | **0.0028 J** | **0.0025 J** | **0.0026 J** | **0.002 J** | **0.0017 J** |
| Selenium, Total | 0.05 | **0.00035 J** | 0.005 U | **0.00073 J** | 0.005 U | 0.005 U | 0.005 UJ | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U | **0.00008 J** | **0.000066 J** | **0.00061 J** | 0.001 U | **0.000088 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | |
| Radium-226 | NA | **0.330 J ± 0.0973** | **0.390 ± 0.118** | **1.28 ± 0.664** | 0.439 U ± 0.399 | **0.744 ± 0.22** | **0.719 ± 0.182** | **0.398 ± 0.129** | **0.308 ± 0.095** | **0.312 ± 0.0954** | **0.480 ± 0.216** | 0.520 R ± 0.141 | **0.423 ± 0.123** | **0.194 J ± 0.097** |
| Radium-228 | NA | 0.166 U ± 0.267 | **0.625 J ± 0.344** | 0.434 U ± 0.433 | 0.558 U ± 0.451 | 0.365 U ± 0.252 | **0.830 ± 0.427** | **0.895 ± 0.413** | 0.369 R ± 0.234 | 0.405 R ± 0.227 | 0.0986 U ± 0.257 | 0.307 U ± 0.231 | 0.112 U ± 0.31 | **1.02 ± 0.324** |
| Radium-226 & 228 | 5 | **0.496 ± 0.284** | **1.02 J ± 0.363** | **1.72 J ± 0.792** | **0.997 ± 0.602** | **1.11 J ± 0.335** | **1.55 ± 0.464** | **1.29 ± 0.433** | 0.677 R ± 0.253 | 0.717 R ± 0.246 | **0.579 J ± 0.336** | 0.827 R ± 0.271 | **0.535 J ± 0.334** | **1.21 ± 0.338** |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name | Maximum | CCR-AP-7 | CCR-AP-7 | CCR-AP-7 | CCR-AP-7 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 | WAP-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Contaminant | CCR-AP-7-20200219 | WAP-7-20200330 | CCR-AP-7-20200518 | CCR-AP-7-20201112 | WAP-1-20170323 | WAP-1-20180315 | WAP-1-20180402 | WAP-1-20180504 | WAP-1-20180524 | WAP-1-20180615 | WAP-1-20180705 | WAP-1-20180725 | WAP-1-20180816 | WAP-1-20181205 | WAP-1-20191028 |
| Sample Date | Level/ Regional | 02/19/2020 | 03/30/2020 | 05/18/2020 | 11/12/2020 | 03/23/2017 | 03/15/2018 | 04/02/2018 | 05/04/2018 | 05/24/2018 | 06/15/2018 | 07/05/2018 | 07/25/2018 | 08/16/2018 | 12/05/2018 | 10/28/2019 |
| Lab Sample ID | Screening Level | 180-102603-6 | 180-104189-6 | 180-106111-9 | 180-113688-9 | 180-64617-1 | 180-75879-3 | 180-76407-1 | 180-77434-1 | 180-78136-1 | 180-78840-1 | 180-79554-1 | 180-80247-1 | 180-81032-1 | 180-84710-1 | 180-97909-1 |
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U | **0.00083 J** | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | **0.0014 J** | **0.0018 J** | 0.002 U | 0.002 U | 0.002 U | **0.00059 J** |
| Arsenic, Total | 0.01 | **0.004** | **0.0018** | **0.015** | **0.0062** | **0.0015** | **0.0033** | **0.0085** | **0.0038** | **0.0079** | **0.021** | **0.012** | **0.0049** | **0.0051** | **0.0032** | **0.0066** |
| Barium, Total | 2 | **0.12** | **0.11** | **0.19** | **0.13** | **0.21** | **0.37** | **0.46** | **0.37** | **0.51** | **0.88** | **0.67** | **0.39** | **0.4** | **0.38** | **0.54** |
| Beryllium, Total | 0.004 | 0.001 U | 0.001 U | **0.00027 J** | 0.001 U | 0.001 U | 0.001 U | **0.00049 J** | **0.000072 J** | **0.00039 J** | **0.00089 J-** | **0.0012** | **0.00042 J** | **0.0003 J** | **0.000089 J** | **0.00027 J** |
| Cadmium, Total | 0.005 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00021 J** | 0.001 U | **0.00018 J** | **0.00049 J** | **0.00044 J** | **0.00013 J** | 0.001 U | 0.001 U | **0.00022 J** |
| Chromium, Total | 0.1 | **0.0018 J** | 0.002 U | **0.0062** | 0.002 U | **0.0009 J** | 0.0022 U | **0.016** | **0.005 J+** | **0.017** | **0.043** | **0.046** | **0.0088** | **0.014 J+** | **0.0057 J+** | **0.011** |
| Cobalt, Total | 0.006 | **0.0011** | **0.00029 J** | **0.0049** | **0.00021 J** | **0.00026 J** | **0.00044 J** | **0.0067** | **0.0013** | **0.0059** | **0.019** | **0.017** | **0.0047** | **0.0045** | **0.0019** | **0.0047** |
| Fluoride | 4 | **0.22** | **0.3** | **0.29** | **0.33** | **0.25 J+** | **0.31** | **0.23** | **0.21** | **0.28** | **0.24** | **0.28** | **0.28** | **0.27** | **0.29** | **0.19 J+** |
| Lead, Total | 0.015 | **0.0015** | 0.001 U | **0.006** | 0.001 U | **0.0011** | **0.00068 J** | **0.014** | **0.0024** | **0.012** | **0.035** | **0.034** | **0.0099** | **0.0089** | **0.0036** | **0.0072** |
| Lithium, Total | 0.04 | **0.011** | **0.01** | **0.018** | **0.0099** | 0.05 U | **0.0066** | **0.015 J** | **0.01 J+** | **0.012 J+** | **0.027** | **0.024** | **0.0095** | **0.01** | **0.01** | **0.015** |
| Mercury, Total | 0.002 | - | - | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 UJ | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.0015 J** | **0.0014 J** | **0.002 J** | **0.0011 J** | **0.002 J** | **0.0009 J** | **0.0026 J** | **0.00086 J** | **0.0015 J** | **0.0028 J** | **0.0028 J** | 0.005 U | **0.0013 J** | **0.0011 J** | **0.0012 J** |
| Selenium, Total | 0.05 | - | - | **0.0028 J** | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | **0.0018 J** | **0.0018 J** | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00027 J** | 0.001 U | **0.00018 J** | **0.00047 J** | **0.00053 J** | **0.00019 J** | **0.00014 J** | **0.000083 J** | **0.00025 J** |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | | | |
| Radium-226 | NA | **0.309 J- ± 0.125** | **0.243 ± 0.117** | 0.0602 U ± 0.147 | 0.0646 U ± 0.223 | **0.191 ± 0.0932** | **0.638 ± 0.17** | **0.531 ± 0.144** | **0.538 ± 0.161** | **0.673 ± 0.193** | **0.708 ± 0.284** | 0.608 R ± 0.232 | 0.445 R ± 0.135 | **0.813 ± 0.239** | **0.457 ± 0.156** | **0.737 ± 0.329** |
| Radium-228 | NA | 0.111 U ± 0.217 | 0.197 U ± 0.268 | 0.242 U ± 0.611 | 0.0611 U ± 0.291 | 0.0647 U ± 0.205 | 0.839 R ± 0.337 | **0.550 ± 0.27** | 0.268 U ± 0.332 | 0.411 U ± 0.295 | 0.853 R ± 0.342 | 0.367 U ± 0.294 | 0.0344 U ± 0.269 | 0.950 R ± 0.552 | 0.417 U ± 0.313 | 0.715 U ± 1.18 |
| Radium-226 & 228 | 5 | **0.419 J- ± 0.25** | 0.441 UJ ± 0.292 | 0.302 U ± 0.628 | 0.126 U ± 0.367 | 0.256 UJ ± 0.225 | 1.48 R ± 0.377 | **1.08 ± 0.306** | **0.807 J ± 0.369** | **1.08 J ± 0.353** | 1.56 R ± 0.445 | 0.976 R ± 0.375 | 0.480 UJ ± 0.301 | 1.76 R ± 0.602 | **0.875 J ± 0.35** | 1.45 UJ ± 1.23 |

**ABBREVIATIONS AND NOTES:**
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name | Maximum | WAP-1 | WAP-1 | WAP-1 | WAP-2 | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-2R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Contaminant | WAP-1-20200219 | WAP-1-20200331 | WAP-1-20201124 | WAP-2-20170323 | WAP-2R-20180315 | WAP-2R-20180403 | BLIND DUPLICATE-20180403 | WAP-2R-20180504 | WAP-2R-20180524 | WAP-2R-20180615 | WAP-2R-20180706 | WAP-2R-20180726 | WAP-2R-20180816 | WAP-2R-20181205 |
| Sample Date | Level/ Regional | 02/19/2020 | 03/31/2020 | 11/24/2020 | 03/23/2017 | 03/15/2018 | 04/03/2018 | 04/03/2018 | 05/04/2018 | 05/24/2018 | 06/15/2018 | 07/06/2018 | 07/26/2018 | 08/16/2018 | 12/05/2018 |
| Lab Sample ID | Screening Level | 180-102603-1 | 180-104189-1 | 180-114117-1 | 180-64617-2 | 180-75879-1 | 180-76407-2 | 180-76407-7 | 180-77434-2 | 180-78136-2 | 180-78840-2 | 180-79554-2 | 180-80247-2 | 180-81032-2 | 180-84710-2 |
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | **0.00045 J** | **0.00073 J** | **0.0011 J** | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Arsenic, Total | 0.01 | **0.0073** | **0.004** | **0.025** | **0.00087 J** | 0.001 U | **0.0059** | **0.0068** | **0.00095 J** | **0.00081 J** | **0.00092 J** | **0.00071 J** | **0.00047 J** | **0.00084 J** | **0.00064 J** |
| Barium, Total | 2 | **0.56** | **0.45** | **0.99** | **0.015** | **0.053** | **0.062** | **0.065** | **0.045** | **0.042** | **0.041** | **0.041** | **0.032** | **0.035** | **0.025** |
| Beryllium, Total | 0.004 | **0.00023 J** | 0.001 U | **0.00099 J** | 0.001 U | 0.001 U | **0.00024 J** | **0.00031 J** | 0.001 U | 0.001 U | 0.001 UJ | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | 0.001 U | 0.001 U | **0.00033 J** | **0.00017 J** | **0.00054 J** | **0.001** | **0.001** | **0.00044 J** | **0.0005 J** | **0.00043 J** | **0.00041 J** | **0.00032 J** | **0.00044 J** | **0.00032 J** |
| Chromium, Total | 0.1 | **0.012** | **0.005** | **0.027** | 0.002 U | 0.002 U | **0.0041** | **0.0048** | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Cobalt, Total | 0.006 | **0.0058** | **0.0033** | **0.012** | **0.0021** | **0.0023** | **0.0062** | **0.0068** | **0.002** | **0.0024** | **0.0019** | **0.0022** | **0.0017** | **0.0023** | **0.00096** |
| Fluoride | 4 | **0.17** | **2** | **0.11** | **0.49** | **0.24** | **0.23** | **0.21** | **0.13 J** | **0.17** | **0.16** | **0.16** | **0.15** | **0.11** | **0.26** |
| Lead, Total | 0.015 | **0.0094** | **0.0041** | **0.022** | 0.001 U | 0.001 U | **0.0064** | **0.0067** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00016 J** |
| Lithium, Total | 0.04 | **0.011** | **0.0096** | **0.021** | **0.022 J** | **0.059** | **0.029 J** | **0.029 J** | **0.06** | **0.041** | **0.052** | **0.04** | **0.026** | **0.033** | **0.02** |
| Mercury, Total | 0.002 | - | - | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 UJ | 0.0002 U | 0.0002 U | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.001 J** | **0.00068 J** | **0.0017 J** | **0.35** | **0.063** | **0.013** | **0.014** | **0.042** | **0.035** | **0.04** | **0.035** | **0.032** | **0.034** | **0.018** |
| Selenium, Total | 0.05 | - | - | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | **0.00021 J** | **0.00063 J** | 0.001 U | **0.0003 J** | **0.00047 J** | **0.00052 J** | **0.00014 J** | **0.00011 J** | **0.000082 J** | **0.000084 J** | 0.001 U | **0.000067 J** | **0.00014 J** |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | | |
| Radium-226 | NA | **0.549 J- ± 0.241** | **0.569 ± 0.238** | **2.54 ± 1.16** | **0.186 ± 0.1** | **0.194 ± 0.0786** | **0.206 ± 0.09** | **0.357 ± 0.124** | **0.189 ± 0.0826** | 0.0929 U ± 0.083 | 0.182 U ± 0.159 | 0.254 R ± 0.141 | 0.268 R ± 0.105 | 0.344 R ± 0.103 | 0.0986 U ± 0.0783 |
| Radium-228 | NA | **0.962 ± 0.489** | 0.792 U ± 0.561 | **2.20 ± 0.951** | 0.227 U ± 0.241 | -0.0629 U ± 0.174 | **0.673 ± 0.334** | **0.694 ± 0.332** | 0.193 U ± 0.199 | 0.0762 U ± 0.215 | 0.441 R ± 0.243 | 0.325 U ± 0.226 | 0.353 U ± 0.294 | 0.151 U ± 0.243 | 0.119 U ± 0.213 |
| Radium-226 & 228 | 5 | **1.51 J- ± 0.545** | **1.36 J ± 0.609** | **4.74 ± 1.5** | **0.413 ± 0.261** | 0.194 UJ ± 0.191 | **0.878 ± 0.346** | **1.05 ± 0.354** | **0.382 J ± 0.215** | 0.169 U ± 0.23 | 0.623 R ± 0.29 | 0.579 R ± 0.266 | **0.621 J+ ± 0.312** | 0.495 R ± 0.264 | 0.218 U ± 0.227 |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name | Maximum | WAP-2R | WAP-2R | WAP-2R | WAP-2R | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Contaminant | WAP-2R-20191028 | WAP-2R-20200218 | WAP-2R-20200331 | WAP-2R-20201124 | WAP-3-20170323 | DUP_032317_0800 | WAP-3-20180315 | WAP-3-20180403 | WAP-3-20180503 | WAP-3-20180524 | WAP-3-20180615 | BLIND DUPLICATE-20180615 | WAP-3-20180706 | WAP-3-20180726 | WAP-3-20180816 |
| Sample Date | Level/ Regional | 10/28/2019 | 02/18/2020 | 03/31/2020 | 11/24/2020 | 03/23/2017 | 03/23/2017 | 03/15/2018 | 04/03/2018 | 05/03/2018 | 05/24/2018 | 06/15/2018 | 06/15/2018 | 07/06/2018 | 07/26/2018 | 08/16/2018 |
| Lab Sample ID | Screening Level | 180-97909-2 | 180-102603-2 | 180-104189-2 | 180-114117-2 | 180-64617-3 | 180-64617-10 | 180-75879-2 | 180-76407-3 | 180-77434-3 | 180-78136-3 | 180-78840-3 | 180-78840-6 | 180-79554-3 | 180-80247-3 | 180-81032-3 |
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Arsenic, Total | 0.01 | **0.001** | **0.00054 J** | **0.00056 J** | **0.0078** | **0.005** | **0.0055** | **0.0038** | **0.0031** | **0.003** | **0.0032** | **0.003** | **0.003** | **0.0022** | **0.0018** | **0.0023** |
| Barium, Total | 2 | **0.031** | **0.023** | **0.025** | **0.086** | **0.22** | **0.19** | **0.35** | **0.32** | **0.23** | **0.1** | **0.2** | **0.19** | **0.12** | **0.22** | **0.17** |
| Beryllium, Total | 0.004 | 0.001 U | 0.001 U | 0.001 U | **0.00037 J** | **0.00019 J** | 0.001 U | **0.000068 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 UJ | 0.001 UJ | 0.001 U | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | **0.00027 J** | 0.001 U | 0.001 U | **0.00053 J** | **0.00016 J** | **0.00027 J** | **0.00024 J** | 0.001 U | **0.00022 J** | **0.0003 J** | **0.00022 J** | **0.00022 J** | **0.00022 J** | **0.00017 J** | **0.00022 J** |
| Chromium, Total | 0.1 | 0.002 U | 0.002 U | 0.002 U | **0.0057** | **0.001 J** | **0.0024** | 0.0029 U | **0.00099 J** | 0.002 U | 0.002 U | 0.0021 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Cobalt, Total | 0.006 | **0.0015 J** | **0.00052** | **0.00083** | **0.0097** | **0.0027 J** | **0.0046 J** | **0.0015** | **0.0011** | **0.00053** | **0.00044 J** | **0.00071** | **0.00061** | **0.00034 J** | **0.00037 J** | **0.00048 J** |
| Fluoride | 4 | **0.25 J+** | **0.2** | **0.23** | **0.27** | **0.28** | **0.35 J+** | **0.43** | **0.33** | **0.6** | **0.77** | **0.56** | **0.57** | **0.68** | **0.53** | **0.52** |
| Lead, Total | 0.015 | **0.00029 J** | 0.001 U | **0.00019 J** | **0.0056** | **0.0012** | **0.0019** | **0.0018** | **0.0011** | 0.001 U | **0.0003 J** | **0.00038 J** | **0.00038 J** | **0.00023 J** | **0.00027 J** | **0.00037 J** |
| Lithium, Total | 0.04 | **0.016** | **0.012** | **0.014** | **0.041** | **0.053** | **0.073** | **0.04** | **0.036 J** | **0.052** | **0.061** | **0.062** | **0.06** | **0.066** | **0.044** | **0.07** |
| Mercury, Total | 0.002 | 0.0002 U | - | - | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 UJ | 0.0002 U | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.16** | **0.05** | **0.07** | **0.05** | **0.45 J** | **0.69 J** | **0.72** | **0.41** | **1.2** | **1.5** | **0.98** | **0.97** | **1.2** | **0.78** | **1** |
| Selenium, Total | 0.05 | 0.005 U | - | - | **0.0033 J** | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U | 0.001 U | **0.00027 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | | | |
| Radium-226 | NA | 0.0181 U ± 0.0789 | 0.0350 R ± 0.0713 | 0.112 U ± 0.105 | 0.561 U ± 0.621 | **0.623 ± 0.159** | **0.355 ± 0.132** | **0.684 ± 0.156** | **0.560 ± 0.14** | **0.458 ± 0.126** | **0.155 ± 0.0928** | **0.350 ± 0.174** | **0.442 ± 0.175** | 0.512 R ± 0.183 | 0.652 R ± 0.165 | **0.545 ± 0.134** |
| Radium-228 | NA | 0.0701 U ± 0.341 | 0.204 U ± 0.218 | -0.0721 U ± 0.334 | **0.969 ± 0.556** | **0.660 ± 0.378** | **0.528 ± 0.342** | 0.317 U ± 0.255 | **0.507 ± 0.232** | 0.327 U ± 0.258 | 0.0439 U ± 0.275 | 0.734 R ± 0.275 | 0.508 R ± 0.253 | **0.416 ± 0.219** | **0.629 J ± 0.382** | 0.399 R ± 0.225 |
| Radium-226 & 228 | 5 | 0.0883 U ± 0.35 | 0.239 UJ ± 0.229 | 0.112 U ± 0.35 | **1.53 J ± 0.834** | **1.28 ± 0.411** | **0.883 ± 0.367** | **1.00 J ± 0.299** | **1.07 ± 0.271** | **0.785 J ± 0.287** | 0.199 UJ ± 0.29 | 1.08 R ± 0.325 | 0.951 R ± 0.308 | 0.928 R ± 0.285 | 1.28 R ± 0.416 | 0.943 R ± 0.262 |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
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SU: standard units.
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**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name | Maximum | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-3S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Contaminant | WAP-3-20181205 | WAP-3-20191028 | WAP-3I-20200219 | WAP-3-20200330 | WAP-3S-20201124 | WAP-4S-20170322 | WAP-4S-20180314 | DUP-20180315 | WAP-4S-20180402 | WAP-4S-20180503 | WAP-4S-20180524 | WAP-4S-20180614 | WAP-4S-20180705 | BLIND DUPLICATE-20180705 | WAP-4S-20180725 |
| Sample Date | Level/ Regional | 12/05/2018 | 10/28/2019 | 02/19/2020 | 03/30/2020 | 11/24/2020 | 03/22/2017 | 03/14/2018 | 03/15/2018 | 04/02/2018 | 05/03/2018 | 05/24/2018 | 06/14/2018 | 07/05/2018 | 07/05/2018 | 07/25/2018 |
| Lab Sample ID | Screening Level | 180-84710-3 | 180-97909-3 | 180-102603-3 | 180-104189-3 | 180-114117-4 | 180-64617-4 | 180-75879-4 | 180-75879-12 | 180-76407-4 | 180-77434-4 | 180-78136-4 | 180-78840-4 | 180-79554-4 | 180-79554-6 | 180-80247-4 |
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | **0.00043 J** | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Arsenic, Total | 0.01 | **0.0027** | **0.002** | **0.0014** | **0.0064** | **0.00091 J** | **0.0044** | **0.0036** | **0.0035** | **0.0048** | **0.0042** | **0.0043** | **0.00073 J** | **0.0033** | **0.0034** | **0.003** |
| Barium, Total | 2 | **0.16** | **0.25** | **0.39** | **0.33** | **0.031** | **0.07** | **0.063** | **0.063** | **0.08** | **0.06** | **0.06** | **0.056** | **0.058** | **0.059** | **0.052** |
| Beryllium, Total | 0.004 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 UJ | 0.001 U | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | **0.00016 J** | **0.0002 J** | 0.001 U | 0.001 U | 0.001 U | **0.00012 J** | 0.001 U | 0.001 U | **0.00025 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Chromium, Total | 0.1 | 0.002 U | **0.0024** | 0.002 U | **0.003** | 0.002 U | **0.00047 J** | 0.002 U | 0.002 U | **0.00088 J** | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Cobalt, Total | 0.006 | **0.00067** | **0.00094** | **0.00043 J** | **0.0016** | **0.0018** | **0.0021** | **0.0019** | **0.0019** | **0.0026** | **0.0015** | **0.0014** | **0.0093** | **0.0013** | **0.0015** | **0.0014** |
| Fluoride | 4 | **0.55** | **0.39 J+** | **0.24** | **0.48** | **0.75** | 0.25 U | **0.24** | **0.23** | **0.19** | **0.14 J** | **0.24** | **0.11** | **0.23** | **0.23** | **0.25** |
| Lead, Total | 0.015 | **0.00042 J** | **0.00094 J** | **0.00071 J** | **0.0027** | **0.001** | 0.001 U | 0.001 U | 0.001 U | **0.0007 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Lithium, Total | 0.04 | **0.08** | **0.079** | **0.033** | **0.1** | **0.087** | **0.023 J** | **0.014** | **0.014** | **0.011 J** | **0.017 J+** | **0.016 J+** | **0.0037 J** | **0.011** | **0.011** | 0.005 U |
| Mercury, Total | 0.002 | 0.0002 U | 0.0002 U | - | - | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 UJ | 0.0002 UJ | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.86** | **0.92** | **0.26** | **0.7** | **1.1** | **0.3** | **0.39** | **0.39** | **0.33** | **0.43** | **0.42** | **0.00078 J** | **0.41** | **0.41** | **0.4** |
| Selenium, Total | 0.05 | 0.005 U | 0.005 U | - | - | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | | | |
| Radium-226 | NA | **0.315 ± 0.115** | **0.308 ± 0.119** | **0.462 J- ± 0.147** | **0.500 ± 0.174** | **1.21 ± 0.744** | 0.112 U ± 0.0894 | **0.100 ± 0.0583** | **0.131 ± 0.078** | **0.181 ± 0.0774** | **0.0892 ± 0.0601** | **0.190 ± 0.102** | 0.00495 U ± 0.0976 | 0.168 U ± 0.128 | 0.449 R ± 0.176 | 0.231 R ± 0.0966 |
| Radium-228 | NA | **0.436 ± 0.238** | 0.243 U ± 0.34 | **0.629 ± 0.261** | **0.650 ± 0.391** | 0.166 U ± 0.614 | 0.329 U ± 0.245 | 0.127 U ± 0.204 | 0.468 R ± 0.272 | **0.512 ± 0.219** | 0.102 U ± 0.213 | -0.00480 U ± 0.231 | 0.471 R ± 0.272 | 0.259 U ± 0.206 | 0.149 U ± 0.197 | 0.496 U ± 0.35 |
| Radium-226 & 228 | 5 | **0.751 ± 0.264** | 0.551 UJ ± 0.36 | **1.09 J- ± 0.3** | **1.15 ± 0.428** | **1.38 J ± 0.965** | **0.440 ± 0.261** | 0.227 UJ ± 0.212 | 0.600 R ± 0.283 | **0.693 ± 0.232** | 0.191 UJ ± 0.221 | 0.190 UJ ± 0.253 | 0.476 R ± 0.289 | 0.428 R ± 0.243 | 0.597 R ± 0.264 | **0.726 J+ ± 0.363** |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
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SU: standard units.
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F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name | Maximum | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-4S | WAP-5S | WAP-5S | WAP-5S | WAP-5S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Contaminant | BLIND DUPLICATE-20180725 | WAP-4S-20180816 | BLIND DUPLICATE-20180816 | WAP-4S-20181204 | WAP-4S-20191025 | WAP-4S-20200219 | WAP-4-20200330 | BLIND DUP-20200330 | WAP-4S-20201123 | WAP-5S-20170321 | WAP-5S-20180313 | WAP-5S-20180402 | WAP-5S-20180503 |
| Sample Date | Level/ Regional | 07/25/2018 | 08/16/2018 | 08/16/2018 | 12/04/2018 | 10/25/2019 | 02/19/2020 | 03/30/2020 | 03/30/2020 | 11/23/2020 | 03/21/2017 | 03/13/2018 | 04/02/2018 | 05/03/2018 |
| Lab Sample ID | Screening Level | 180-80247-6 | 180-81032-4 | 180-81032-6 | 180-84710-4 | 180-97909-4 | 180-102603-4 | 180-104189-4 | 180-104189-7 | 180-114117-8 | 180-64617-7 | 180-75879-7 | 180-76407-5 | 180-77434-5 |
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.0021 U | 0.002 U |
| Arsenic, Total | 0.01 | **0.0026** | **0.0031** | **0.0032** | **0.0035** | **0.0054** | **0.0032** | **0.0061** | **0.0068** | **0.0049** | **0.00073 J** | 0.001 U | **0.00076 J** | **0.00089 J** |
| Barium, Total | 2 | **0.051** | **0.05** | **0.052** | **0.053** | **0.049** | **0.056** | **0.056** | **0.057** | **0.049** | **0.055** | **0.058** | **0.053** | **0.061** |
| Beryllium, Total | 0.004 | **0.000079 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | 0.001 U | 0.001 U | 0.001 U | **0.00018 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Chromium, Total | 0.1 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Cobalt, Total | 0.006 | **0.0016** | **0.0016** | **0.0018** | **0.0018** | **0.0023** | **0.0022** | **0.0019** | **0.002** | **0.002** | **0.0098** | **0.0089** | **0.0085** | **0.0093** |
| Fluoride | 4 | **0.23** | **0.18** | **0.18** | **0.24** | **0.17 J+** | **0.16** | **0.17** | **0.2** | **0.23** | **0.11** | **0.1** | **0.11** | **0.075 J** |
| Lead, Total | 0.015 | 0.001 U | 0.001 U | 0.001 U | **0.00031 J** | 0.001 U | 0.001 U | 0.001 U | **0.00014 J** | **0.00015 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Lithium, Total | 0.04 | 0.005 U | 0.005 U | 0.005 U | **0.012** | **0.0036 J** | 0.005 U | **0.0049 J** | **0.0056** | 0.005 U | 0.05 U | **0.0037 J** | 0.05 U | 0.0054 U |
| Mercury, Total | 0.002 | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | - | 0.0002 U | - | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.39** | **0.45** | **0.45** | **0.43** | **0.5** | **0.33** | **0.47** | **0.48** | **0.5** | **0.00063 J** | **0.00064 J** | **0.0024 J** | **0.0007 J** |
| Selenium, Total | 0.05 | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | - | - | - | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00025 J** | 0.001 U | 0.001 U | 0.001 U | **0.00011 J** | 0.001 U |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | |
| Radium-226 | NA | 0.300 R ± 0.115 | 0.380 R ± 0.109 | 0.243 R ± 0.0908 | **0.136 ± 0.0833** | 0.131 U ± 0.102 | **0.136 J- ± 0.0915** | 0.128 U ± 0.122 | 0.0740 U ± 0.097 | 0.165 U ± 0.323 | 0.0946 U ± 0.0747 | **0.0892 ± 0.0606** | 0.0528 U ± 0.0514 | **0.112 ± 0.065** |
| Radium-228 | NA | 0.0516 U ± 0.347 | 0.178 U ± 0.205 | 0.273 U ± 0.28 | 0.178 U ± 0.197 | -0.0635 U ± 0.322 | 0.154 U ± 0.227 | 0.774 U ± 0.589 | 0.540 U ± 0.484 | **1.04 ± 0.432** | 0.377 U ± 0.255 | 0.157 U ± 0.226 | 0.161 U ± 0.192 | 0.150 U ± 0.249 |
| Radium-226 & 228 | 5 | 0.352 UJ ± 0.366 | 0.558 R ± 0.232 | **0.517 J+ ± 0.294** | 0.315 UJ ± 0.214 | 0.131 U ± 0.338 | 0.289 UJ ± 0.245 | 0.901 U ± 0.602 | 0.614 U ± 0.494 | **1.21 J ± 0.539** | **0.472 ± 0.266** | 0.246 UJ ± 0.234 | 0.214 U ± 0.199 | 0.262 UJ ± 0.257 |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name<br>Sample Name<br>Sample Date<br>Lab Sample ID | Maximum Contaminant Level/ Regional Screening Level | WAP-5S<br>BLIND DUPLICATE-20180503<br>05/03/2018<br>180-77434-6 | WAP-5S<br>WAP-5S-20180523<br>05/23/2018<br>180-78136-5 | WAP-5S<br>BLIND DUPLICATE-20180523<br>05/23/2018<br>180-78136-6 | WAP-5S<br>WAP-5S-20180614<br>06/14/2018<br>180-78840-5 | WAP-5S<br>WAP-5S-20180705<br>07/05/2018<br>180-79554-5 | WAP-5S<br>WAP-5S-20180725<br>07/25/2018<br>180-80247-5 | WAP-5S<br>WAP-5S-20180816<br>08/16/2018<br>180-81032-5 | WAP-5S<br>WAP-5S-20181204<br>12/04/2018<br>180-84710-5 | WAP-5S<br>BLIND DUPLICATE-20181204<br>12/04/2018<br>180-84710-6 | WAP-5S<br>WAP-5S-20191025<br>10/25/2019<br>180-97909-5 | WAP-5S<br>BLIND DUPLICATE-20191025<br>10/25/2019<br>180-97909-6 | WAP-5S<br>WAP-5S-20200218<br>02/18/2020<br>180-102603-5 | WAP-5S<br>BLIND DUPLICATE-20200218<br>02/18/2020<br>180-102603-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | | | | | | | | | | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Arsenic, Total | 0.01 | **0.00081 J** | **0.00065 J** | **0.00074 J** | **0.0042** | **0.00057 J** | **0.00055 J** | **0.00086 J** | **0.00069 J** | **0.00072 J** | **0.0013** | **0.0013** | **0.00058 J** | **0.00054 J** |
| Barium, Total | 2 | **0.058** | **0.053** | **0.055** | **0.063** | **0.055** | **0.049** | **0.056** | **0.053** | **0.053** | **0.061** | **0.059** | **0.047** | **0.045** |
| Beryllium, Total | 0.004 | 0.001 U | 0.001 U | 0.001 U | 0.001 UJ | 0.001 U | **0.000084 J** | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00015 J** | 0.001 U | 0.001 U | 0.001 U |
| Chromium, Total | 0.1 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | **0.0016 J** | 0.002 U | 0.002 U |
| Cobalt, Total | 0.006 | **0.0087** | **0.008** | **0.0085** | **0.0016** | **0.0079** | **0.0074** | **0.0086** | **0.0078** | **0.0077** | **0.0094** | **0.0097** | **0.0063** | **0.0062** |
| Fluoride | 4 | **0.067 J** | **0.15** | **0.15** | **0.21** | **0.094 J** | **0.12** | **0.087 J** | **0.11** | **0.12** | 0.1 U | 0.11 U | **0.099 J** | **0.11** |
| Lead, Total | 0.015 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Lithium, Total | 0.04 | 0.005 U | 0.005 U | 0.005 U | **0.016** | 0.005 U | 0.005 U | 0.005 U | **0.0044 J** | **0.0038 J** | **0.0047 J** | **0.0041 J** | 0.005 U | 0.005 U |
| Mercury, Total | 0.002 | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 UJ | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | 0.0002 U | - | - |
| Molybdenum, Total | 0.1 | **0.00061 J** | **0.00067 J** | **0.00065 J** | **0.4** | **0.00065 J** | 0.005 U | **0.00068 J** | **0.00077 J** | **0.00073 J** | **0.00097 J** | **0.00086 J** | **0.00097 J** | **0.00091 J** |
| Selenium, Total | 0.05 | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U | - | - |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U | **0.00022 J** | 0.001 U | 0.001 U | 0.001 U |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | |
| Radium-226 | NA | **0.109 ± 0.0729** | **0.178 ± 0.0963** | 0.0881 U ± 0.073 | 0.110 U ± 0.126 | 0.343 R ± 0.153 | 0.397 R ± 0.138 | 0.248 R ± 0.0916 | 0.0740 U ± 0.073 | **0.121 ± 0.0871** | 0.0779 U ± 0.0866 | 0.00333 U ± 0.0873 | 0.0104 R ± 0.0669 | 0.0796 R ± 0.0617 |
| Radium-228 | NA | -0.00993 U ± 0.215 | 0.231 U ± 0.245 | 0.119 U ± 0.242 | 0.110 U ± 0.241 | 0.0391 U ± 0.19 | 0.0522 U ± 0.242 | 0.194 U ± 0.222 | 0.113 U ± 0.213 | 0.0614 U ± 0.207 | 0.276 U ± 0.271 | 0.130 U ± 0.26 | 0.249 U ± 0.224 | 0.0650 U ± 0.21 |
| Radium-226 & 228 | 5 | 0.109 UJ ± 0.227 | **0.409 J ± 0.263** | 0.207 U ± 0.253 | 0.220 U ± 0.272 | 0.382 R ± 0.244 | 0.450 R ± 0.279 | 0.442 R ± 0.24 | 0.187 U ± 0.225 | 0.182 UJ ± 0.225 | 0.354 U ± 0.285 | 0.133 U ± 0.274 | 0.259 UJ ± 0.234 | 0.145 UJ ± 0.219 |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

**TABLE I**
**ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSITUENTS**
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

| Location Name<br>Sample Name<br>Sample Date<br>Lab Sample ID | Maximum Contaminant Level/ Regional Screening Level | WAP-5S<br>WAP-5-20200330<br>03/30/2020<br>180-104189-5 | WAP-5S<br>WAP-5S-20201124<br>11/24/2020<br>180-114117-11 |
|---|---|---|---|
| **Assessment Monitoring - EPA Appendix IV Constituents (mg/L)** | | | |
| Antimony, Total | 0.006 | 0.002 U | 0.002 U |
| Arsenic, Total | 0.01 | 0.001 U | **0.0017** |
| Barium, Total | 2 | **0.046** | **0.052** |
| Beryllium, Total | 0.004 | 0.001 U | 0.001 U |
| Cadmium, Total | 0.005 | 0.001 U | 0.001 U |
| Chromium, Total | 0.1 | 0.002 U | 0.002 U |
| Cobalt, Total | 0.006 | **0.0062** | **0.0088** |
| Fluoride | 4 | **0.064 J** | **0.081 J** |
| Lead, Total | 0.015 | 0.001 U | **0.00036 J** |
| Lithium, Total | 0.04 | 0.005 U | 0.005 U |
| Mercury, Total | 0.002 | - | 0.0002 U |
| Molybdenum, Total | 0.1 | **0.00086 J** | **0.00081 J** |
| Selenium, Total | 0.05 | - | 0.005 U |
| Thallium, Total | 0.002 | 0.001 U | 0.001 U |
| **Radiological (pCi/L)** | | | |
| Radium-226 | NA | 0.000 U ± 0.0649 | 0.104 U ± 0.3 |
| Radium-228 | NA | **0.648 ± 0.364** | 0.305 U ± 0.245 |
| Radium-226 & 228 | 5 | **0.648 J ± 0.37** | 0.409 U ± 0.387 |

**ABBREVIATIONS AND NOTES:**

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

**TABLE II**

**SUMMARY OF CORRECTIVE MEASURES**

F.B. CULLEY GENERATING STATION - WEST ASH POND

NEWBURGH, INDIANA

| Alternative Number | Remedial Alternative Description | THRESHOLD CRITERIA | | | | | BALANCING CRITERIA | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CATEGORY 1 | Sub-Category 1 | | | | | | | | CATEGORY 2 | Sub-Cat. 2 | | CATEGORY 3 | Sub-Category 3 | | | | |
| | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 1 | 2 | | 1 | 2 | 3 | 4 | 5 |
| | | Be protective of human health and the environment | Attain the groundwater protective standard | Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment | Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems | Management of waste to comply with all applicable RCRA requirements | Long- and Short-Term Effectiveness, Protectiveness, and Certainty of Success that the remedy will prove successful | *Magnitude of reduction of existing risks* | *Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy* | *Type and degree of long-term management required including monitoring, operation and maintenance* | *Short-term risk to community or environment during implementation of remedy* | *Time until full protection is achieved* | *Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment* | *Long-term reliability of engineering and institutional controls* | *Potential need for replacement of the remedy* | Effectiveness in controlling the source to reduce further releases | *Extent to which containment practices will reduce further releases* | *Extent to which treatment technologies may be used* | The ease or difficulty of implementation | *Degree of difficulty associated with constructing the technology* | *Expected operational reliability of the technologies* | *Need to coordinate with and obtain necessary approvals and permits from other agencies* | *Availability of necessary equipment and specialists* | *Available capacity and location of needed treatment, storage, and disposal services* |
| 1 | Hybrid Closure in Place (CIP) with Monitored Natural Attenuation (MNA) and Remediation Performance Monitoring | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | |
| 2 | Hybrid CIP with Hydraulic Containment and No Treatment | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | |
| 3 | Hybrid CIP with Hydraulic Containment and No Treatment with a Barrier Wall | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | |
| 4 | Hybrid CIP with Hydraulic Containment and Ex-Situ Treatment | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | |

**TABLE II**

**SUMMARY OF CORRECTIVE MEASURES**

F.B. CULLEY GENERATING STATION - WEST ASH POND

NEWBURGH, INDIANA

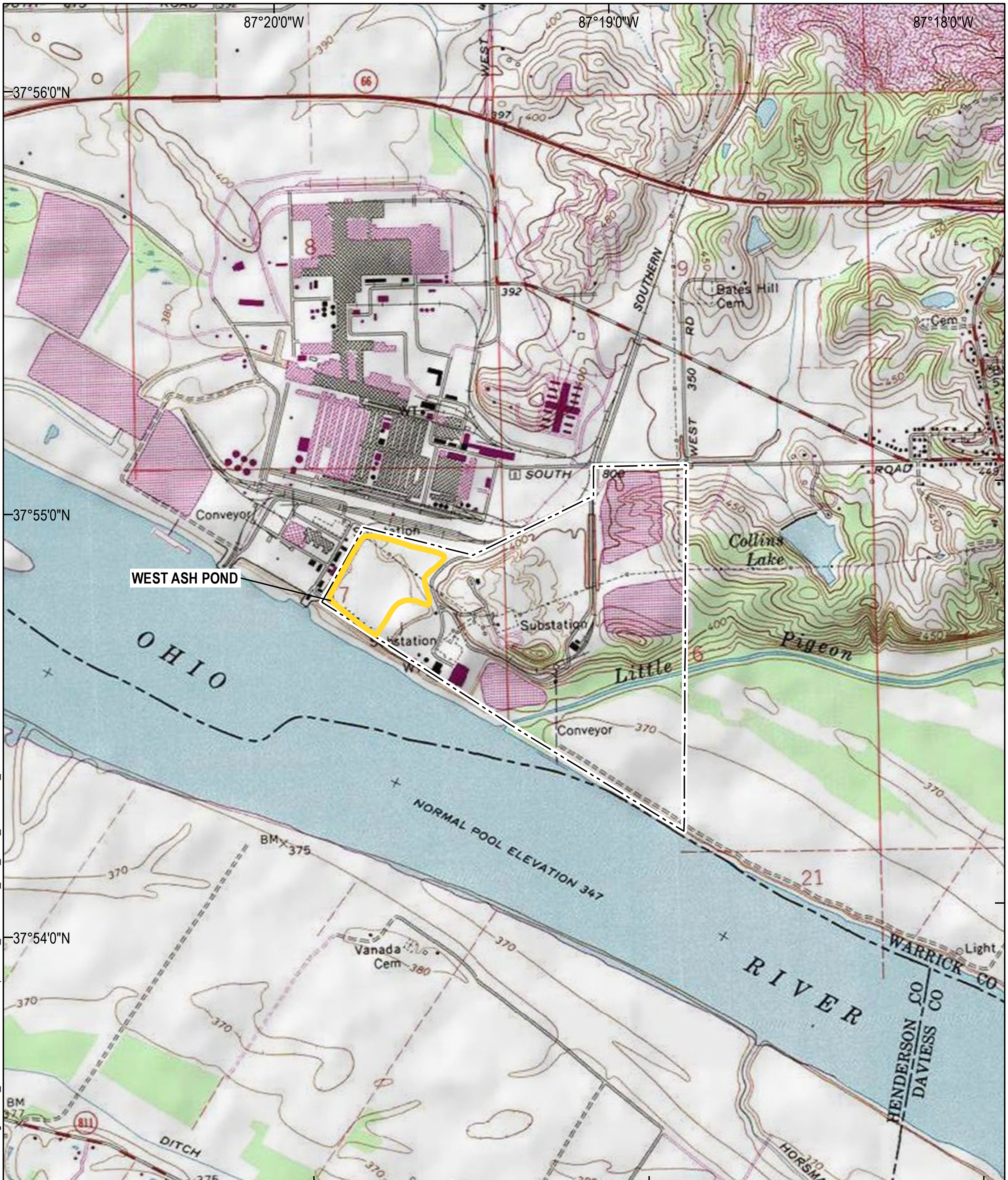
| Alternative Number | Remedial Alternative Description | THRESHOLD CRITERIA | | | | | BALANCING CRITERIA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Sub-Category 1 | | | | | | | | | Sub-Cat. 2 | | | Sub-Category 3 | | | | |
| | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 1 | 2 | | 1 | 2 | 3 | 4 | 5 |
| | | Be protective of human health and the environment | Attain the groundwater protective standard | Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment | Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems | Management of waste to comply with all applicable RCRA requirements | **CATEGORY 1** Long- and Short-Term Effectiveness, Protectiveness, and Certainty of Success that the remedy will prove successful | *Magnitude of reduction of existing risks* | *Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy* | *Type and degree of long-term management required including monitoring, operation and maintenance* | *Short-term risk to community or environment during implementation of remedy* | *Time until full protection is achieved* | *Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment* | *Long-term reliability of engineering and institutional controls* | *Potential need for replacement of the remedy* | **CATEGORY 2** Effectiveness in controlling the source to reduce further releases | *Extent to which containment practices will reduce further releases* | *Extent to which treatment technologies may be used* | **CATEGORY 3** The ease or difficulty of implementation | *Degree of difficulty associated with constructing the technology* | *Expected operational reliability of the technologies* | *Need to coordinate with and obtain necessary approvals and permits from other agencies* | *Availability of necessary equipment and specialists* | *Available capacity and location of needed treatment, storage, and disposal services* |
| 5 | Hybrid CIP with Hydraulic Containment and Ex-Situ Treatment with a Barrier Wall | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | |
| 6 | Closure by Removal (CBR) with MNA | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | |

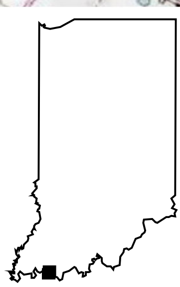
**COLOR LEGEND**

| | |
|---|---|
| | Most favorable when compared to other alternatives |
| | Less favorable when compared to other alternatives |
| | Least favorable when compared to other alternatives |

HALEY ALDRICH

**FIGURES**



MAP SOURCE: ESRI
SITE COORDINATES: 36°30'28"N, 89°33'37"W

HALEY ALDRICH

F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

SITE LOCATION MAP

APPROXIMATE SCALE: 1 IN = 2000 FT
FEBRUARY 2021

FIGURE 1-1


LEGEND

UPGRADIENT WELL

DOWNGRADIENT WELL

APPROXIMATE LIMITS OF WEST ASH POND FINAL COVER

APPROXIMATE LIMITS OF WEST ASH POND CCR REMOVAL

WEST ASH POND

APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. AERIAL IMAGERY SOURCE: GOOGLE 2018

HALEY ALDRICH

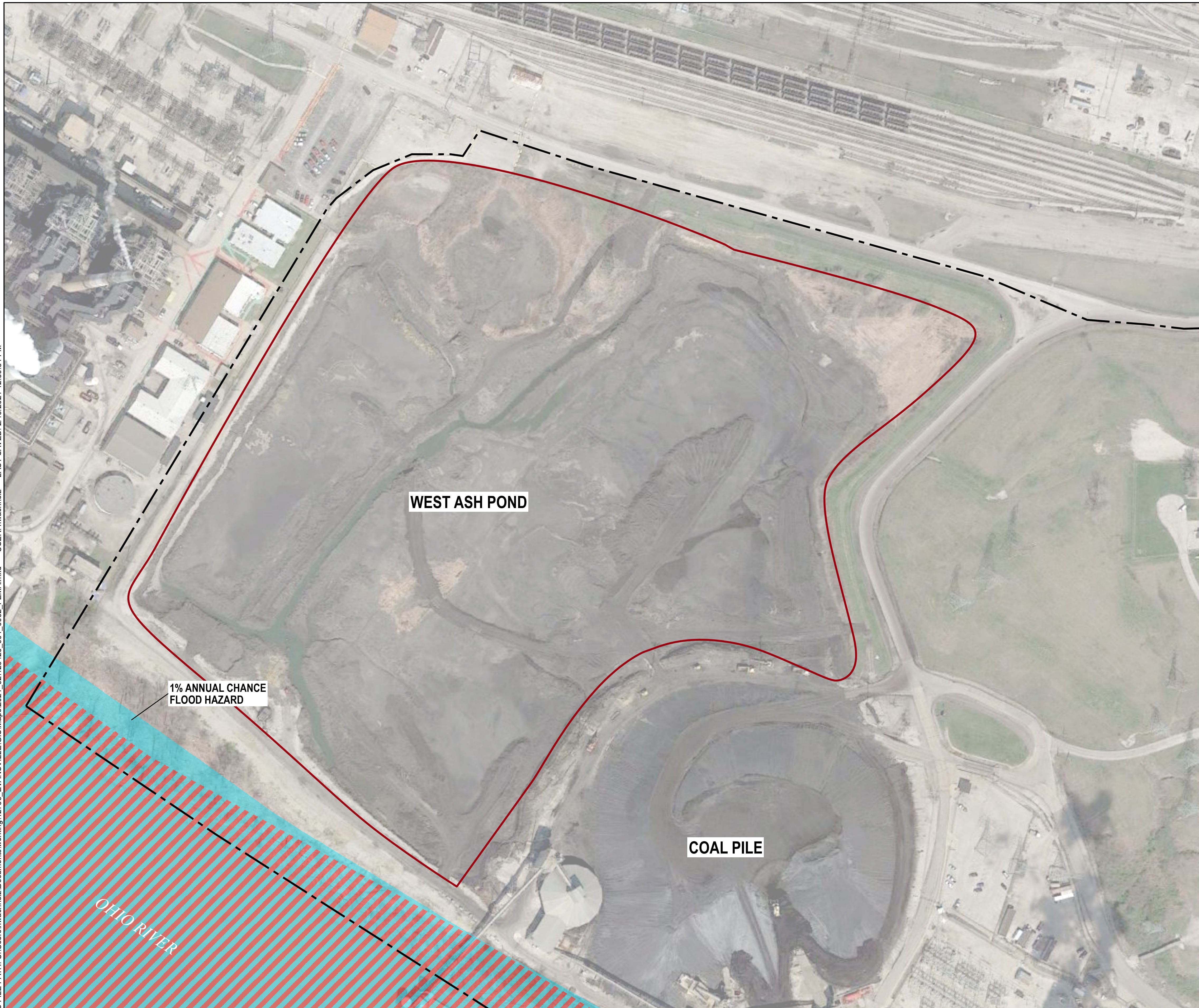
F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

MONITORING WELL LOCATIONS

FEBRUARY 2021

FIGURE 1-2

GIS FILE PATH: C:\Users\hwachholz\Documents\working\42796_EVANSVILLE\GISMaps\2021_02\129420_001_001-2_MONITORING_WELL_LOCATIONS.mxd — USER: hwachholz — LAST SAVED: 2/9/2021 10:42:47 AM




**LEGEND**

- CCR BOUNDARY
- F.B. CULLEY PROJECT BOUNDARY

FLOOD HAZARD ZONES

- 1% ANNUAL CHANCE FLOOD HAZARD
- REGULATORY FLOODWAY
- SPECIAL FLOODWAY
- AREA OF UNDETERMINED FLOOD HAZARD
- 0.2% ANNUAL CHANCE FLOOD HAZARD
- FUTURE CONDITIONS 1% ANNUAL CHANCE FLOOD HAZARD
- AREA WITH REDUCED RISK DUE TO LEVEE

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. FEMA FLOOD MAP SOURCE: FEDERAL EMERGENCY MANAGEMENT AGENCY
3. AERIAL IMAGERY SOURCE: GOOGLE 2018

HALEY ALDRICH

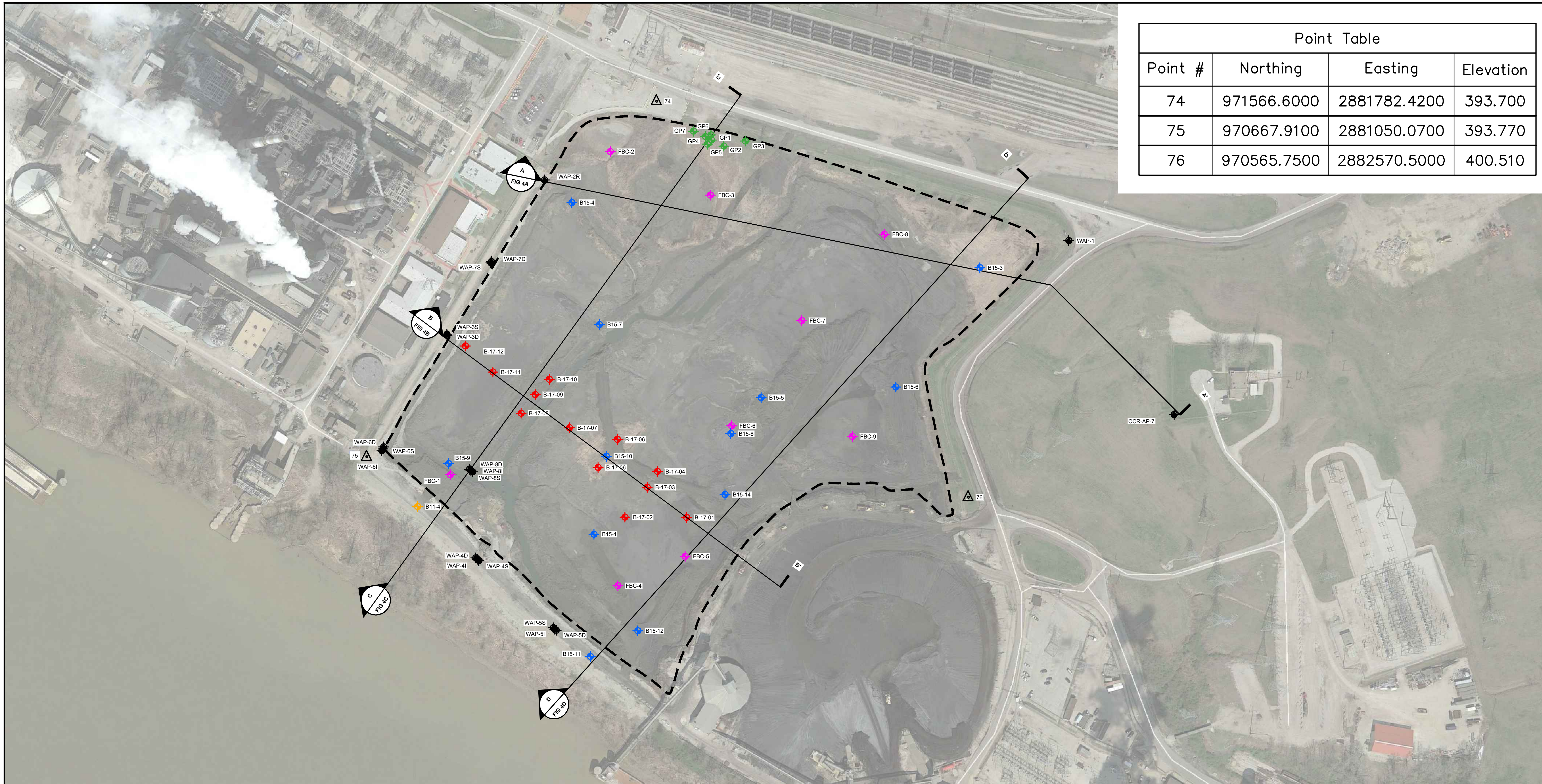
F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

FEMA FLOOD HAZARD AREAS

FEBRUARY 2021

FIGURE 2-1

GIS FILE PATH: C:\Users\hwachholz\Documents\working\42796_EVANSVILLE\GIS\Maps\2021_02\129420_001_0002_FEMA.mxd — USER: hwachholz — LAST SAVED: 2/15/2021 12:59:34 PM




| Point Table | | | |
|---|---|---|---|
| Point # | Northing | Easting | Elevation |
| 74 | 971566.6000 | 2881782.4200 | 393.700 |
| 75 | 970667.9100 | 2881050.0700 | 393.770 |
| 76 | 970565.7500 | 2882570.5000 | 400.510 |

**LEGEND**

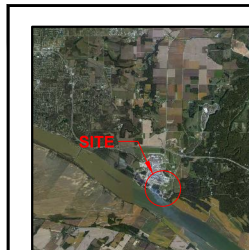
- APPROX. F.B. CULLEY PROJECT BOUNDARY
- CROSS-SECTION ID AND FIGURE NUMBER
- 2011 ATC SOIL BORINGS
- 2015 CARDNO ATC SOIL BORINGS
- 2015 AECOM BORINGS
- 2017 AECOM BORINGS
- 2019 AECOM BORINGS
- MONITORING WELLS
- SURVEY BENCHMARK (AS REPORTED BY THREE I DESIGN ON SITE PLAN REV 8/08/16)

**NOTES**

1. AERIAL IMAGERY SOURCE: GOOGLE EARTH PRO MARCH 2016

N

0 250 500
SCALE IN FEET




PROJECT LOCATION
AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

HALEY ALDRICH

PREPARED FOR:
SIGECO

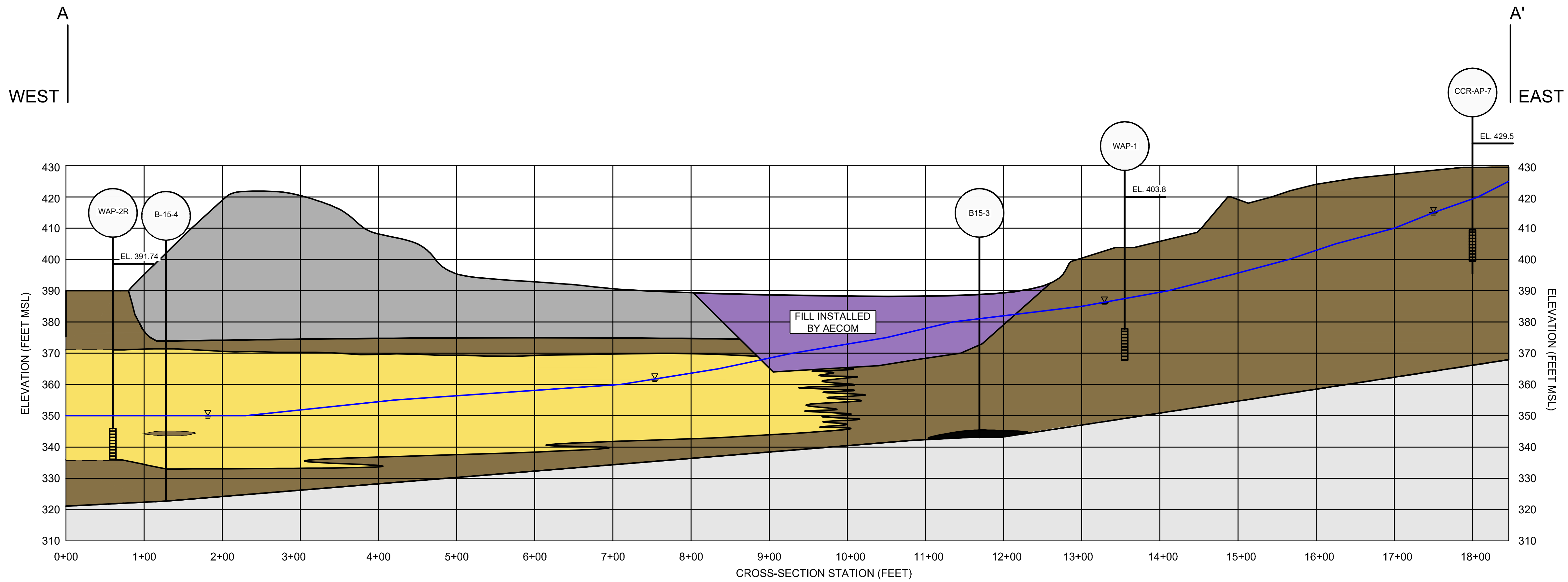
F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

FIGURE 2-2

**CROSS-SECTION MAP**
**WEST ASH POND**

| PROJECT: 129420 | BY: RY | REVISIONS: |
|---|---|---|
| DATE: FEB 2021 | CHECKED: NK | |

HALEY & ALDRICH




**F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION A-A'**

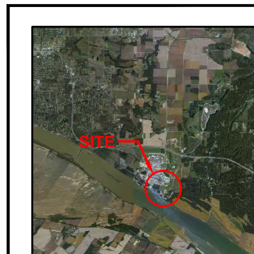
HORIZ. 0 160 320
VERT. 0 40 80
SCALE IN FEET

**LEGEND**

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

**NOTES:**

1. GROUNDWATER ELEVATIONS PROVIDED BY HALEY & ALDRICH DATED NOVEMBER 2020.
2. SUBGRADE AND EXCAVATION GRADES PROVIDED BY AECOM, "SUBRADE PLAN" (SHEET C-400 REV1) AND "CCR MATERIAL EXCAVATION PLAN" (SHEET C-300A) OF "HYBRID CLOSURE OF WEST ASH POND - F.B. CULLEY GENERATING STATION" SET, DATED AUGUST 4, 2020.




**PROJECT LOCATION**

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

HALEY ALDRICH

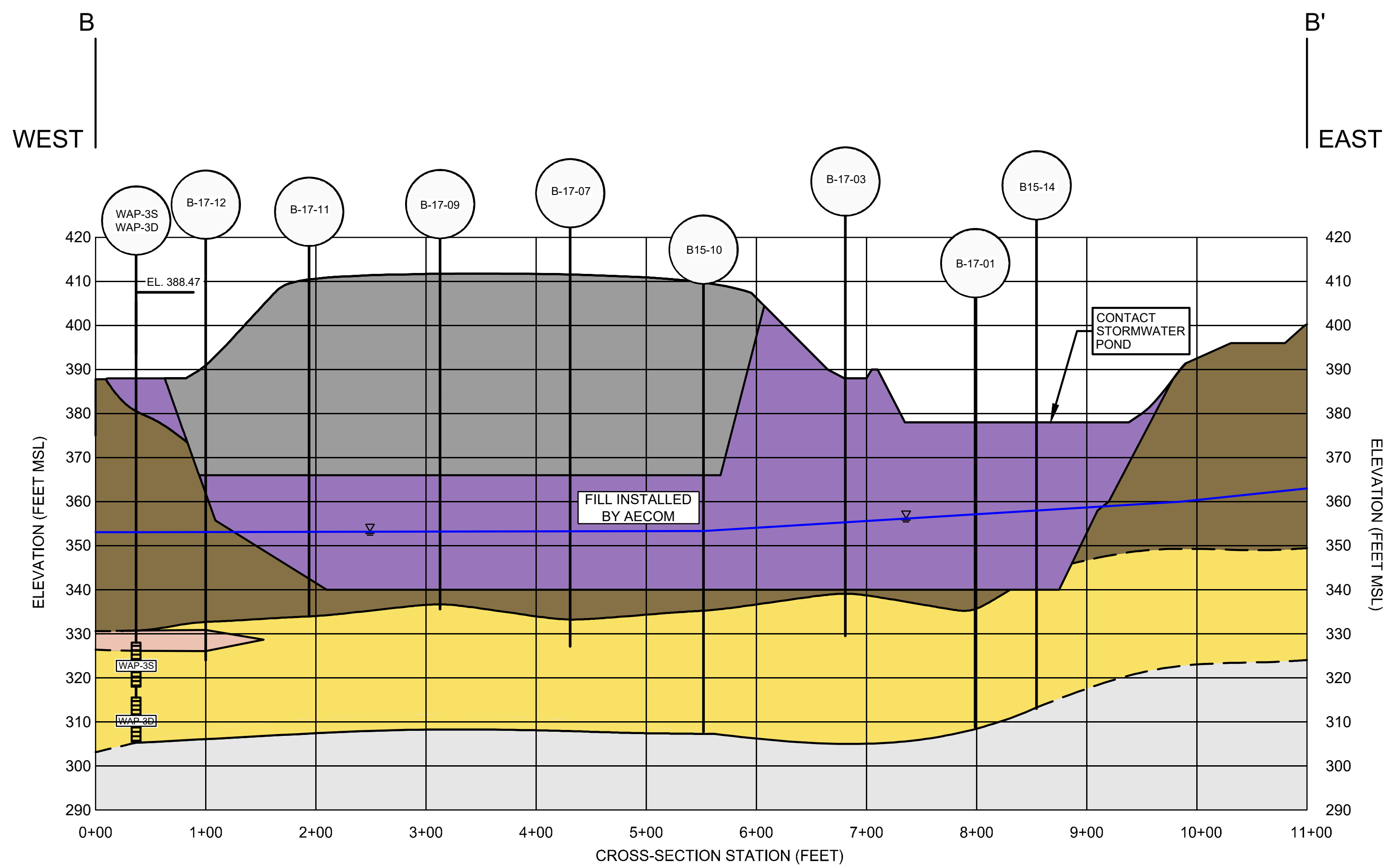
PREPARED FOR:
SIGECO

**F.B. CULLEY GENERATING STATION**
**WEST ASH POND**
**NEWBURGH, INDIANA**

FIGURE 2-3
**POST CLOSURE**
**CROSS SECTION A-A'**
**WEST ASH POND**

| | | |
|---|---|---|
| PROJECT: 129420 | BY: RY | REVISIONS: |
| DATE: FEB 2021 | CHECKED: NK | |

**HALEY & ALDRICH**




**F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION B-B'**

HORIZ. 0 160 320

VERT. 0 40 80

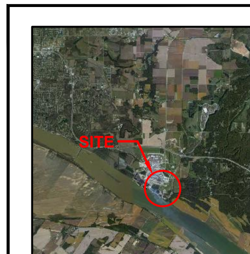
SCALE IN FEET

**LEGEND**

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

**NOTES:**

1. GROUNDWATER ELEVATIONS PROVIDED BY HALEY & ALDRICH DATED NOVEMBER 2020.
2. SUBGRADE AND EXCAVATION GRADES PROVIDED BY AECOM, "SUBRADE PLAN" (SHEET C-400 REV1) AND "CCR MATERIAL EXCAVATION PLAN" (SHEET C-300A) OF "HYBRID CLOSURE OF WEST ASH POND - F.B. CULLEY GENERATING STATION" SET, DATED AUGUST 4, 2020.




**PROJECT LOCATION**

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

**PREPARED FOR:**

**SIGECO**

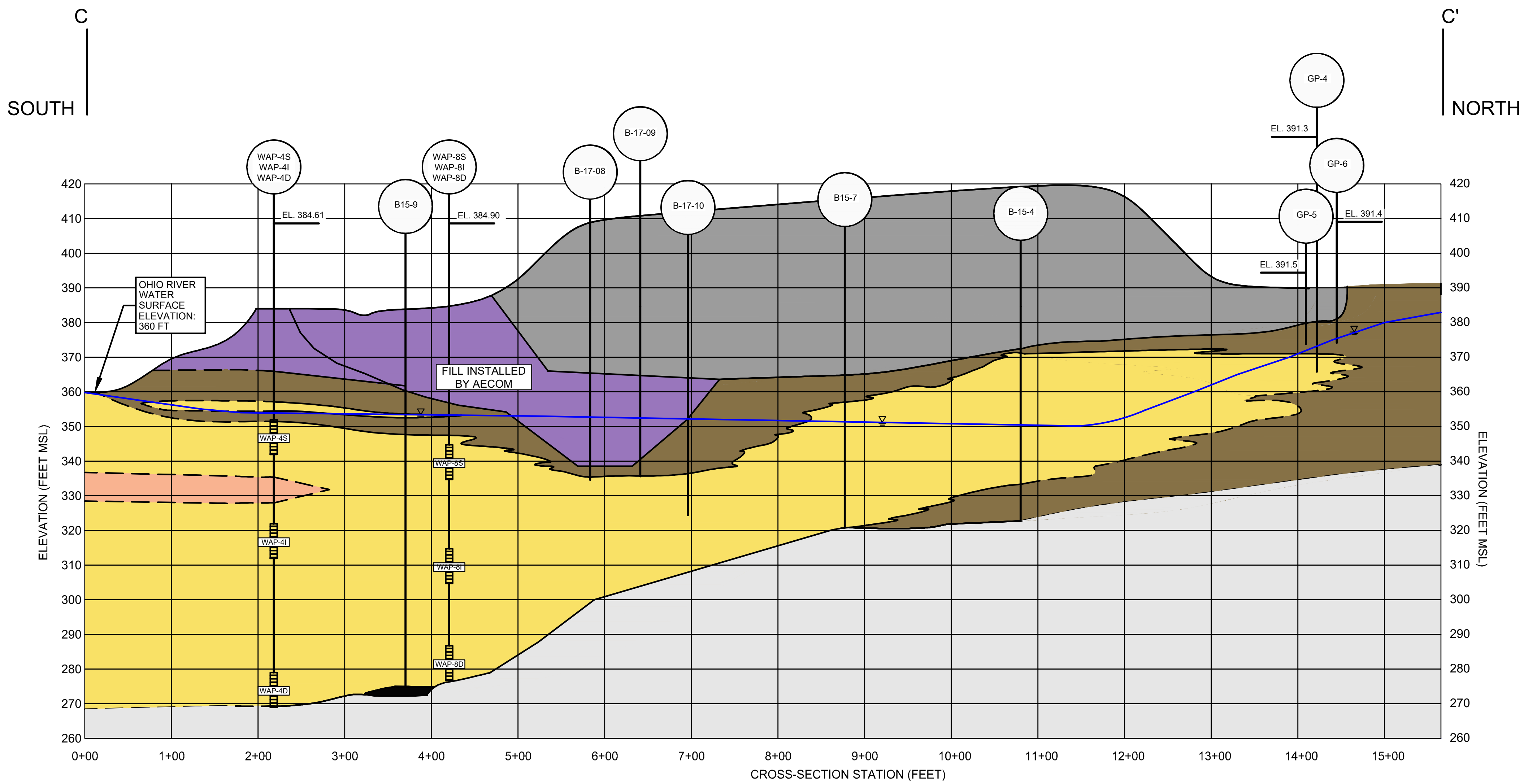
**F.B. CULLEY GENERATING STATION**
**WEST ASH POND**
**NEWBURGH, INDIANA**

FIGURE 2-4

**POST CLOSURE**
**CROSS SECTION B-B'**
**WEST ASH POND**

| | | |
|---|---|---|
| PROJECT: 129420 | BY: GW | REVISIONS: |
| DATE: FEB 2021 | CHECKED: NK | |

**HALEY & ALDRICH**




**F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION C-C'**

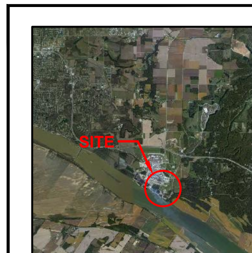
HORIZ. 0 160 320
VERT. 0 40 80
SCALE IN FEET

**LEGEND**

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

**NOTES:**

1. GROUNDWATER ELEVATIONS PROVIDED BY HALEY & ALDRICH DATED NOVEMBER 2020.
2. SUBGRADE AND EXCAVATION GRADES PROVIDED BY AECOM, "SUBRADE PLAN" (SHEET C-400 REV1) AND "CCR MATERIAL EXCAVATION PLAN" (SHEET C-300A) OF "HYBRID CLOSURE OF WEST ASH POND - F.B. CULLEY GENERATING STATION" SET, DATED AUGUST 4, 2020.




**PROJECT LOCATION**
AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

HALEY ALDRICH

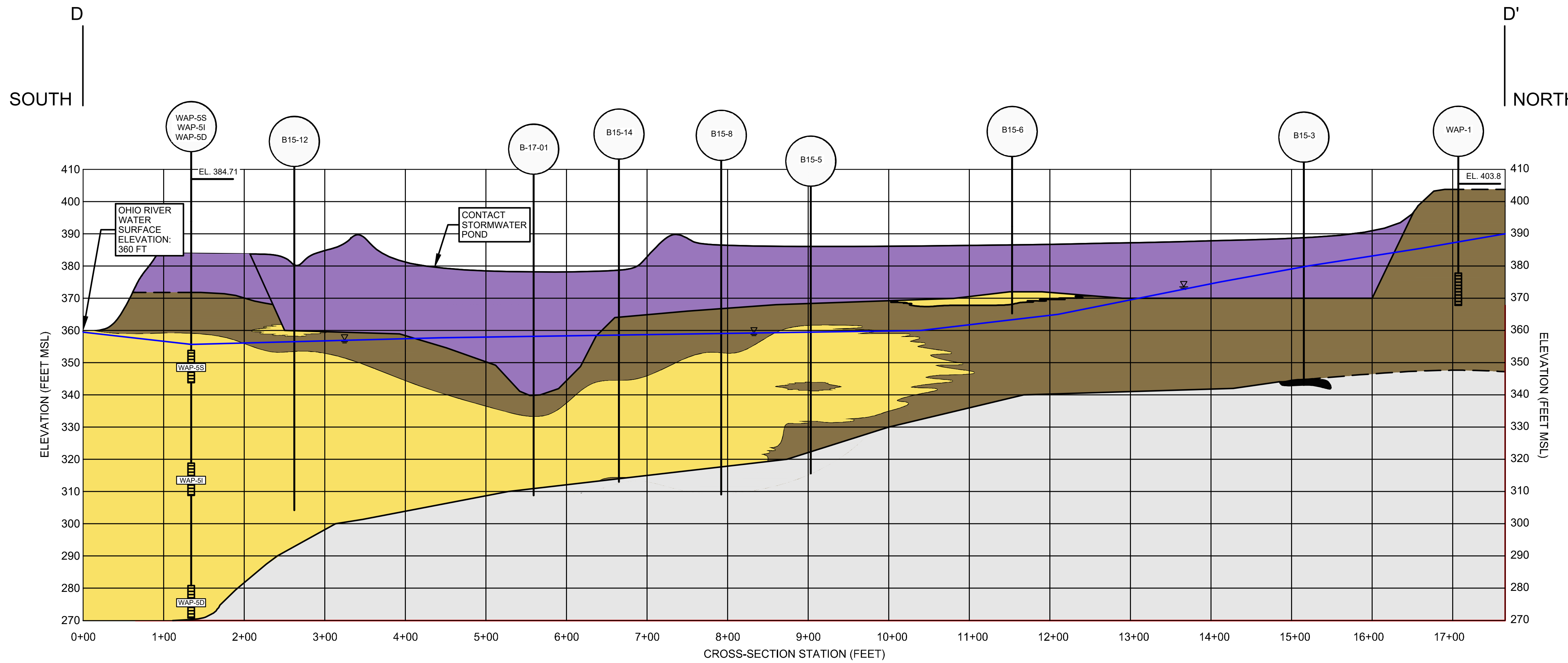
PREPARED FOR:
SIGECO

**F.B. CULLEY GENERATING STATION**
**WEST ASH POND**
**NEWBURGH, INDIANA**

FIGURE 2-5
**POST CLOSURE**
**CROSS SECTION C-C'**
**WEST ASH POND**

| | | |
|---|---|---|
| PROJECT: 129420 | BY: RY | REVISIONS: |
| DATE: FEB 2021 | CHECKED: NK | |

**HALEY & ALDRICH**




**F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION D-D'**

HORIZ. 0 160 320

VERT. 0 40 80

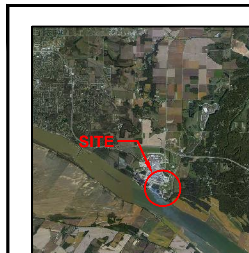
SCALE IN FEET

**LEGEND**

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

**NOTES:**

1. GROUNDWATER ELEVATIONS PROVIDED BY HALEY & ALDRICH DATED NOVEMBER 2020.
2. SUBGRADE AND EXCAVATION GRADES PROVIDED BY AECOM, "SUBRADE PLAN" (SHEET C-400 REV1) AND "CCR MATERIAL EXCAVATION PLAN" (SHEET C-300A) OF "HYBRID CLOSURE OF WEST ASH POND - F.B. CULLEY GENERATING STATION" SET, DATED AUGUST 4, 2020.




**PROJECT LOCATION**

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

**PREPARED FOR:**

**SIGECO**

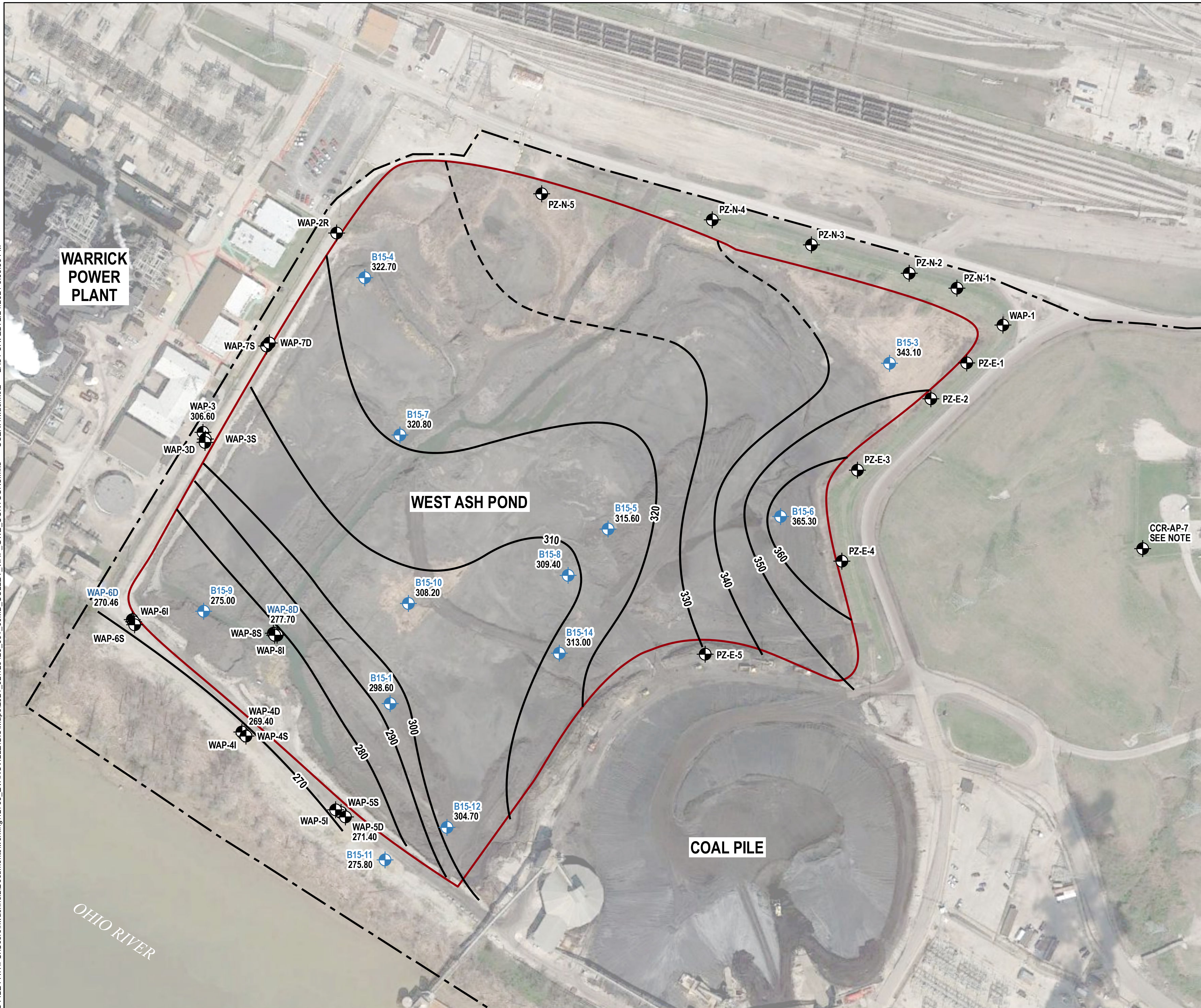
**F.B. CULLEY GENERATING STATION**
**WEST ASH POND**
**NEWBURGH, INDIANA**

FIGURE 2-6

**POST CLOSURE**
**CROSS SECTION D-D'**
**WEST ASH POND**

| | | |
|---|---|---|
| PROJECT: 129420 | BY: RY | REVISIONS: |
| DATE: FEB 2021 | CHECKED: NK | |

**HALEY & ALDRICH**




**LEGEND**

- MONITORING WELL WITH DESIGNATION AND TOP OF BEDROCK ELEVATION
- 2015 AECOM BORING WITH DESIGNATION AND TOP OF BEDROCK ELEVATION
- TOP OF BEDROCK CONTOUR, IN FEET
- INFERRED TOP OF BEDROCK CONTOUR
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

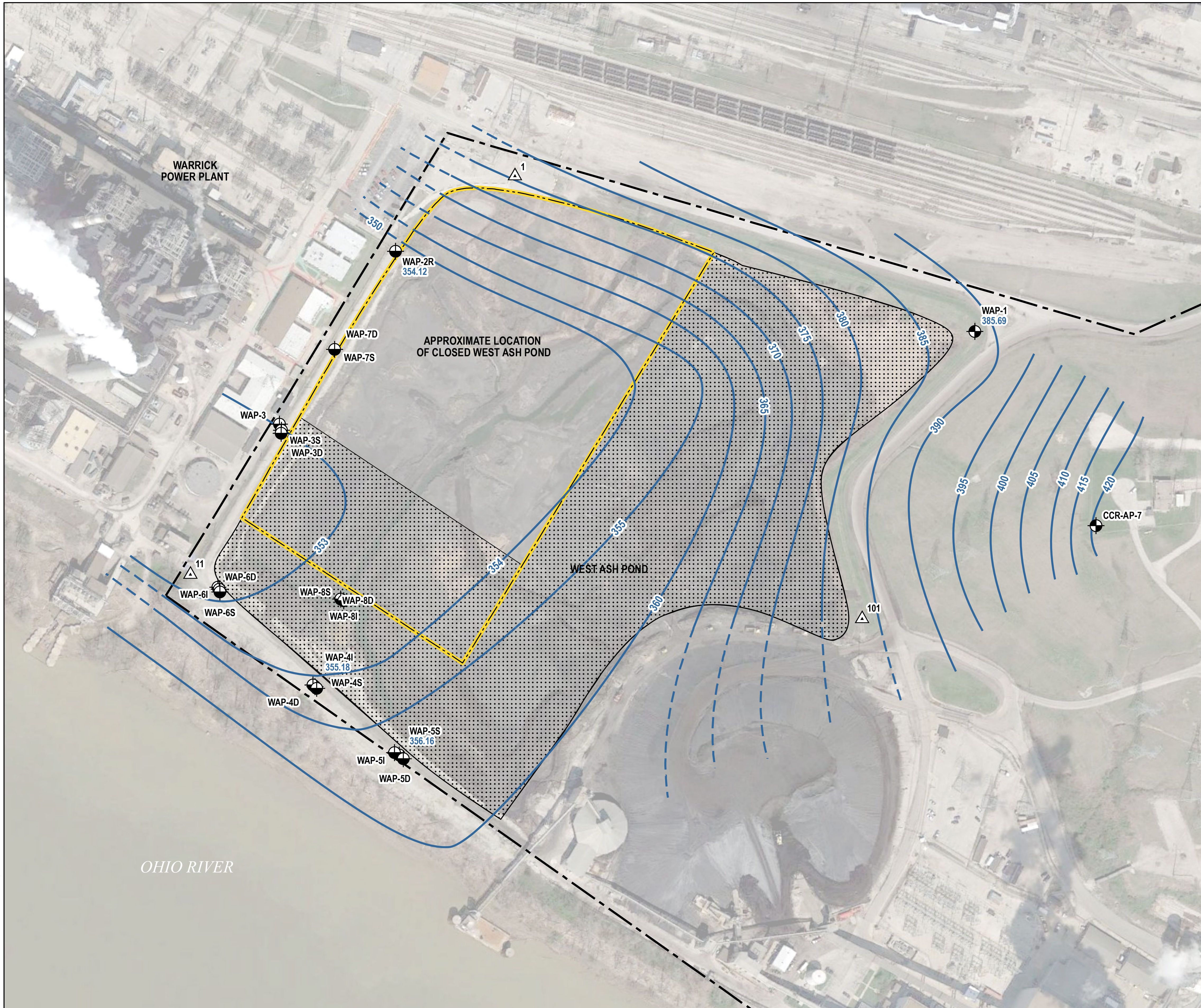
F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

TOP OF BEDROCK CONTOURS

FEBRUARY 2021

FIGURE 2-7

GIS FILE PATH: C:\Users\hwachholz\Documents\working\42796_EVANSVILLE\GIS\Maps\2021_021129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: hwachholz — LAST SAVED: 2/24/2021 3:09:56 PM




**LEGEND**

- UPGRADIENT WELL
- DOWNGRADIENT WELL
- GROUNDWATER ELEVATION CONTOUR, IN
- INFERRED GROUNDWATER ELEVATION CONTOUR, IN FEET
- APPROXIMATE LIMITS OF WEST ASH POND FINAL COVER
- APPROXIMATE LIMITS OF WEST ASH POND CCR REMOVAL
- WEST ASH POND
- APPROXIMATE F.B. CULLEY PROJECT
- SURVEY BENCHMARK (AS REPORTED BY THREE i DESIGN ON SITE PLAN REV 8/08/16)

| POINT | NORTHING | EASTING | ELEVATION (FT) |
|---|---|---|---|
| 1 | 97566.60 | 2881782.42 | 393.70 |
| 11 | 970667.91 | 2881050.07 | 393.77 |
| 101 | 970565.75 | 2882570.50 | 400.51 |

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. OHIO RIVER BASE FLOW ELEVATION: ~360 FT
3. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 230 460

SCALE IN FEET

HALEY ALDRICH

F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

WATER TABLE CONFIGURATION MAP - 23 NOVEMBER 2020

FEBRUARY 2021

FIGURE 2-8

GIS FILE PATH: C:\Users\hwachholz\Documents\working\42796_EVANSVILLE\GISMaps\2021_02\129420_001_002-8_SITE_WATER_TABLE_CONFIGURATION_NOVEMBER_2020.mxd — USER: hwachholz — LAST SAVED: 2/24/2021 2:39:12 PM


**LEGEND**

- UPGRADIENT WELL
- DOWNGRADIENT WELL
- MONITORING WELL WITH CONCENTRATION ABOVE THE GWPS
- APPROXIMATE LIMITS OF WEST ASH POND FINAL COVER
- APPROXIMATE LIMITS OF WEST ASH POND CCR REMOVAL
- WEST ASH POND
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. GWPS = GROUNDWATER PROTECTION STANDARD
3. ABREVIATIONS:
Li = LITHIUM
Mo = MOLYBDENUM
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

HALEY ALDRICH

F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

MONITORING WELL LOCATIONS
WITH STATISTICALLY SIGNIFICANT
LEVELS ABOVE GWPS

FEBRUARY 2021

FIGURE 2-9

GIS FILE PATH: C:\Users\hwachholz\Documents\working\42796_EVANSVILLE\GIS\Maps\2021_02\129420_001_002-1_MONITORING_WELL_LOCATIONS_ABOVE_GWPS.mxd — USER: hwachholz — LAST SAVED: 2/10/2021 4:16:01 PM

**FIGURE 4-1**
**REMEDIAL ALTERNATIVES ROADMAP**
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

<table>
<tr><th rowspan="2">Alternative Number</th><th rowspan="2">Remedial Alternative Description</th><th rowspan="2">Ash Pond Closure Description</th><th colspan="3">Groundwater Remedy Components</th></tr>
<tr><th>A. Groundwater Remedy Approach</th><th>B. Groundwater Treatment Method</th><th>C. Post-Closure Actions</th></tr>
<tr><td>1</td><td>Hybrid Closure in Place (CIP) with Monitored Natural Attenuation (MNA) and Remediation Performance Monitoring</td><td rowspan="5">Hybrid Closure in Place through Partial Removal and Consolidation with a Cap</td><td>Monitored Natural Attenuation with Performance Monitoring<br>Mitigate groundwater with CCR constituents above GWPS through processes of natural attenuation following source depletion achieved through partial removal and capping</td><td rowspan="3">No Active Treatment<br>No active treatment technologies for groundwater to address CCR constituents</td><td>Performance Monitoring<br>Long-term groundwater monitoring to confirm reduction of CCR constituents</td></tr>
<tr><td>2</td><td>Hybrid CIP with Hydraulic Containment and No Treatment</td><td>Groundwater Pumping with Direct Discharge<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS using groundwater extraction</td><td rowspan="2">Pump Long-Term<br>Continue to operate hydraulic containment system to maintain reduction of CCR constituents in groundwater</td></tr>
<tr><td>3</td><td>Hybrid CIP with Hydraulic Containment and No Treatment with a Barrier Wall</td><td>Groundwater Pumping with Direct Discharge<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS using groundwater extraction, potentially install a barrier wall to improve pumping efficiency.</td></tr>
<tr><td>4</td><td>Hybrid CIP with Hydraulic Containment and Ex-Situ Treatment</td><td>Groundwater Pumping with Treatment<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS using groundwater extraction and ex-situ treatment</td><td rowspan="2">Ex-Situ Treatment<br>Treatment system to remove CCR constituents from groundwater and discharge under applicable permits</td><td rowspan="2">Pump & Treat Long-Term<br>Continue to operate hydraulic containment system to maintain reduction of CCR constituents in groundwater</td></tr>
<tr><td>5</td><td>Hybrid CIP with Hydraulic Containment and Ex-Situ Treatment with a Barrier Wall</td><td>Groundwater Pumping with Treatment<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS using groundwater extraction and ex-situ treatment, potentially install a barrier wall to improve pumping efficiency</td></tr>
<tr><td>6</td><td>Closure By Removal (CBR) with MNA</td><td>CBR</td><td>Monitored Natural Attenuation with Performance Monitoring<br>Mitigate groundwater with CCR constituents above GWPS through processes of natural attenuation following source depletion achieved through removal</td><td>No Active Treatment<br>No active treatment technologies for groundwater to address CCR constituents</td><td>Performance Monitoring<br>Long-term groundwater monitoring to confirm reduction of CCR constituents</td></tr>
</table>

# APPENDIX A

Groundwater Risk Evaluation

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**REPORT ON**

# GROUNDWATER RISK EVALUATION F.B. CULLEY GENERATING STATION WEST ASH POND NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-025
February 2021

## Table of Contents

## List of Tables



## List of Figures

## List of Abbreviations and Acronyms

| Abbreviation | Definition |
|---|---|
| CCR | Coal Combustion Residual |
| CiP | Closed-in-Place |
| CSM | Conceptual Site Model |
| EAP | East Ash Pond |
| ELCR | Excess Lifetime Cancer Risk |
| FBC | F.B. Culley Generating Station |
| GWPS | Groundwater Protection Standards |
| Haley & Aldrich | Haley & Aldrich, Inc. |
| HI | Hazard Index |
| IDEM | Indiana Department of Environmental Management |
| IDNR | Indiana Department of Natural Resources |
| IWPCD | Indiana Water Pollution Control Division |
| MCL | Maximum Contaminant Level |
| mg/L | Milligram per Liter |
| ORSANCO | Ohio River Valley Water Sanitation Commission |
| pCi/L | pico-Curies per Liter |
| RBSL | Risk-Based Screening Level |
| RSL | Regional Screening Level |
| SIGECO | Southern Indiana Gas and Electric Company |
| SSI | Statistically Significant Increase |
| SSL | Statistically Significant Level |
| ug/L | Microgram per Liter |
| USEPA | United States Environmental Protection Agency |
| WAP | West Ash Pond |

# 1. Introduction

The F.B. Culley Generating Station (FBC) is a coal-fired power plant (the Site) located on the Ohio River in Warrick County, Indiana. The facility is located adjacent to the northern bank of the Ohio River and Little Pigeon Creek approximately three miles east of the town of Newburgh, Indiana. The facility has been in operation since 1953, and coal combustion residuals (CCR) are currently managed on the Site in a 10-acre impoundment known as the East Ash Pond (EAP), commissioned around 1971. The West Ash Pond (WAP) is an approximately 32-acre inactive impoundment located to the west of the EAP and coal storage pile. The WAP was commissioned in the mid-1960s with an earthen berm constructed along the southern and western boundaries. It was used to store the various residuals from plant operations, plant storm water, and direct precipitation. In 1999, fly ash generated on the Site was stored in a silo and shipped to an offsite cement kiln. The WAP also received fly ash from a neighboring industrial site until 2007 when the CCR input was stopped. Some process residuals contained in the WAP were removed in 2008. This Risk Assessment has been developed for the WAP. Southern Indiana Gas and Electric Company (SIGECO) currently owns the land and operates the station for supplying electric power to industrial, commercial, and residential customers in its service territory. Figure 1 shows the location of the facility, and the location of the WAP.

As shown in Figure 1, and as described in the Closure Plan, which was approved by IDEM in an Approval Letter dated December 19, 2019, CCR material in the southern and eastern portions of the WAP has been excavated. The excavated material has been dewatered and consolidated with the material present above the water table in the western portion of the existing pond footprint and closed-in-place (CiP). The CCR material in the CiP area has been capped by the final CiP cover system. The designated CiP area will effectively reduce the existing CCR footprint from 32 acres to 15 acres.

The U.S. Environmental Protection Agency (USEPA) issued a final rule for "Disposal of Coal Combustion Residuals from Electric Utilities" in 2015 (the CCR Rule) (USEPA, 2015). One of the requirements in the CCR Rule is that utilities monitor groundwater at coal ash management facilities, and that the data be reported publicly. SIGECO is complying with the CCR Rule and has posted the required information on their publicly-available website: *https://www.vectren.com/reporting/ccr*. The WAP was inactive when the CCR Rule was promulgated and was scheduled to be closed by October 18, 2018 and, therefore, it was not considered to be subject to the compliance and schedule requirements in the CCR Rule. However, due to subsequent CCR Rule changes, the WAP must meet the requirements of the CCR Rule. The CCR Rule changes extend the deadlines for inactive ash management areas to comply with the groundwater monitoring requirements.

This "Groundwater Risk Evaluation" report has been prepared by Haley & Aldrich, Inc. (Haley & Aldrich), and is a companion document to the "Corrective Measures Assessment for the F.B. Culley Generating Station – West Ash Pond, Newburgh, Indiana." The purpose of this risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for the FBC WAP under the CCR Rule.

Beyond the specific monitoring requirements of the CCR Rule, SIGECO has also voluntarily taken the additional step to evaluate potential groundwater-to-surface water transport and exposure pathways through the development of risk-based groundwater screening levels that are protective of surface water in the Ohio River. Details about the evaluation are provided below.

# 2. Approach

The analysis presented in this report was conducted by evaluating the environmental setting of the FBC, including its location and where ash management has occurred at the facility. Information on where groundwater is located at the facility, the rate(s) of groundwater flow, the direction(s) of groundwater flow, and where waterbodies may intercept groundwater flow are reviewed and summarized here.

A conceptual model was developed based on this physical setting information, and the model was used to identify what human populations could contact groundwater and/or surface water in the area of the facility. This information was also used to identify where ecological populations could come into contact with surface water.

Human health risk assessment is a process used to estimate the chance that contact with constituents in the environment may result in harm to people. Generally, there are four components to the process (USEPA, 1989): (1) Hazard Identification/Data Evaluation, (2) Toxicity Assessment, (3) Exposure Assessment, and (4) Risk Characterization.

The USEPA and other regulatory agencies, including the Indiana Department of Environmental Management (IDEM), develop "screening levels" of constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures. In developing screening levels, USEPA uses a specific target risk level (component 4) combined with an assumed exposure scenario (component 3) and toxicity information from USEPA (component 2) to derive an estimate of a concentration of a constituent in an environmental medium, for example groundwater, (component 1) that is protective of a person in that exposure scenario (for example, drinking water). Similarly, ecological screening levels for surface water are developed by USEPA and IDEM to be protective of the wide range of potential aquatic ecological resources, or receptors.

Risk-based screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists but indicate that further evaluation may be warranted.

Human health risk-based and ecological risk-based screening levels drawn from USEPA and IDEM sources are used to determine if the concentration levels of constituents in groundwater could pose a risk to human health or the environment that warrants further evaluation.

## 2.1 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is used to evaluate the potential for human or ecological exposure to constituents that may have been released to the environment. Some of the questions posed during the CSM evaluation include:

> What is the source? How can constituents be released from the source? What environmental media may be affected by constituent release? How and where do constituents travel within a

medium? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? Are the constituent concentrations high enough to potentially exert a toxic effect?

For the evaluation of the ash management operations at the FBC WAP, the coal ash stored in the WAP is the potential source. Constituents present in the coal ash can be dissolved into infiltrating water (either from precipitation or from groundwater intrusion prior to closure) that flows to groundwater, and those constituents may then be present in shallow groundwater. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction.

Groundwater flow in the vicinity of the WAP is to the southwest toward the Ohio River with a component of flow to the west towards the production wells located adjacent to the Ohio River on the south side of the Warrick Power Plant. While the water levels vary in response to the Ohio River stages the interpreted groundwater flow directions do not change. Figure 1 shows the facility location and layout and identifies the Ohio River. The facility is bounded by the Warrick Power Plant to the west, the Alcoa Warrick Operations facility to the north, and by the F.B. Culley Generating Station to the east.

The Indiana Department of Natural Resources (IDNR) Division of Water Well Records database lists 28 wells within a half-mile radius of the facility. Of these, 18 are located upgradient (north or east) of the WAP (see Figure 2), meaning that groundwater does not flow from the WAP toward those wells (IN.gov, 2020a). There are nine wells located to the west of the WAP at the Warrick Power Plant, including six production wells (Significant Withdrawal Well 00445 on Figure 2). The production wells at the Warrick Power Plant are used for process water but are permitted for potable purposes (IDEM regulated Public Water Supply System Number IN2870801). It is currently unknown if workers at the Warrick Power Plant facility use water from the facility for drinking water, however, use of groundwater as drinking water and for showering by workers at the Warrick Power Plant facility is evaluated as a potentially complete exposure pathway in this evaluation. The remaining well is located on FBC facility property within the WAP footprint. According to SIGECO personnel familiar with the WAP, this well does not exist.

There are three additional water wells on facility property that are used to supply water to the FBC. These wells are located cross-gradient and east of the WAP (Significant Withdrawal Well 02346 on Figure 2) and, therefore, would not be impacted by groundwater from the WAP (i.e., users of the water from the wells would not have complete exposure pathways to groundwater potentially affected by the WAP). These wells are used for grey water (handwashing and other non-drinking uses) at the facility and bottled water is provided for drinking water.

The Ohio River is a supply source for drinking water and the nearest public water supply intake is located approximately 18.4 miles downstream near the City of Evansville, Indiana. The Ohio River can be used for human recreation – wading, swimming, boating, fishing. The river serves as habitat for aquatic species – fish, amphibians, etc.

Thus, the environmental media of interest for this evaluation are:

- Groundwater at the facility; and
- Ohio River surface water.

A depiction of the conceptual site model is shown in Figure 3. The potentially complete exposure pathways identified in the figure are those evaluated here:

- Off-Site Worker (Direct contact with groundwater during use of the water as potable water and for showering);
- Recreational User (Recreational use of the Ohio River for swimming, wading, boating, and fishing activities);
- Ecological Receptors (Ohio River); and
- Off-Site Resident (Direct contact with surface water used as drinking water).

The potentially complete exposure pathways are evaluated using groundwater analytical data for on-site monitoring wells associated with the WAP. Figure 1 shows the locations of the upgradient and downgradient groundwater monitoring wells.

Groundwater downgradient of the WAP in the area between the WAP and the river is greater than 20 feet below ground surface, therefore, contact with groundwater in a trench during a construction/excavation event is considered unlikely to occur and is not evaluated further.

Based on this conceptual site model and the facility setting, samples collected from groundwater monitoring wells have been included in the evaluation. The samples have been analyzed for constituents that are commonly associated with CCR, as discussed below. However, it is recognized by the USEPA that all of these constituents can also be naturally occurring and can be found in rocks, soils, water and sediments; thus, it is necessary to understand what the naturally occurring background levels are for these constituents. The CCR Rule requires sampling and analysis of upgradient and/or background groundwater just for this reason. The sampling is detailed in the next section.

To answer the question, "Are the constituent concentrations high enough to potentially exert a toxic effect?" health risk-based screening levels from USEPA and IDEM sources are used for comparison to the data, as described in Section 5.

# 3. Sample Collection and Analysis

## 3.1 GROUNDWATER SAMPLES

The CCR Rule requires that groundwater monitoring occur at a minimum of one upgradient location and three downgradient locations. For the WAP evaluation, four groundwater monitoring wells were initially installed around the perimeter of the WAP to assess groundwater conditions in the uppermost aquifer at the ash management area, and two monitoring wells were installed northeast and southeast of the WAP to assess background groundwater conditions. Figure 1 shows the locations of the monitoring wells. Each well is identified by a unique name. WAP-2R, WAP-3, WAP-4 and WAP-5 are located around the perimeter of the WAP, and WAP-1 and CCR-AP-7 are the two background wells that are used to identify upgradient/background conditions in groundwater.

In October 2020, one additional downgradient monitoring well cluster (WAP-6S, WAP-6I, and WAP-6D) was installed along the southwestern perimeter of the WAP near the off-site production wells. These wells are used for evaluation of nature and extent of constituents in groundwater.

## 3.2 SAMPLE ANALYSIS

The CCR Rule identifies the constituents that are included for groundwater testing; these are:

| Appendix III | Appendix IV | |
|---|---|---|
| Boron | Antimony | Lead |
| Calcium | Arsenic | Lithium |
| Chloride | Barium | Mercury |
| pH | Beryllium | Molybdenum |
| Sulfate | Cadmium | Selenium |
| TDS | Chromium | Thallium |
| Fluoride | Cobalt | Radium 226/228 |
| | Fluoride | |

The CCR Rule requires eight rounds of groundwater sampling and analysis be conducted for all wells to provide a baseline for current conditions. Under the CCR Rule, further rounds are defined as "Detection" sampling. At this facility, nine rounds of groundwater samples were collected through April 2019 and were analyzed for all constituents. Assessment Monitoring samples collected in October 2019 and March 2020 were analyzed for Appendix III and Appendix IV constituents (Appendix IV constituents under the CCR Rule are shown in the last two columns above – the remaining are referred to as Appendix III constituents). Section 1.3 of the "Corrective Measures Assessment" report provides more detail on the objectives of the rounds of groundwater sampling. Appendix III and IV analytical results for the baseline and Assessment Monitoring events are summarized in Table 1.

# 4. Risk-Based Screening Levels

A comprehensive set of risk-based screening levels have been compiled for this evaluation for the three types of potential exposures identified in the conceptual site model discussion above:

- Human health drinking water consumption;
- Human health recreational use of surface water; and
- Aquatic ecological receptors for surface water.

It is important to note that the CCR Rule requires that the downgradient monitoring wells be located at the edge of the ash management area. Moreover, the CCR Rule limits the evaluation of groundwater monitoring data from ash management areas to groundwater protection standards (GWPS), which are protective for use of the groundwater as drinking water, regardless of whether or not that groundwater is used as a source of drinking water. GWPS used to evaluate potential drinking water exposures for CCR monitoring wells are shown on Table 1.

## 4.1 GROUNDWATER PROTECTION STANDARDS

The GWPS is defined in the CCR Rule at §257.95 Assessment monitoring program:

> (h) The owner or operator of the CCR unit must establish a groundwater protection standard for each constituent in appendix IV to this part detected in the groundwater. The groundwater protection standard shall be:
>
> > (1) For constituents for which a maximum contaminant level (MCL) has been established under §§141.62 and 141.66 of this title, the MCL for that constituent;
> >
> > (2) For constituents for which an MCL has not been established, the background concentration for the constituent established from wells in accordance with §257.91; or
> >
> > (3) For constituents for which the background level is higher than the MCL identified under paragraph (h)(1) of this section, the background concentration.

Therefore, GWPS are the Federal primary drinking water standards, also known as Maximum Contaminant Levels or MCLs (USEPA, 2018a) or background values. USEPA published Amendments to the National Minimum Criteria Finalized in 2018 (Phase One, Part One) in the Federal Register on July 30, 2018 (USEPA, 2018b). This included revising the groundwater protection standard for constituents that do not have an established drinking water standard (or MCL) at §257.95 Assessment monitoring program (h) (2):

- Cobalt – 6 ug/L (micrograms per liter)
- Lead – 15 ug/L
- Lithium – 40 ug/L
- Molybdenum – 100 ug/l

GWPS used to evaluate potential drinking water exposures for CCR monitoring wells are shown on Table 1.

### 4.2 SCREENING LEVELS FOR THE PROTECTION OF SURFACE WATER

The GWPS are specific to the evaluation of groundwater at the CCR Rule monitoring wells. Based on the CSM presented in Section 2.1 and Figure 3, this section outlines the risk-based human health and ecological surface water screening levels that are protective of surface water in the Ohio River.

Human health screening levels for surface water are identified for the following exposure settings: 1) use of surface water as a drinking water source, 2) the consumption of fish from a surface water body, and 3) recreational uses of surface water.

#### 4.2.1 Drinking Water Screening Levels

The human health screening levels for drinking water are from IDEM and USEPA sources and address the drinking water exposure pathway. The IDEM criteria for drinking water class groundwater are the same as the Federal primary drinking water standards (MCLs). USEPA risk-based Regional Screening Levels (RSLs) (USEPA, 2020a) for tapwater (drinking water, or untreated groundwater used as potable water) have also been included for constituents which do not have promulgated IDEM/MCL criteria. The tapwater RSLs are based on USEPA default assumptions for residential exposure to tapwater. These sources, in the order in which they are to be used, are:

- USEPA Office of Water, Health Advisory Program. 2018 Edition of the Drinking Water Standards and Health Advisories. (USEPA, 2018a)
- USEPA. Regional Screening Levels, November 2020. Values for tapwater. (USEPA, 2020a)
- Indiana Administrative Code Title 327 - Water Pollution Control Division. 327 IAC 2-11-6(a)(1). Health protective goals for select inorganic contaminants in untreated groundwater used as drinking water. (IWPCD, 2020a)

Screening levels for human health drinking water are provided in Table 2.

#### 4.2.2 Published Recreational Screening Levels

Published human health screening levels for surface water are generally derived to be protective of the use of surface water as a drinking water source and the consumption of fish from a surface water body. The drinking water screening levels are also protective of, but highly conservative for, recreational uses of a surface water body (such as swimming or boating) because drinking water exposure is of a higher magnitude and frequency. The drinking water screening levels used to evaluate surface water, as discussed above, are protective for other recreational uses of the river such as swimming, wading, and boating. Note that this evaluation of other uses of surface water are above and beyond the requirements of the CCR Rule.

The human health screening levels for surface water are from federal and state sources. Values that address use of surface water as drinking water are the values for drinking water provided in Table 2. Values that address the fish consumption pathway are the federal and state values for surface water. Where the surface water body is not within the Great Lakes System, is on the Ohio River, and is a source of public drinking water, these screening level sources, in the order in which they are to be used, are:

- Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision. Chapter 3 Water Quality Criteria - Human Health.

Human health protection criteria are protective of drinking water, recreational, and fish consumption uses. (ORSANCO, 2019)

- USEPA Ambient Water Quality Criteria for Human Health Consumption of Organisms. (USEPA, 2020b)
- Indiana Administrative Code Title 327 – Water Pollution Control Division. Active Projects. Proposed revisions to Indiana's Aquatic Life and Human Health Ambient Water Quality Criteria for metals. Revisions are proposed to reflect updates to National Recommended Water Quality Criteria at Section 304(a) of the Clean Water Act. The proposed revisions are to 327 IAC 2-1-6 Minimum Surface Water Quality Standards for metals in Indiana waters not within the Great Lakes System, for consumption of organisms. (IN.gov, 2020b; 2017)
- Indiana Administrative Code Title 327 – Water Pollution Control Division. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters Within the Great Lakes System. 327 IAC 2-1-6 Minimum Surface Water Quality Standards (current/ promulgated surface water quality standards), for consumption or organisms. (IWPCD, 2020b)

If values from the above surface water sources are not published for a given constituent, then the selected drinking water screening level from Section 4.2.1 is used.

#### 4.2.3 Calculated Recreational Risk-Based Screening Levels

Site-specific risk-based screening levels (RBSLs) are essentially refined screening levels to account for receptor population characteristics and exposure pathways. As such, the site-specific RBSLs are more realistic for evaluation of potential exposures to surface water than the published screening levels discussed above and, therefore, are useful for evaluating whether constituents may have the potential to pose health risks in excess of risk thresholds. For example, whereas surface water that is used as a recreational water body for swimming could be evaluated using drinking water standards which assume that people are drinking and bathing in the water daily, site-specific RBSLs for surface water will reflect incidental ingestion and dermal contact at an exposure rate and magnitude commensurate with swimming activities.

Potential exposures to constituents in surface water could, in general, occur through ingestion and dermal contact. However, the specific nature of the potential exposures is dependent on the type of water body. Specifically:

- Incidental ingestion and dermal contact with shallow surface water (e.g., less than two feet in depth) can only occur via wading because the water is not deep enough to permit swimming. Wading exposures could potentially occur in near-shore or shallow water areas of the Ohio River.
- Incidental ingestion and dermal contact with deeper surface water (e.g., more than three feet in depth) could occur via swimming. Exposures during swimming could be potentially complete in the Ohio River.
- Dermal contact with surface water could occur during boating or fishing activities in the Ohio River. Since these types of activities are not associated with intense exposures to water (such as is the case with swimming), incidental ingestion of surface water would be insignificant.

RBSLs derived for recreational exposures to surface water for a recreational swimmer, wader, and boater are presented in Table 3. The RBSLs were calculated using USEPA-derived exposure factors and equations, as well as site-specific inputs where appropriate using the USEPA RSL calculator (USEPA, 2020c). The RBSL presented is the lower of the noncancer RBSL at a target noncancer hazard index of 1 and the RBSL calculated for a target cancer-based risk of $10^{-4}$. The RSL calculator output, including the exposure parameters used, is provided in Attachment A.

#### 4.2.4 Ecological Screening Levels

Ecological screening levels for surface water are published to provide a conservative estimate of the concentration to which an ecological receptor can be exposed without experiencing adverse effects. Due to the conservative methods used to derive published reference screening levels, it can be assumed with reasonable certainty that concentrations at or below screening levels will not result in any adverse effects to survival, growth and/or reproduction. Concentrations above published ecological screening levels for surface water, however, do not necessarily indicate that a potential ecological risk exists, but rather that further evaluation may be warranted.

Table 4 presents the published ecological risk-based screening levels for surface water. Some of the screening levels are based on the hardness of the water, a default hardness value of 100 milligrams per liter (mg/L) has been used, in accordance with USEPA and IDEM guidance. Note that this ecological evaluation of surface water is above and beyond the requirements of the CCR Rule.

Water quality criteria are concentrations calculated from controlled laboratory tests on freshwater or marine organisms that are protective of the most sensitive organism (often zooplankton such as daphnids) for the most sensitive life stage (typically reproduction). The following criteria are used to evaluate the levels of metals in off-site surface water, in the order in which they were used:

- ORSANCO Pollution Control Standards for Discharges to the Ohio River. 2019 Revision. Chapter 3 Water Quality Criteria - Aquatic life. Aquatic Life criteria are protective of maintaining fish and other aquatic life. (ORSANCO, 2019).
- USEPA Ambient Water Quality Criteria Freshwater Chronic and Acute. (USEPA, 2020d)
- Planned Revisions to Metals Criteria for the Protection of Aquatic Life and Human Health. IDEM Aquatic Life Criterion Applicable to All State Waters Except Waters of the State Within the Great Lakes System; acute aquatic criterion and chronic aquatic criterion.

  (IN.gov, 2020b; 2017).
- Current (promulgated) IDEM Aquatic Life Criterion Applicable to All State Waters Except Waters of the State Within the Great Lakes System; acute aquatic criterion and chronic aquatic criterion. Indiana Administrative Code Title 327 Water Pollution Control Division. (IWPCD, 2020b)
- USEPA Region 5 Resource Conservation and Recovery Act Ecological Screening Levels, Archive Document. (USEPA, 2003)

#### 4.2.5 Selected Screening Levels

Table 5 presents the selected human health and ecological screening levels (from Tables 1 through 4) for the human health drinking water, human health recreational, and ecological potential exposure scenarios.

# 5. Results

The level of analysis and comparison to risk-based screening levels presented below is above and beyond the requirements of the CCR Rule. The analysis of the groundwater results required by the CCR Rule is presented in the 2020 "Annual Groundwater Monitoring and Corrective Action Report" for FBC West Ash Pond [*https://www.vectren.com/assets/downloads/planning/ccr/Culley-West-Ash-Pond-Annual-Ground-Water-Report-2020.pdf*]. This report serves to supplement that report by providing the risk-based analysis of groundwater, so that the groundwater results can be understood in their broader environmental context.

## 5.1 SHALLOW ALLUVIAL AQUIFER GROUNDWATER – CCR RULE EVALUATION

SIGECO has filed reports and notification required by the federal CCR Rule on its website, as noted above, and additional reports will be prepared and posted on SIGECO's website per the CCR Rule. The statistical analysis of the data has indicated a statistically significant increase (SSI) for a subset of the parameters identified in Section 4: boron, calcium, chloride, fluoride, sulfate, and total dissolved solids. The Appendix III statistical analysis results, followed by an unsuccessful Alternate Source Demonstration, moved the groundwater sampling into the Assessment Monitoring phase.

Groundwater data from samples collected between October 2019 and March 2020 from the shallow alluvial aquifer groundwater were compared to the site-specific GWPS required by the CCR Rule. Figure 1 shows that the monitoring wells are all located at the edge of the WAP and, therefore, provide worst-case groundwater results. Based on the assessment monitoring results, concentrations of only two constituents, lithium and molybdenum, of the 15 Appendix IV constituents analyzed in the downgradient wells are statistically above the GWPS. These measured concentrations are then referred to as Statistically Significant Levels (SSLs). Therefore, the Assessment of Corrective Measures phase of the CCR Rule is triggered for these Appendix IV constituents.

Table 1 compares the results of all CCR monitoring well sampling rounds to the GWPS. The vast majority of the results indicate concentration levels below the site-specific GWPS. A limited number of parameters are above the GWPS for some, but not all, sampling events.

The striking aspect of the analysis shown in Table 1 is how few CCR monitoring well results are above a conservative GWPS based on MCLs, health-based GWPS, or background levels, given that the wells are located immediately adjacent to the base of the ash management area, and the facility has been in operation for over 60 years. Out of the 984 groundwater analyses conducted, only 45 results are above the GWPS (see Table 1). Put another way, approximately 95% of the groundwater results for the CCR Rule monitoring wells located at the edge of the WAP (WAP-2R, WAP-3, WAP-4, WAP-5, and WAP-6) are below the GWPS. Even for the very few results that may be above screening values for some of the sampling events, including the SSI results identified under the CCR Rule, there is no complete drinking water exposure pathway to groundwater. Without the complete drinking water exposure pathway, there is no risk.

The SSI and SSL values reflect a statistical evaluation that mathematically compares the results of the various rounds of samples to background water quality and GWPS as required under the CCR Rule. However, such values without further evaluation do not establish that there is an actual adverse impact to human health or the environment. The CSM process and screening analysis described in this report provide the relevant context for such groundwater monitoring results and whether the WAP poses a true risk to human health and the environment. As explained in the remaining sections of this report, based upon the application of risk assessment principles uniformly adopted by USEPA, no such risk exists.

## 5.2 EVALUATION OF POTENTIAL USE OF GROUNDWATER AT THE WARRICK POWER PLANT

As shown in Figures 1 and 2, the WAP-6 and WAP-3S wells are the nearest downgradient wells to the Warrick Power Plant facility production wells. The WAP-6 samples were collected at the following intervals (depth below ground surface):

- WAP-6S – 40 to 50 feet
- WAP-6I – 70 to 80 feet
- WAP-6D – 107 to 117 feet
- WAP-3S – 60 to 70 feet

The IDNR Division of Water Well Records database lists the depth of the Warrick Power Plant facility production wells screen intervals as ranging from 79 to 125 feet below ground surface. The single WAP-6 result for molybdenum above the GWPS is from WAP-6S, located 40 to 50 feet below ground surface. Results for molybdenum in the intermediate and deep depths for WAP-6I and WAP-6D that correspond to the depth of the Warrick Power Plant facility production wells are below the GWPS for molybdenum, demonstrating that these wells would not be not affected by facility coal ash management operations.

There is no evidence that groundwater containing constituents associated with the WAP have migrated onto the Warrick Power Plant property or to their production wells. However, an evaluation of potential risks to a Warrick Power Plant facility worker from groundwater used for drinking water and for showering was included in this risk assessment. Specifically, the average concentrations of constituents in well WAP-3S and the analytical results from the October 2020 sampling of WAP-6S were each used to represent groundwater quality that power plant workers for this assessment are assumed to be exposed to. This evaluation represents a hypothetical condition in which the groundwater quality in the production wells is assumed to be represented by the groundwater quality in wells WAP-3S and WAP-6S. Even if groundwater quality as represented by wells WAP-3S and WAP-6S was migrating to the production wells, concentrations in the production wells would likely be much lower than those in the WAP monitoring wells. This is because the production wells are screened at depths where analytical data for wells WAP-6I and -6D demonstrate that constituents are below screening levels, and because the production wells pull groundwater from multiple directions around the wells, not just the direction of the WAP. The analytical results for WAP-6S are shown on Table 1, and the average concentrations for WAP 3-1 are shown on Table 6. Risks were calculated using USEPA-derived exposure factors and equations, as well as site-specific inputs where appropriate using the USEPA RSL calculator (USEPA, 2020c). The RSL calculator risk output, including the worker exposure parameters used, is provided in Attachment B.

As shown in Table 7, off-site worker (adult) exposure to WAP-6S groundwater is associated with an Excess Lifetime Cancer Risk (ELCR) of $4\times10^{-6}$, below the IDEM target risk of $1\times10^{-4}$ and within the USEPA risk range of $10^{-6}$ to $10^{-4}$. The cumulative noncarcinogenic hazard index (HI) is 0.4, which is below the IDEM and USEPA target HI of 1. Off-site worker (adult) exposure to WAP-3S groundwater is associated with an ELCR of $1\times10^{-5}$ (IDEM, 2012; USEPA, 1991). Constituents in WAP-3S groundwater have chronic non-carcinogenic health criteria termed reference doses for oral and dermal exposure routes that are based on effects to different target organs, as shown in Table 7. The HI values for WAP-3S groundwater based on target organ are at or below the noncarcinogenic hazard quotient of 1.

This evaluation demonstrates that if the adjacent off-site production wells had groundwater quality represented by wells WAP-6S or WAP-3S, there would not be an unacceptable risk posed to the off-site workers. Potential risks for the off-site worker groundwater scenario are not above the target risk range of $1 \times 10^{-6}$ to $1 \times 10^{-4}$ for USEPA and the target risk level of $1 \times 10^{-4}$ for IDEM, for potential carcinogens, or above a target HI of 1 for noncarcinogens (that act on the same target organ), as defined in USEPA and IDEM guidance (USEPA, 1991; IDEM, 2012). In addition, the WAP-3S samples were collected between approximately 25 and 40 feet below ground surface, and therefore represent a conservative estimate of potential groundwater quality in the deeper off-site production wells.

# 6. Derivation of Risk-Based Screening Levels for Groundwater

FBC is located on the Ohio River – a major river system with a massive and rapid river flow. This section illustrates how the groundwater – which is a fraction of the volume and flow rate of the river – may interact with the Ohio River under an assumed set of criteria and conditions (see Attachment C). Such an exercise in assumptions can help put in context whether a theoretical risk to river water and its uses exists.

Impacts to groundwater do not mean that surface waters are impaired. The degree of interface between groundwater and surface waters is variable and complex and dependent upon a variety of factors including gradient and flow rate. It is possible, however, to determine the maximum concentration level that would need to be present on-site in groundwater and still be protective of the surface water environment, assuming gradient and flow rates are such that groundwater flows into the surface water. Groundwater and surface waters flow at very different rates and volumes. The Ohio River is a large river system in North America and as depicted on Table 8 and Attachment C, and as groundwater flows into the river, it is diluted by more than 83,000 times.

It is possible to calculate a protective screening level for groundwater based upon the amount of dilution that occurs under the above assumption. This calculated risk-based screening level for groundwater can be used to determine whether an on-site groundwater concentration level is protective of the river. Stated differently, at what concentration level does groundwater entering the river system pose a potential human health or ecological risk?

Table 8 is summarized below and shows the application of the dilution factor to calculate risk-based groundwater screening levels that are protective for surface water, for Appendix III and Appendix IV constituents with risk-based screening levels available. For each constituent, the selected human health drinking water and recreational screening levels, as well as the ecological screening levels (from Table 5) are presented. The lowest of the three screening levels is then identified for surface water. The dilution factor is then applied to this lowest screening level for surface water to result in the groundwater screening level that is protective for human and ecological uses of surface water, as shown in the table below.

This evaluation is not limited to only those constituents for which SSIs or SSLs have been identified. The constituents listed in Table 8 are those for which there is one or more detected groundwater result with available risk-based screening levels.

The groundwater risk-based screening levels are calculated in units of mg/L. One mg/L is equivalent to one part per million.

Table 8 identifies the maximum groundwater concentration of each constituent detected in the WAP monitoring wells. The comparison between the target levels and the maximum concentrations indicates that there is a wide margin of safety between the two values. This margin is shown in the last column of the table. To illustrate, concentration levels of lithium and molybdenum would need to be more than 33,000 and more than 5,500 times higher, respectively, than currently measured levels before an adverse impact in the river could occur.

**CALCULATING RISK-BASED SCREENING LEVELS FOR GROUNDWATER (see Table 8)**

| | Dilution Attenuation Factor for Ohio River | 83,000 | | | |
|---|---|---|---|---|---|
| **Constituents** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Target Groundwater Screening Level - Ohio River (mg/L)*** | **Maximum Groundwater Concentration (mg/L)** | | **Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration** |
| **Detection Monitoring - EPA Appendix III Constituents** | | | | | |
| Boron | 4 | 332,000 | 22 | WAP-2R | >15,000 |
| Fluoride | 1 | 83,000 | 0.77 | WAP-3S | >100,000 |
| **Assessment Monitoring - EPA Appendix IV Constituents** | | | | | |
| Antimony | 0.0056 | 465 | 0.0011 | WAP-5D | >420,000 |
| Arsenic | 0.01 | 830 | 0.097 | WAP-5D | >8,500 |
| Barium | 0.22 | 18,260 | 0.44 | WAP-5D | >41,000 |
| Beryllium | 0.00117 | 97 | 0.00044 | WAP-5D | >220,000 |
| Cadmium | 0.00025 | 20 | 0.001 | WAP-2R | >20,000 |
| Chromium (Total) | 0.074 | 6,152 | 0.015 | WAP-5D | >410,000 |
| Cobalt | 0.006 | 498 | 0.0098 | WAP-5S | >50,000 |
| Lead | 0.0025 | 209 | 0.011 | WAP-5D | >18,000 |
| Lithium | 0.04 | 3,320 | 0.1 | WAP-3S | >33,000 |
| Mercury | 0.000012 | 1.0 | 0.0002 U | | NA |
| Molybdenum | 0.1 | 8,300 | 1.5 | WAP-3S | >5,500 |
| Selenium | 0.0031 | 257 | 0.0013 | WAP-5D | >190,000 |
| Thallium | 0.00024 | 20 | 0.00047 | WAP-2R | >42,000 |
| **Radiological Constituent** | | **(pCi/L)** | **(pCi/L)** | | **(pCi/L)** |
| Radium | 4 | 332,000 | 1.28 ± 0.411 | WAP-3S | >190,000 |

*** Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.**
**pCi/L = pico-Curies per liter.**

This means that not only do the present concentrations of constituents in groundwater at the WAP not pose a risk to human health or the environment from the Ohio River, but even much higher concentrations in groundwater would not be harmful.

# 7. Summary

This comprehensive evaluation demonstrates that there are no adverse impacts on human health or ecological receptors from constituents present in groundwater resulting from coal ash management practices at the West Ash Pond at the F.B. Culley Generating Station.

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# TABLES

**TABLE 1**
**COMPARISON OF WEST ASH POND GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS –**
**JUNE 2016 THROUGH OCTOBER 2020 SAMPLING EVENTS**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| Monitoring Well ID | | Date Sampled | pH (lab) | Boron, Total | Calcium, Total | Chloride | Fluoride | Sulfate | Total Dissolved Solids (TDS) | Antimony, Total | Arsenic, Total | Barium, Total | Beryllium, Total | Cadmium, Total | Chromium, Total | Cobalt, Total | Lead, Total | Lithium, Total | Mercury, Total | Molybdenum, Total | Selenium, Total | Thallium, Total | Radium-226 | Radium-228 | Radium-226 & 228 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | pCi/L | pCi/L |
| Site GWPS (a) | | | NA | NA | NA | NA | 4 | NA | NA | 0.006 | 0.015 | 2 | 0.004 | 0.005 | 0.1 | 0.019 | 0.032 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | NA | NA | 5 |
| Upgradient | WAP-1 | 03/15/2018 | 7.3 J | 0.08 U | 150 | 13 | 0.31 | 280 | 850 | 0.002 U | 0.0033 | 0.37 | 0.001 U | 0.001 U | 0.0022 U | 0.00044 J | 0.00068 J | 0.0066 | 0.0002 U | 0.0009 J | 0.005 U | 0.001 U | 0.638 ± 0.17 | 0.839 R ± 0.337 | 1.48 R ± 0.377 |
| | | 04/02/2018 | 7.5 J | 0.08 U | 160 | 13 | 0.23 | 340 | 870 | 0.002 U | 0.0085 | 0.46 | 0.00049 J | 0.00021 J | 0.016 | 0.0067 | 0.014 | 0.015 J | 0.0002 U | 0.0026 J | 0.005 U | 0.00027 J | 0.531 ± 0.144 | 0.550 ± 0.27 | 1.08 ± 0.306 |
| | | 05/04/2018 | 7.4 J | 0.08 U | 160 | 12 | 0.21 | 270 | 900 | 0.002 U | 0.0038 | 0.37 | 0.000072 J | 0.001 U | 0.005 J+ | 0.0013 | 0.0024 | 0.01 J+ | 0.0002 U | 0.00086 J | 0.005 U | 0.001 U | 0.538 ± 0.161 | 0.268 U ± 0.332 | 0.807 J ± 0.369 |
| | | 05/24/2018 | 7.5 J | 0.08 U | 160 | 15 | 0.28 | 330 | 880 | 0.002 U | 0.0079 | 0.51 | 0.00039 J | 0.00018 J | 0.017 | 0.0059 | 0.012 | 0.012 J+ | 0.0002 U | 0.0015 J | 0.005 U | 0.00018 J | 0.673 ± 0.193 | 0.411 U ± 0.295 | 1.08 J ± 0.353 |
| | | 06/15/2018 | 7.3 J | 0.08 U | 160 | 15 | 0.24 | 330 | 870 | 0.0014 J | **0.021** | 0.88 | 0.00089 J- | 0.00049 J | 0.043 | 0.019 | **0.035** | 0.027 | 0.0002 U | 0.0028 J | 0.0018 J | 0.00047 J | 0.708 ± 0.284 | 0.853 R ± 0.342 | 1.56 R ± 0.445 |
| | | 07/05/2018 | 7.3 J | 0.08 U | 160 | 15 | 0.28 | 240 | 890 | 0.0018 J | 0.012 | 0.67 | 0.0012 | 0.00044 J | 0.046 | 0.017 | **0.034** | 0.024 | 0.0002 UJ | 0.0028 J | 0.0018 J | 0.00053 J | 0.608 R ± 0.232 | 0.367 U ± 0.294 | 0.976 R ± 0.375 |
| | | 07/25/2018 | 7.3 J | 0.08 U | 160 | 15 | 0.28 | 300 | 860 | 0.002 U | 0.0049 | 0.39 | 0.00042 J | 0.00013 J | 0.0088 | 0.0047 | 0.0099 | 0.0095 | 0.0002 U | 0.005 U | 0.005 U | 0.00019 J | 0.445 R ± 0.135 | 0.0344 U ± 0.269 | 0.480 UJ ± 0.301 |
| | | 08/16/2018 | 7.3 J | 0.08 U | 150 | 12 | 0.27 | 290 | 900 | 0.002 U | 0.0051 | 0.4 | 0.0003 J | 0.001 U | 0.014 J+ | 0.0045 | 0.0089 | 0.01 | 0.0002 U | 0.0013 J | 0.005 U | 0.00014 J | 0.813 ± 0.239 | 0.950 R ± 0.552 | 1.76 R ± 0.602 |
| | | 12/05/2018 | 7.4 J | 0.08 U | 150 | 17 | 0.29 | 320 | 890 | 0.002 U | 0.0032 | 0.38 | 0.000089 J | 0.001 U | 0.0057 J+ | 0.0019 | 0.0036 | 0.01 | 0.0002 U | 0.0011 J | 0.005 U | 0.000083 J | 0.457 ± 0.156 | 0.417 U ± 0.313 | 0.875 J ± 0.35 |
| | | 10/28/2019 | 7.4 J | 0.08 U | - | - | 0.19 J+ | - | - | 0.00059 J | 0.0066 | 0.54 | 0.00027 J | 0.00022 J | 0.011 | 0.0047 | 0.0072 | 0.015 | 0.0002 U | 0.0012 J | 0.005 U | 0.00025 J | 0.737 ± 0.329 | 0.715 U ± 1.18 | 1.45 UJ ± 1.23 |
| | | 02/19/2020 | 7.4 J | 0.08 U | 180 | 25 J+ | 0.17 | 340 J+ | 930 | 0.00045 J | 0.0073 | 0.56 | 0.00023 J | 0.001 U | 0.012 | 0.0058 | 0.0094 | 0.011 | - | 0.001 J | - | 0.001 U | 0.549 J- ± 0.241 | 0.962 ± 0.489 | 1.51 J- ± 0.545 |
| | | 03/31/2020 | 7.3 J | 0.08 U | 180 | 260 | 2 | 340 | 910 | 0.00073 J | 0.004 | 0.45 | 0.001 U | 0.001 U | 0.005 | 0.0033 | 0.0041 | 0.0096 | - | 0.00068 J | - | 0.00021 J | 0.569 ± 0.238 | 0.792 U ± 0.561 | 1.36 J ± 0.609 |
| | CCR-AP-7 | 06/10/2016 | 7.37 J | 0.034 J+ | 86 | 31 | 0.11 R | 93 J- | 590 | 0.002 U | 0.0025 | 0.1 | 0.001 U | 0.001 U | 0.00048 J | 0.0012 | 0.00062 J | 0.01 J | 0.0002 U | 0.0082 | 0.00035 J | 0.001 U | 0.330 J ± 0.0973 | 0.166 U ± 0.267 | 0.496 ± 0.284 |
| | | 08/12/2016 | 7.9 J | 0.034 U | 88 | 26 | 0.24 | 73 | 580 | 0.002 U | 0.0048 | 0.12 | 0.001 U | 0.001 U | 0.00047 J | 0.0023 | 0.00099 J | 0.011 J | 0.0002 U | 0.0054 | 0.005 U | 0.001 U | 0.390 ± 0.118 | 0.625 J ± 0.344 | 1.02 J ± 0.363 |
| | | 10/28/2016 | 7.1 J | 0.02 J+ | 120 J- | 25 J+ | 0.25 | 66 J+ | 530 | 0.002 U | 0.0084 | 0.16 | 0.00017 J | 0.001 U | 0.0026 | 0.0053 J | 0.0082 J | 0.02 J | 0.0002 U | 0.0044 J | 0.00073 J | 0.00008 J | 1.28 ± 0.664 | 0.434 U ± 0.433 | 1.72 J ± 0.792 |
| | | 12/07/2016 | 7.4 J | 0.071 U | 99 | 26 | 0.37 J+ | 96 | 620 | 0.00016 J | 0.0083 | 0.14 | 0.00012 J | 0.001 U | 0.0039 | 0.0037 | 0.0036 | 0.012 J | 0.0002 U | 0.0088 | 0.005 U | 0.000066 J | 0.439 U ± 0.399 | 0.558 U ± 0.451 | 0.997 ± 0.602 |
| | | 02/08/2017 | 7.4 J | 0.034 U | 150 J- | 25 | 0.28 J+ | 110 | 630 | 0.00062 J | **0.018** | 0.19 | 0.00075 J | 0.00032 J | 0.019 | 0.015 | 0.02 | 0.039 J | 0.0002 U | 0.013 | 0.005 U | 0.00061 J | 0.744 ± 0.22 | 0.365 U ± 0.252 | 1.11 J ± 0.335 |
| | | 04/06/2017 | 7.3 J | 0.08 U | 110 J+ | 27 | 0.29 | 110 | 640 | 0.002 U | 0.008 | 0.15 | 0.00022 J | 0.00014 J | 0.0048 | 0.0054 | 0.0087 J+ | 0.019 J | 0.0002 U | 0.0058 | 0.005 UJ | 0.001 U | 0.719 ± 0.182 | 0.830 ± 0.427 | 1.55 ± 0.464 |
| | | 06/07/2017 | 7.3 J | 0.15 U | 100 | 28 | 0.34 | 100 | 620 | 0.002 U | 0.0075 | 0.15 | 0.00015 J | 0.001 U | 0.0039 J+ | 0.0032 | 0.0041 | 0.019 J | 0.0002 U | 0.0069 | 0.005 U | 0.000088 J | 0.398 ± 0.129 | 0.895 ± 0.413 | 1.29 ± 0.433 |
| | | 09/28/2017 | 7.3 J | 0.056 J | 94 | 29 | 0.19 | 82 | 570 | 0.002 U | 0.0058 | 0.12 | 0.001 U | 0.001 U | 0.002 U | 0.00054 | 0.001 U | 0.01 J | 0.0002 U | 0.0036 J | 0.005 U | 0.001 U | 0.308 ± 0.095 | 0.369 R ± 0.234 | 0.677 R ± 0.253 |
| | | 11/17/2017 | 7.2 J | 0.091 U | 96 | 31 | 0.25 | 77 J- | 550 | 0.002 U | 0.0034 | 0.11 | 0.001 U | 0.001 U | 0.002 U | 0.0003 J | 0.001 U | 0.012 J | 0.0002 U | 0.0028 J | 0.005 U | 0.001 U | 0.312 ± 0.0954 | 0.405 R ± 0.227 | 0.717 R ± 0.246 |
| | | 06/11/2018 | - | - | - | - | 0.31 | - | - | 0.002 U | 0.0071 | 0.14 | 0.001 U | 0.001 U | 0.0014 U | 0.00065 | 0.00041 J | 0.011 | 0.0002 U | 0.0025 J | 0.005 U | 0.001 U | 0.480 ± 0.216 | 0.0986 U ± 0.257 | 0.579 J ± 0.336 |
| | | 08/28/2018 | 7.5 J | 0.08 U | 100 | 27 | 0.31 | 70 | 580 | 0.002 U | 0.0064 | 0.14 | 0.000067 J | 0.001 U | 0.0061 J+ | 0.0014 | 0.0014 | 0.013 | - | 0.0026 J | 0.005 U | 0.001 U | 0.520 R ± 0.141 | 0.307 U ± 0.231 | 0.827 R ± 0.271 |
| | | 05/28/2019 | 7.5 J | 0.28 J | 100 | 28 | 0.27 J+ | 82 | 590 | 0.002 U | 0.0037 | 0.13 | 0.001 U | 0.001 U | 0.002 U | 0.00047 J | 0.001 U | 0.011 | 0.0002 U | 0.002 J | 0.005 U | 0.001 U | 0.423 ± 0.123 | 0.112 U ± 0.31 | 0.535 J ± 0.334 |
| | | 10/23/2019 | 7.4 J | 0.08 U | 110 | 27 | 0.14 J+ | 65 | 530 | 0.002 U | 0.0075 | 0.15 | 0.001 U | 0.001 U | 0.0018 J | 0.001 | 0.0014 J+ | 0.02 J+ | 0.0002 U | 0.0017 J | 0.005 U | 0.001 U | 0.194 J ± 0.097 | 1.02 ± 0.324 | 1.21 ± 0.338 |
| | | 02/19/2020 | 7.4 J | 0.082 U | 110 | 16 J+ | 0.22 | 45 J+ | 570 | 0.002 U | 0.004 | 0.12 | 0.001 U | 0.001 U | 0.0018 J | 0.0011 | 0.0015 | 0.011 | - | 0.0015 J | - | 0.001 U | 0.309 J- ± 0.125 | 0.111 U ± 0.217 | 0.419 J- ± 0.25 |
| | | 03/30/2020 | 7.3 J | 0.047 J | 110 | 27 | 0.3 | 76 | 560 | 0.002 U | 0.0018 | 0.11 | 0.001 U | 0.001 U | 0.002 U | 0.00029 J | 0.001 U | 0.01 | - | 0.0014 J | - | 0.001 U | 0.243 ± 0.117 | 0.197 U ± 0.268 | 0.441 UJ ± 0.292 |
| Downgradient | WAP-2 | 03/23/2017 | 7.3 J | 12 | 140 | 130 | 0.49 | 420 | 980 | 0.002 U | 0.00087 J | 0.015 | 0.001 U | 0.00017 J | 0.002 U | 0.0021 | 0.001 U | 0.022 J | 0.0002 U | **0.35** | 0.005 U | 0.001 U | 0.186 ± 0.1 | 0.227 U ± 0.241 | 0.413 ± 0.261 |
| | WAP-2R | 03/15/2018 | 7.3 J | 19 | 260 | 260 | 0.24 | 570 | 1500 | 0.002 U | 0.001 U | 0.053 | 0.001 U | 0.00054 J | 0.002 U | 0.0023 | 0.001 U | **0.059** | 0.0002 U | 0.063 | 0.005 U | 0.0003 J | 0.194 ± 0.0786 | -0.0629 U ± 0.174 | 0.194 UJ ± 0.191 |
| | | 04/03/2018 | 7 J | 12 | 300 | 190 | 0.23 | 680 | 1600 | 0.002 U | 0.0059 | 0.062 | 0.00024 J | 0.001 | 0.0041 | 0.0062 | 0.0064 | 0.029 J | 0.0002 U | 0.013 | 0.005 U | 0.00047 J | 0.206 ± 0.09 | 0.673 ± 0.334 | 0.878 ± 0.346 |
| | | 05/04/2018 | 7.2 J | 22 | 240 | 190 | 0.13 J | 460 | 1500 | 0.002 U | 0.00095 J | 0.045 | 0.001 U | 0.00044 J | 0.002 U | 0.002 | 0.001 U | **0.06** | 0.0002 U | 0.042 | 0.005 U | 0.00014 J | 0.189 ± 0.0826 | 0.193 U ± 0.199 | 0.382 J ± 0.215 |
| | | 05/24/2018 | 7.1 J | 17 | 240 | 240 | 0.17 | 600 | 1500 | 0.002 U | 0.00081 J | 0.042 | 0.001 U | 0.0005 J | 0.002 U | 0.0024 | 0.001 U | **0.041** | 0.0002 U | 0.035 | 0.005 U | 0.00011 J | 0.0929 U ± 0.083 | 0.0762 U ± 0.215 | 0.169 U ± 0.23 |
| | | 06/15/2018 | 7.3 J | 17 | 260 | 250 | 0.16 | 620 | 1500 | 0.002 U | 0.00092 J | 0.041 | 0.001 UJ | 0.00043 J | 0.002 U | 0.0019 | 0.001 U | **0.052** | 0.0002 U | 0.04 | 0.005 U | 0.000082 J | 0.182 U ± 0.159 | 0.441 R ± 0.243 | 0.623 R ± 0.29 |
| | | 07/06/2018 | 7.1 J | 16 | 250 | 230 | 0.16 | 530 | 1400 | 0.002 U | 0.00071 J | 0.041 | 0.001 U | 0.00041 J | 0.002 U | 0.0022 | 0.001 U | 0.04 | 0.0002 UJ | 0.035 | 0.005 U | 0.000084 J | 0.254 R ± 0.141 | 0.325 U ± 0.226 | 0.579 R ± 0.266 |
| | | 07/26/2018 | 7 J | 12 | 200 | 210 | 0.15 | 520 | 1200 | 0.002 U | 0.00047 J | 0.032 | 0.001 U | 0.00032 J | 0.002 U | 0.0017 | 0.001 U | 0.026 | 0.0002 U | 0.032 | 0.005 U | 0.001 U | 0.268 R ± 0.105 | 0.353 U ± 0.294 | 0.621 J+ ± 0.312 |
| | | 08/16/2018 | 7.1 J | 12 | 210 | 230 | 0.11 | 480 | 1300 | 0.002 U | 0.00084 J | 0.035 | 0.001 U | 0.00044 J | 0.002 U | 0.0023 | 0.001 U | 0.033 | 0.0002 U | 0.034 | 0.005 U | 0.000067 J | 0.344 R ± 0.103 | 0.151 U ± 0.243 | 0.495 R ± 0.264 |
| | | 12/05/2018 | 7 J | 10 | 150 | 91 | 0.26 | 330 | 920 | 0.002 U | 0.00064 J | 0.025 | 0.001 U | 0.00032 J | 0.002 U | 0.00096 | 0.00016 J | 0.02 | 0.0002 U | 0.018 | 0.005 U | 0.00014 J | 0.0986 U ± 0.0783 | 0.119 U ± 0.213 | 0.218 U ± 0.227 |
| | | 10/28/2019 | 7.1 J | 6.1 | - | - | 0.25 J+ | - | - | 0.002 U | 0.001 | 0.031 | 0.001 U | 0.00027 J | 0.002 U | 0.0015 J | 0.00029 J | 0.016 | 0.0002 U | **0.16** | 0.005 U | 0.001 U | 0.0181 U ± 0.0789 | 0.0701 U ± 0.341 | 0.0883 U ± 0.35 |
| | | 02/18/2020 | 7.2 J | 6.3 | 140 | 47 J+ | 0.2 | 180 J+ | 630 | 0.002 U | 0.00054 J | 0.023 | 0.001 U | 0.001 U | 0.002 U | 0.00052 | 0.001 U | 0.012 | - | 0.05 | - | 0.001 U | 0.0350 R ± 0.0713 | 0.204 U ± 0.218 | 0.239 UJ ± 0.229 |
| | | 03/31/2020 | 7 J | 6.7 | 140 | 42 | 0.23 | 160 | 650 | 0.002 U | 0.00056 J | 0.025 | 0.001 U | 0.001 U | 0.002 U | 0.00083 | 0.00019 J | 0.014 | - | 0.07 | - | 0.001 U | 0.112 U ± 0.105 | -0.0721 U ± 0.334 | 0.112 U ± 0.35 |
| | WAP-3S | 03/23/2017 | 6.9 J | 12 | 240 | 130 J | 0.28 | 310 | 1200 | 0.002 U | 0.005 | 0.22 | 0.00019 J | 0.00016 J | 0.001 J | 0.0027 J | 0.0012 | **0.053** | 0.0002 U | **0.45 J** | 0.005 U | 0.001 U | 0.623 ± 0.159 | 0.660 ± 0.378 | 1.28 ± 0.411 |
| | | 03/15/2018 | 7.1 J | 7.8 | 160 | 62 | 0.43 | 150 | 760 | 0.002 U | 0.0038 | 0.35 | 0.000068 J | 0.00024 J | 0.0029 U | 0.0015 | 0.0018 | 0.04 | 0.0002 U | **0.72** | 0.005 U | 0.001 U | 0.684 ± 0.156 | 0.317 U ± 0.255 | 1.00 J ± 0.299 |
| | | 04/03/2018 | 7.3 J | 7.3 | 200 | 65 | 0.33 | 130 | 850 | 0.002 U | 0.0031 | 0.32 | 0.001 U | 0.001 U | 0.00099 J | 0.0011 | 0.0011 | 0.036 J | 0.0002 U | **0.41** | 0.005 U | 0.001 U | 0.560 ± 0.14 | 0.507 ± 0.232 | 1.07 ± 0.271 |
| | | 05/03/2018 | 7 J | 7.7 | 140 | 45 | 0.6 | 110 | 630 | 0.002 U | 0.003 | 0.23 | 0.001 U | 0.00022 J | 0.002 U | 0.00053 | 0.001 U | **0.052** | 0.0002 U | **1.2** | 0.005 U | 0.001 U | 0.458 ± 0.126 | 0.327 U ± 0.258 | 0.785 J ± 0.287 |
| | | 05/24/2018 | 7.4 J | 6.9 | 130 | 52 | 0.77 | 190 | 620 | 0.002 U | 0.0032 | 0.1 | 0.001 U | 0.0003 J | 0.002 U | 0.00044 J | 0.0003 J | **0.061** | 0.0002 U | **1.5** | 0.005 U | 0.001 U | 0.155 ± 0.0928 | 0.0439 U ± 0.275 | 0.199 UJ ± 0.29 |
| | | 06/15/2018 | 7.2 J | 5.6 | 170 | 76 | 0.56 | 250 | 770 | 0.002 U | 0.003 | 0.2 | 0.001 UJ | 0.00022 J | 0.0021 U | 0.00071 | 0.00038 J | **0.062** | 0.0002 U | **0.98** | 0.005 U | 0.001 U | 0.350 ± 0.174 | 0.734 R ± 0.275 | 1.08 R ± 0.325 |
| | | 07/06/2018 | 7.3 J | 5.5 | 160 | 72 | 0.68 | 280 | 770 | 0.002 U | 0.0022 | 0.12 | 0.001 U | 0.00022 J | 0.002 U | 0.00034 J | 0.00023 J | **0.066** | 0.0002 UJ | **1.2** | 0.005 U | 0.001 U | 0.512 R ± 0.183 | 0.416 ± 0.219 | 0.928 R ± 0.285 |
| | | 07/26/2018 | 7 J | 5.2 | 160 | 66 | 0.53 | 180 | 730 | 0.002 U | 0.0018 | 0.22 | 0.001 U | 0.00017 J | 0.002 U | 0.00037 J | 0.00027 J | **0.044** | 0.0002 U | **0.78** | 0.005 U | 0.001 U | 0.652 R ± 0.165 | 0.629 J ± 0.382 | 1.28 R ± 0.416 |
| | | 08/16/2018 | 7.3 J | 7.6 | 180 | 97 | 0.52 | 290 | 820 | 0.002 U | 0.0023 | 0.17 | 0.001 U | 0.00022 J | 0.002 U | 0.00048 J | 0.00037 J | **0.07** | 0.0002 U | **1** | 0.005 U | 0.001 U | 0.545 ± 0.134 | 0.399 R ± 0.225 | 0.943 R ± 0.262 |
| | | 12/05/2018 | 7.1 J | 13 | 190 | 120 | 0.55 | 450 | 1100 | 0.002 U | 0.0027 | 0.16 | 0.001 U | 0.00016 J | 0.002 U | 0.00067 | 0.00042 J | **0.08** | 0.0002 U | **0.86** | 0.005 U | 0.001 U | 0.315 ± 0.115 | 0.436 ± 0.238 | 0.751 ± 0.264 |
| | | 10/28/2019 | 7 J | 14 | - | - | 0.39 J+ | - | - | 0.002 U | 0.002 | 0.25 | 0.001 U | 0.0002 J | 0.0024 | 0.00094 | 0.00094 J | **0.079** | 0.0002 U | **0.92** | 0.005 U | 0.001 U | 0.308 ± 0.119 | 0.243 U ± 0.34 | 0.551 UJ ± 0.36 |
| | | 02/19/2020 | 7 J | 9.9 | 200 | 89 J+ | 0.24 | 230 J+ | 920 | 0.002 U | 0.0014 | 0.39 | 0.001 U | 0.001 U | 0.002 U | 0.00043 J | 0.00071 J | 0.033 | - | **0.26** | - | 0.001 U | 0.462 J- ± 0.147 | 0.629 ± 0.261 | 1.09 J- ± 0.3 |
| | | 03/30/2020 | 6.9 J | 13 | 280 | 130 | 0.48 | 550 | 1200 | 0.002 U | 0.0064 | 0.33 | 0.001 U | 0.001 U | 0.003 | 0.0016 | 0.0027 | **0.1** | - | **0.7** | - | 0.001 U | 0.500 ± 0.174 | 0.650 ± 0.391 | 1.15 ± 0.428 |
| | WAP-4D | 03/22/2017 | 7.6 J | 0.057 | 43 | 24 | 0.16 J+ | 42 | 240 | 0.002 U | 0.01 | 0.24 | 0.001 U | 0.001 U | 0.002 U | 0.00021 J | 0.001 U | 0.05 U | 0.0002 U | 0.0041 J | 0.005 U | 0.001 U | 0.307 ± 0.112 | 0.109 U ± 0.206 | 0.417 ± 0.235 |
| | | 03/14/2018 | 7.8 J | 0.048 J | 55 | 24 | 0.13 | 35 | 240 | 0.002 U | **0.022** | 0.34 | 0.001 U | 0.001 U | 0.0027 U | 0.00091 | 0.00076 J | 0.005 | 0.0002 U | 0.0047 J | 0.005 U | 0.001 U | 0.558 ± 0.137 | 0.640 R ± 0.259 | 1.20 R ± 0.293 |
| | | 04/10/2018 | 7.7 J | 0.048 J | 55 | 26 | 0.11 | 41 | 270 | 0.002 U | 0.013 J+ | 0.3 | 0.001 U | 0.001 U | 0.002 U | 0.00028 J | 0.00057 J | 0.0058 U | 0.0002 U | 0.0045 J | 0.005 U | 0.001 U | 0.481 ± 0.12 | 0.405 R ± 0.215 | 0.885 J+ ± 0.246 |
| | WAP-4I | 03/22/2017 | 7.6 J | 0.093 | 38 | 32 | 0.16 J+ | 74 | 260 | 0.002 U | 0.0027 | 0.19 | 0.001 U | 0.001 U | 0.00045 J | 0.00075 | 0.0004 J | 0.05 U | 0.0002 U | 0.0032 J | 0.005 U | 0.001 U | 0.208 ± 0.0991 | 0.227 U ± 0.205 | 0.435 ± 0.228 |
| | | 03/14/2018 | 7.7 J | 0.059 J | 43 | 21 | 0.1 J | 47 | 210 | 0.002 U | 0.0034 | 0.19 | 0.001 U | 0.001 U | 0.002 U | 0.00048 J | 0.001 U | 0.0062 | 0.0002 U | 0.0028 J | 0.005 U | 0.001 U | 0.228 ± 0.0916 | 0.320 U ± 0.241 | 0.548 J ± 0.258 |
| | | 04/10/2018 | 7.8 J | 0.045 J | 43 | 29 | 0.11 | 56 | 220 | 0.002 U | 0.0031 J+ | 0.19 | 0.001 U | 0.001 U | 0.002 U | 0.00092 | 0.00038 J | 0.0072 U | 0.0002 U | 0.0024 J | 0.005 U | 0.001 U | 0.234 ± 0.0867 | 0.208 U ± 0.216 | 0.442 J ± 0.233 |

**TABLE 1**
**COMPARISON OF WEST ASH POND GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS –**
**JUNE 2016 THROUGH OCTOBER 2020 SAMPLING EVENTS**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| Monitoring Well ID | | Date Sampled | pH (lab) | Boron, Total | Calcium, Total | Chloride | Fluoride | Sulfate | Total Dissolved Solids (TDS) | Antimony, Total | Arsenic, Total | Barium, Total | Beryllium, Total | Cadmium, Total | Chromium, Total | Cobalt, Total | Lead, Total | Lithium, Total | Mercury, Total | Molybdenum, Total | Selenium, Total | Thallium, Total | Radium-226 | Radium-228 | Radium-226 & 228 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | pCi/L | pCi/L |
| Site GWPS (a) | | | NA | NA | NA | NA | 4 | NA | NA | 0.006 | 0.015 | 2 | 0.004 | 0.005 | 0.1 | 0.019 | 0.032 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | NA | NA | 5 |
| Downgradient | WAP-4S | 03/22/2017 | 7.4 J | 12 | 340 | 230 | 0.25 U | 660 | 1700 | 0.002 U | 0.0044 | 0.07 | 0.001 U | 0.00012 J | 0.00047 J | 0.0021 | 0.001 U | 0.023 J | 0.0002 U | 0.3 | 0.005 U | 0.001 U | 0.112 U ± 0.0894 | 0.329 U ± 0.245 | 0.440 ± 0.261 |
| | | 03/14/2018 | 7.4 J | 14 | 330 | 230 | 0.24 | 600 | 1500 | 0.002 U | 0.0036 | 0.063 | 0.001 U | 0.001 U | 0.002 U | 0.0019 | 0.001 U | 0.014 | 0.0002 U | 0.39 | 0.005 U | 0.001 U | 0.100 ± 0.0583 | 0.127 U ± 0.204 | 0.227 UJ ± 0.212 |
| | | 04/02/2018 | 7.4 J | 10 | 360 | 240 | 0.19 | 650 | 1600 | 0.002 U | 0.0048 | 0.08 | 0.001 U | 0.00025 J | 0.00088 J | 0.0026 | 0.0007 J | 0.011 J | 0.0002 U | 0.33 | 0.005 U | 0.001 U | 0.181 ± 0.0774 | 0.512 ± 0.219 | 0.693 ± 0.232 |
| | | 05/03/2018 | 7.4 J | 17 | 310 | 200 | 0.14 J | 490 | 1600 | 0.002 U | 0.0042 | 0.06 | 0.001 U | 0.001 U | 0.002 U | 0.0015 | 0.001 U | 0.017 J+ | 0.0002 U | 0.43 | 0.005 U | 0.001 U | 0.0892 ± 0.0601 | 0.102 U ± 0.213 | 0.191 UJ ± 0.221 |
| | | 05/24/2018 | 7.5 J | 12 | 310 | 220 | 0.24 | 620 | 1600 | 0.002 U | 0.0043 | 0.06 | 0.001 U | 0.001 U | 0.002 U | 0.0014 | 0.001 U | 0.016 J+ | 0.0002 U | 0.42 | 0.005 U | 0.001 U | 0.190 ± 0.102 | -0.00480 U ± 0.231 | 0.190 UJ ± 0.253 |
| | | 06/14/2018 | 6.9 J | 4.2 | 250 | 81 | 0.11 | 510 | 1300 | 0.002 U | 0.00073 J | 0.056 | 0.001 UJ | 0.001 U | 0.002 U | 0.0093 | 0.001 U | 0.0037 J | 0.0002 U | 0.00078 J | 0.005 U | 0.001 U | 0.00495 U ± 0.0976 | 0.471 R ± 0.272 | 0.476 R ± 0.289 |
| | | 07/05/2018 | 7.4 J | 13 | 300 | 210 | 0.23 | 600 | 1500 | 0.002 U | 0.0033 | 0.058 | 0.001 U | 0.001 U | 0.002 U | 0.0013 | 0.001 U | 0.011 | 0.0002 UJ | 0.41 | 0.005 U | 0.001 U | 0.168 U ± 0.128 | 0.259 U ± 0.206 | 0.428 R ± 0.243 |
| | | 07/25/2018 | 7.3 J | 12 | 320 | 220 | 0.25 | 630 | 1400 | 0.002 U | 0.003 | 0.052 | 0.001 U | 0.001 U | 0.002 U | 0.0014 | 0.001 U | 0.005 U | 0.0002 U | 0.4 | 0.005 U | 0.001 U | 0.231 R ± 0.0966 | 0.496 U ± 0.35 | 0.726 J+ ± 0.363 |
| | | 08/16/2018 | 7.3 J | 12 | 290 | 230 | 0.18 | 630 | 1500 | 0.002 U | 0.0031 | 0.05 | 0.001 U | 0.001 U | 0.002 U | 0.0016 | 0.001 U | 0.005 U | 0.0002 U | 0.45 | 0.005 U | 0.001 U | 0.380 R ± 0.109 | 0.178 U ± 0.205 | 0.558 R ± 0.232 |
| | | 12/04/2018 | 7.3 J | 14 | 270 | 190 | 0.24 | 600 | 1300 | 0.002 U | 0.0035 | 0.053 | 0.001 U | 0.00018 J | 0.002 U | 0.0018 | 0.00031 J | 0.012 | 0.0002 U | 0.43 | 0.005 U | 0.001 U | 0.136 ± 0.0833 | 0.178 U ± 0.197 | 0.315 UJ ± 0.214 |
| | | 10/25/2019 | 7.3 J | 12 | - | - | 0.17 J+ | - | - | 0.002 U | 0.0054 | 0.049 | 0.001 U | 0.001 U | 0.002 U | 0.0023 | 0.001 U | 0.0036 J | 0.0002 U | 0.5 | 0.005 U | 0.001 U | 0.131 U ± 0.102 | -0.0635 U ± 0.322 | 0.131 U ± 0.338 |
| | | 02/19/2020 | 7.4 J | 10 | 290 | 150 J+ | 0.16 | 530 J+ | 1200 | 0.002 U | 0.0032 | 0.056 | 0.001 U | 0.001 U | 0.002 U | 0.0022 | 0.001 U | 0.005 U | - | 0.33 | - | 0.001 U | 0.136 J- ± 0.0915 | 0.154 U ± 0.227 | 0.289 UJ ± 0.245 |
| | | 03/30/2020 | 7.2 J | 12 | 320 | 180 | 0.17 | 530 | 1200 | 0.002 U | 0.0061 | 0.056 | 0.001 U | 0.001 U | 0.002 U | 0.0019 | 0.001 U | 0.0049 J | 0.0002 U | 0.47 | - | 0.001 U | 0.128 U ± 0.122 | 0.774 U ± 0.589 | 0.901 U ± 0.602 |
| | WAP-5D | 03/21/2017 | 7.5 J | 0.13 | 42 | 26 | 0.23 | 63 | 280 | 0.002 U | 0.0017 | 0.14 | 0.001 U | 0.001 U | 0.002 U | 0.00014 J | 0.001 U | 0.05 U | 0.0002 U | 0.0047 J | 0.005 U | 0.001 U | 0.191 ± 0.0921 | -0.0215 U ± 0.231 | 0.191 UJ ± 0.249 |
| | | 03/13/2018 | 7.6 J | 0.057 J | 54 | 22 | 0.13 | 47 | 230 | 0.0011 J | 0.097 | 0.44 | 0.00044 J | 0.00014 J | 0.015 J+ | 0.0053 | 0.011 | 0.0092 | 0.0002 U | 0.0064 | 0.0013 J | 0.00014 J | 0.771 ± 0.165 | 1.01 R ± 0.307 | 1.78 R ± 0.349 |
| | | 04/09/2018 | 7.5 J | 0.044 J | 50 | 24 | 0.099 J | 52 | 240 | 0.002 U | 0.013 J+ | 0.23 | 0.001 U | 0.001 U | 0.002 U | 0.000096 J | 0.001 U | 0.005 U | 0.0002 U | 0.0036 J | 0.005 U | 0.001 U | 0.564 ± 0.135 | 0.499 R ± 0.255 | 1.06 J+ ± 0.289 |
| | WAP-5I | 03/21/2017 | 7.5 J | 0.071 | 37 | 31 | 0.17 J+ | 72 | 260 | 0.002 U | 0.002 | 0.12 | 0.001 U | 0.001 U | 0.00057 J | 0.00053 | 0.00037 J | 0.05 U | 0.0002 U | 0.0021 J | 0.005 U | 0.001 U | 0.249 ± 0.099 | 0.268 U ± 0.303 | 0.517 ± 0.319 |
| | | 03/13/2018 | 7.6 J | 0.077 J | 42 | 22 | 0.14 | 51 | 210 | 0.002 U | 0.0021 J+ | 0.13 | 0.001 U | 0.001 U | 0.002 U | 0.0005 | 0.00021 J | 0.0059 | 0.0002 U | 0.0017 J | 0.005 U | 0.001 U | 0.122 ± 0.0622 | 0.332 U ± 0.248 | 0.454 J ± 0.256 |
| | | 04/10/2018 | 7.6 J | 0.048 J | 45 | 30 | 0.046 J | 58 | 230 | 0.002 U | 0.0027 J+ | 0.13 | 0.001 U | 0.001 U | 0.002 U | 0.00049 J | 0.00033 J | 0.0069 U | 0.0002 U | 0.002 J | 0.005 U | 0.001 U | 0.215 ± 0.0828 | 0.576 R ± 0.243 | 0.791 R ± 0.257 |
| | WAP-5S | 03/21/2017 | 6.8 J | 3.8 | 230 | 84 | 0.11 | 420 | 1300 | 0.002 U | 0.00073 J | 0.055 | 0.001 U | 0.001 U | 0.002 U | 0.0098 | 0.001 U | 0.05 U | 0.0002 U | 0.00063 J | 0.005 U | 0.001 U | 0.0946 U ± 0.0747 | 0.377 U ± 0.255 | 0.472 ± 0.266 |
| | | 03/13/2018 | 7 J | 4.5 | 230 | 79 | 0.1 | 420 | 1200 | 0.002 U | 0.001 U | 0.058 | 0.001 U | 0.001 U | 0.002 U | 0.0089 | 0.001 U | 0.0037 J | 0.0002 U | 0.00064 J | 0.005 U | 0.001 U | 0.0892 ± 0.0606 | 0.157 U ± 0.226 | 0.246 UJ ± 0.234 |
| | | 04/02/2018 | 6.9 J | 4.5 | 250 | 71 | 0.11 | 420 | 1200 | 0.0021 U | 0.00076 J | 0.053 | 0.001 U | 0.001 U | 0.002 U | 0.0085 | 0.001 U | 0.05 U | 0.0002 U | 0.0024 J | 0.005 U | 0.00011 J | 0.0528 U ± 0.0514 | 0.161 U ± 0.192 | 0.214 U ± 0.199 |
| | | 05/03/2018 | 6.8 J | 4.7 | 240 | 83 | 0.075 J | 420 | 1300 | 0.002 U | 0.00089 J | 0.061 | 0.001 U | 0.001 U | 0.002 U | 0.0093 | 0.001 U | 0.0054 U | 0.0002 U | 0.0007 J | 0.005 U | 0.001 U | 0.112 ± 0.065 | 0.150 U ± 0.249 | 0.262 UJ ± 0.257 |
| | | 05/23/2018 | 6.9 J | 4.2 | 230 | 84 | 0.15 | 470 | 1300 | 0.002 U | 0.00065 J | 0.053 | 0.001 U | 0.001 U | 0.002 U | 0.008 | 0.001 U | 0.005 U | 0.0002 U | 0.00067 J | 0.005 U | 0.001 U | 0.178 ± 0.0963 | 0.231 U ± 0.245 | 0.409 J ± 0.263 |
| | | 06/14/2018 | 7.5 J | 14 | 320 | 220 | 0.21 | 650 | 1500 | 0.002 U | 0.0042 | 0.063 | 0.001 UJ | 0.001 U | 0.002 U | 0.0016 | 0.001 U | 0.016 | 0.0002 U | 0.4 | 0.005 U | 0.001 U | 0.110 U ± 0.126 | 0.110 U ± 0.241 | 0.220 U ± 0.272 |
| | | 07/05/2018 | 6.8 J | 3.7 | 240 | 81 | 0.094 J | 470 | 1300 | 0.002 U | 0.00057 J | 0.055 | 0.001 U | 0.001 U | 0.002 U | 0.0079 | 0.001 U | 0.005 U | 0.0002 UJ | 0.00065 J | 0.005 U | 0.001 U | 0.343 R ± 0.153 | 0.0391 U ± 0.19 | 0.382 R ± 0.244 |
| | | 07/25/2018 | 6.7 J | 3.8 | 250 | 81 | 0.12 | 470 | 1200 | 0.002 U | 0.00055 J | 0.049 | 0.000084 J | 0.001 U | 0.002 U | 0.0074 | 0.001 U | 0.005 U | 0.0002 U | 0.005 U | 0.005 U | 0.001 U | 0.397 R ± 0.138 | 0.0522 U ± 0.242 | 0.450 R ± 0.279 |
| | | 08/16/2018 | 6.8 J | 4.4 | 240 | 70 | 0.087 J | 420 | 1300 | 0.002 U | 0.00086 J | 0.056 | 0.001 U | 0.001 U | 0.002 U | 0.0086 | 0.001 U | 0.005 U | 0.0002 U | 0.00068 J | 0.005 U | 0.001 U | 0.248 R ± 0.0916 | 0.194 U ± 0.222 | 0.442 R ± 0.24 |
| | | 12/04/2018 | 6.7 J | 4.5 | 220 | 100 | 0.11 | 440 | 1200 | 0.002 U | 0.00069 J | 0.053 | 0.001 U | 0.001 U | 0.002 U | 0.0078 | 0.001 U | 0.0044 J | 0.0002 U | 0.00077 J | 0.005 U | 0.001 U | 0.0740 U ± 0.073 | 0.113 U ± 0.213 | 0.187 U ± 0.225 |
| | | 10/25/2019 | 6.8 J | 4.2 | - | - | 0.1 U | - | - | 0.002 U | 0.0013 | 0.061 | 0.001 U | 0.00015 J | 0.002 U | 0.0094 | 0.001 U | 0.0047 J | 0.0002 U | 0.00097 J | 0.005 U | 0.00022 J | 0.0779 U ± 0.0866 | 0.276 U ± 0.271 | 0.354 U ± 0.285 |
| | | 02/18/2020 | 6.9 J | 3.9 | 210 | 100 J+ | 0.099 J | 320 J+ | 940 | 0.002 U | 0.00058 J | 0.047 | 0.001 U | 0.001 U | 0.002 U | 0.0063 | 0.001 U | 0.005 U | - | 0.00097 J | - | 0.001 U | 0.0104 R ± 0.0669 | 0.249 U ± 0.224 | 0.259 UJ ± 0.234 |
| | | 03/30/2020 | 6.7 J | 4.5 | 250 | 130 | 0.064 J | 390 | 1100 | 0.002 U | 0.001 U | 0.046 | 0.001 U | 0.001 U | 0.002 U | 0.0062 | 0.001 U | 0.005 U | - | 0.00086 J | - | 0.001 U | 0.000 U ± 0.0649 | 0.648 U ± 0.364 | 0.648 J ± 0.37 |
| | WAP-6S | 10/14/2020 | 7.4 HF | 1.2 | 87 | - | - | - | 450 | 0.002 U | 0.00092 J | 0.082 | 0.001 U | 0.001 U | 0.002 U | 0.0016 | 0.001 U | 0.0024 J | 0.0002 U | 0.16 | 0.005 U | 0.001 U | - | - | - |
| | WAP-6I | 10/14/2020 | 7.6 HF | 0.098 | 41 | - | - | - | 210 | 0.002 U | 0.0043 J | 0.14 | 0.00034 J | 0.001 U | 0.002 U | 0.0003 J | 0.001 U | 0.0033 J | 0.0002 U | 0.0063 | 0.005 U | 0.00028 J | - | - | - |
| | WAP 6D | 10/14/2020 | 7.7 HF | 0.051 | 40 | - | - | - | 200 | 0.002 U | 0.0057 | 0.18 | 0.001 U | 0.001 U | 0.002 U | 0.001 U | 0.001 U | 0.0023 J | 0.0002 U | 0.0023 J | 0.005 U | 0.00026 J | - | - | - |

Notes:
Blank cells - Constituent not included in this analysis.
GW - Groundwater.
GWPS - Groundwater Protection Standard.

mg/L - milligrams per liter.
NA - Not Available.
pCi/L - picoCurie per liter.
su - Standard Units

(a) - Site GWPS provided in Table II of 2020 "Annual Groundwater Monitoring and Corrective Action Report" for the FBC West Ash Pond.
Available at: https://www.vectren.com/assets/downloads/planning/ccr/Culley-West-Ash-Pond-Annual-Ground-Water-Report-2020.pdf.

Detected Concentration > Groundwater Protection Standard.

Qualifiers:
HF: Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

**TABLE 2**
**HUMAN HEALTH PUBLISHED SCREENING LEVELS FOR SURFACE WATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| | | Human Health Published Screening Level - Drinking Water | | | Human Health Published Screening Level - Surface Water | | | | Selected Published Human Health Screening Levels for Surface Water | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Constituent** | **CAS RN** | **USEPA MCL (a) (mg/L)** | **USEPA RSL Tap Water (b) (mg/L)** | **IDEM Criteria for Drinking Water Class Groundwater (c) (mg/L)** | **ORSANCO Human Health Water Quality Standards (d) (mg/L)** | **USEPA NRWQC Consumption of Organism Only (e) (mg/L)** | **IDEM CCC HLSC Consumption of Organism Only (proposed) (f)(g) (mg/L)** | **IDEM CCC HLSC Consumption of Organism Only (current) (h) (mg/L)** | **Selected Screening Level - Drinking Water (i) (mg/L)** | **Selected Screening Level - Surface Water Consumption of Organism Only (j) (mg/L)** |
| **Detection Monitoring - USEPA Appendix III Constituents (r)** | | | | | | | | | | |
| Boron | 7440-42-8 | NA | 4 | NA | NA | NA | NA | NA | 4 | NA |
| Fluoride | 16984-48-8 | 4 | 0.8 | 4 | 1 | NA | NA | NA | 4 | 1 |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | | | |
| Antimony | 7440-36-0 | 0.006 | 0.0078 | 0.006 | 0.0056 | 0.64 | 0.64 | 45 | 0.006 | 0.0056 |
| Arsenic | 7440-38-2 | 0.01 | 0.000052 | 0.01 | 0.01 | 0.0014 (m, n) | NP | 0.000175 (l) | 0.01 | 0.01 |
| Barium | 7440-39-3 | 2 | 3.8 | 2 | 1 | NA | NA | NA | 2 | 1 |
| Beryllium | 7440-41-7 | 0.004 | 0.025 | 0.004 | NA | NA | NP | 0.00117 | 0.004 | 0.00117 |
| Cadmium | 7440-43-9 | 0.005 | 0.0092 | 0.005 | NA | NA | NP | NA | 0.005 | NA |
| Chromium (Total) | 7440-47-3 | 0.1 | 22 (k) | 0.1 | NA (k) | NA (k) | NP (k) | 3433 (k) | 0.1 | 3433 |
| Cobalt | 7440-48-4 | NA | 0.006 | NA | NA | NA | NA | NA | 0.006 | NA |
| Lead | 7439-92-1 | 0.015 (o) | 0.015 (o) | 0.015 (o) | NA | NA | NP | NA | 0.015 | NA |
| Lithium | 7439-93-2 | NA | 0.04 | NA | NA | NA | NA | NA | 0.04 | NA |
| Mercury | 7439-97-6 | 0.002 (p) | 0.0057 (q) | 0.002 (p) | 0.000012 | NA | 0.00015 | 0.00015 | 0.002 | 0.000012 |
| Molybdenum | 7439-98-7 | NA | 0.1 | NA | NA | NA | NA | NA | 0.1 | NA |
| Selenium | 7782-49-2 | 0.05 | 0.1 | 0.05 | 0.17 | 4.2 | 4.2 | NA | 0.05 | 0.17 |
| Thallium | 7440-28-0 | 0.002 | 0.0002 | 0.002 | 0.00024 | 0.00047 | 0.048 | 0.048 | 0.002 | 0.00024 |
| **Radiological (pCi/L)** | | | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | 5 | NA | 5 | 4 | NA | NA | NA | 5 | 4 |

Notes:

CAS RN - Chemical Abstracts Service Registry Number.
CCC HLSC - Continuous Criterion Concentration. Human Life-Cycle Safe Concentration.
IDEM - Indiana Department of Environmental Management.
MCL - Maximum Contaminant Level.
mg/L - milligrams/liter.
NA - Not Available.
NP - Not Proposed. Criteria to be deleted.
NRWQC - National Recommended Water Quality Criteria.
ORSANCO - Ohio River Valley Water Sanitation Commission.
pCi/L - picoCuries/liter.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.

(a) - USEPA, 2018. 2018 Edition of the Drinking Water Standards and Health Advisories. March.
https://www.epa.gov/dwstandardsregulations/2018-drinking-water-standards-and-advisory-tables
(b) - USEPA, 2020. Regional Screening Levels (November 2020). Values for Tap Water, Hazard Index = 1.0. TR = 1E-06.
https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
(c) - IDEM Water Quality Standards. Title 327 of the Indiana Administrative Code (IAC). Article 2. Water Quality Standards. Rule 11. Ground Water Quality Standards.
Part 327 IAC 2-11-6. Criteria for Drinking Water Class Ground Water.
http://iac.iga.in.gov/iac//T03270/A00020.PDF?
(d) - Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision.
Chapter 3 Water Quality Criteria - Human Health. Human health protection criteria are protective of drinking water, recreational, and fish consumption uses
http://www.orsanco.org/wp-content/uploads/2019/06/Final-Standards-Doc-2019-Revision.pdf
(e) - USEPA National Recommended Water Quality Criteria - Human Health Criteria Table.
USEPA NRWQC - Human Health Criterion for the Consumption of Organism Only apply to total concentrations
https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table
(f) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards.
http://www.in.gov/idem/cleanwater/2329.htm
(g) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards. Active Projects - Planned Revisions to Metals Criteria for the Protection of Aquatic Life and Human Health.
Second Notice of Tables of Rulemaking. IDEM is providing notice of its intent to revise Indiana's Aquatic Life and Human Health Ambient Water Quality Criteria (WQC) for metals (total recoverable).
Proposed revisions reflect updates to USEPA NRWQC at Section 304(a) of the Clean Water Act.
https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice.pdf
(h) - IDEM Water Quality Standards. Title 327 of the IAC. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters of the State Within the Great Lakes System.
Part 327 IAC 2-1-6 Minimum Surface Water Quality Standards. Table 6-1. Surface Water Quality Standards for metals apply to total recoverable concentrations.
For carcinogenic substances, criteria are to protect human health from unacceptable cancer risk of greater than one (1) additional occurrence of cancer per one hundred thousand (100,000) population.
http://iac.iga.in.gov/iac//T03270/A00020.PDF?
(i) - The hierarchy for selection among the Human Health Published Screening Levels for Drinking Water is:
1) USEPA MCL
2) USEPA RSL - Tap Water
3) IDEM Criteria for Drinking Water Class Groundwater
(j) - The hierarchy for selection among the Human Health Published Screening Values for Surface Water - Consumption of Organism Only is:
1) ORSANCO Human Health Water Quality Standards
2) USEPA NRWQC - Consumption of Organism Only.
3) IDEM CCC HLSC - Consumption of Organism Only (proposed).
4) IDEM CCC HLSC - Consumption of Organism Only (current).
(k) - Value for chromium (III).
(l) - Value for inorganic arsenic as arsenite, As(III). Value derived from nonthreshold cancer risk.
(m) - Value for inorganic arsenic only.
(n) - This criterion adjusted to a carcinogenicity of 1E-05 risk.
(o) - Lead Action Level. This is a drinking water treatment action level applicable to regulated Community and Non-Transient Non-Community public water systems.
http://www.in.gov/idem/files/factsheet_owq_pws_lead_copper.pdf
https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=60001N8P.txt
(p) - Value for inorganic mercury.
(q) - Value for mercuric chloride.
(r) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

**TABLE 3**
**HUMAN HEALTH CALCULATED RISK BASED SCREENING LEVELS FOR SURFACE WATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| Constituent | CAS RN | Human Health Calculated RBSL - Recreational Use of Surface Water (c): Current/Future Off-Site Recreational Swimmer Age-Adjusted (Ages 1 - 26) (a) (mg/L) | | Current/Future Off-Site Recreational Wader Age-Adjusted (Ages 1 - 26) (a) (mg/L) | | Current/Future Off-Site Recreational Boater (Adult) (a) (mg/L) | | Selected Human Health Calculated RBSL - Recreational Use of Surface Water (b) (mg/L) |
|---|---|---|---|---|---|---|---|---|
| **Detection Monitoring - USEPA Appendix III Constituents (d)** | | | | | | | | |
| Boron | 7440-42-8 | 114 | | 120 | | 11,200 | | 114 |
| Fluoride | 16984-48-8 | 22.9 | | 23.9 | | 2,240 | | 22.9 |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | |
| Antimony | 7440-36-0 | 0.171 | | 0.218 | | 3.36 | | 0.171 |
| Arsenic | 7440-38-2 | 0.172 | (e, f) | 0.179 | (e, g) | 16.8 | (e, h) | 0.172 |
| Barium | 7440-39-3 | 63.7 | | 97.1 | | 784 | | 63.7 |
| Beryllium | 7440-41-7 | 0.121 | | 0.345 | | 0.784 | | 0.121 |
| Cadmium | 7440-43-9 | 0.134 | | 0.225 | | 1.4 | | 0.134 |
| Chromium (Total) | 7440-47-3 | 155 | (i) | 386 | (i) | 1,090 | (i) | 155 |
| Cobalt | 7440-48-4 | 0.178 | | 0.181 | | 42 | | 0.178 |
| Lead | 7439-92-1 | 0.015 | (j) | 0.015 | (j) | 0.015 | (j) | 0.015 |
| Lithium | 7439-93-2 | 1.14 | | 1.2 | | 112 | | 1.14 |
| Mercury | 7439-97-6 | 0.0956 | (k) | 0.146 | (k) | 1.18 | (k) | 0.0956 |
| Molybdenum | 7439-98-7 | 2.86 | | 2.99 | | 280 | | 2.86 |
| Selenium | 7782-49-2 | 2.86 | | 2.99 | | 280 | | 2.86 |
| Thallium | 7440-28-0 | 0.00572 | | 0.00598 | | 0.56 | | 0.00572 |
| **Radiological (pCi/L)** | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | NA | | NA | | NA | | NA |

Notes:

CAS RN - Chemical Abstracts Service Registry Number.
NA - Not Available.
pCi/L - picoCuries/liter.
mg/L - micrograms/liter.
RBSL - Risk-Based Screening Level.
USEPA - United States Environmental Protection Agency.

(a) - Documentation for the receptor-specific Human Health Calculated Screening Level for Recreational Use of Surface Water is provided in Attachment B.
(b) - The selected human health RBSL for recreational use of surface water is the minimum value from amongst the Current/Future Off-Site Recreational Swimmer, Current/Future Off-Site Recreational Wader, and Current/Future Off-Site Recreational Boater RBSLs.
(c) - Some calculated values may be above solubility limits.
(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.
(e) - Arsenic RBSLs are based on the lower of the values based on a hazard index of 1 and an excess lifetime cancer risk of 1E-04.
Note that of the constituents evaluated, arsenic is the only constituent with an RSL based on potential carcinogenic effects.
(f) - RBSL based on noncancer endpoint (cancer-based RBSL at 1E-4 is 0.236 mg/L).
(g) - RBSL based on noncancer endpoint (cancer-based RBSL at 1E-4 is 0.389 mg/L).
(h) - RBSL based on noncancer endpoint (cancer-based RBSL at 1E-4 is 26.1 mg/L).
(i) - Value for chromium (III) used.
(j) - USEPA lead action level of 0.015 mg/L for lead in drinking water (USEPA, 2018) is used as the RBSL.
(k) - Value for mercuric chloride used.

**TABLE 4**
**ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| | | Ecological Published Screening Levels - Surface Water | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ORSANCO Aquatic Life Criteria CMC - Freshwater (acute) (a) (mg/L) | | ORSANCO Aquatic Life Criteria CCC - Freshwater (chronic) (a) (mg/L) | | USEPA NRWQC Aquatic Life Criteria CMC - Freshwater (acute) (b) (mg/L) | | USEPA NRWQC Aquatic Life Criteria CCC - Freshwater (chronic) (b) (mg/L) | | USEPA Region 5 Ecological Screening Values (freshwater - chronic) (c) (mg/L) | | IDEM AAC Aquatic Life Criterion (acute) (proposed) (d)(e) (mg/L) | | IDEM CAC Aquatic Life Criterion (chronic) (proposed) (d)(e) (mg/L) | | IDEM AAC Aquatic Life Criterion (acute) (current) (f) (mg/L) | | IDEM CAC Aquatic Life Criterion (chronic) (current) (f) (mg/L) | | Selected Ecological Screening Level (acute) (g) (mg/L) | | Selected Ecological Screening Level (chronic) (g) (mg/L) | |
| **Constituent** | **CAS RN** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** |
| **Detection Monitoring - USEPA Appendix III Constituents (m)** | | | | | | | | | | | | | | | | | | | | | | | |
| Boron | 7440-42-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Fluoride | 16984-48-8 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | | | | | | | | | | | | | | | | |
| Antimony | 7440-36-0 | NA | NA | NA | NA | NA | NA | NA | NA | 0.08 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.08 | NA |
| Arsenic | 7440-38-2 | 0.34 (i) | 0.34 (i) | 0.15 (i) | 0.15 (i) | 0.34 (i) | 0.34 (i) | 0.15 (i) | 0.15 (i) | 0.148 | NA | 0.34 | 0.34 (j) | 0.15 | 0.15 (j) | 0.36 | 0.36 (j) | 0.19 | 0.19 (j) | 0.34 | 0.34 | 0.15 | 0.15 |
| Barium | 7440-39-3 | NA | NA | NA | NA | NA | NA | NA | NA | 0.22 (h) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.22 | NA |
| Beryllium | 7440-41-7 | NA | NA | NA | NA | NA | NA | NA | NA | 0.0036 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.0036 | NA |
| Cadmium | 7440-43-9 | 0.0021 (k) | 0.0020 (k) | 0.00027 (k) | 0.00025 (k) | 0.0019 (k) | 0.0018 (k) | 0.00079 (k) | 0.00072 (k) | 0.00015 (h) | NA | 0.0019 (k) | 0.0018 (k) | 0.00079 (k) | 0.00072 (k) | 0.0039 (k) | 0.0037 (k) | 0.0011 (k) | 0.0010 (k) | 0.0021 | 0.0020 | 0.00027 | 0.00025 |
| Chromium (Total) | 7440-47-3 | 1.8 (n) | 0.57 (n) | 0.086 (n) | 0.074 (n) | 1.8 (n) | 0.57 (n) | 0.086 (n) | 0.074 (n) | 0.042 h, n | NA | 1.8 (n) | 0.57 (n) | 0.086 (n) | 0.074 (n) | 1.7 (n) | 0.55 (n) | 0.21 (n) | 0.18 (n) | 1.8 | 0.57 | 0.086 | 0.074 |
| Cobalt | 7440-48-4 | NA | NA | NA | NA | NA | NA | NA | NA | 0.024 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.024 | NA |
| Lead | 7439-92-1 | 0.082 (k) | 0.065 (k) | 0.0032 (k) | 0.0025 (k) | 0.082 (k) | 0.065 (k) | 0.0032 (k) | 0.0025 (k) | 0.00117 (h) | NA | 0.12 (k) | 0.10 (k) | 0.010 (k) | 0.0079 (k) | 0.082 (k) | 0.065 (k) | 0.0032 (k) | 0.0025 (k) | 0.082 | 0.065 | 0.0032 | 0.0025 |
| Lithium | 7439-93-2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mercury | 7439-97-6 | 0.0017 (l) | 0.0014 (l) | 0.00091 (l) | 0.00077 (l) | 0.0016 (l) | 0.0014 (l) | 0.00091 (l) | 0.00077 (l) | 0.0000013 | NA | 0.0024 | NA | 0.000012 | NA | 0.0024 | NA | 0.000012 | NA | 0.0017 | 0.0014 | 0.00091 | 0.00077 |
| Molybdenum | 7439-98-7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Selenium | 7782-49-2 | NA | NA | 0.005 | NA | NA | NA | NA | 0.0031 (o) | 0.005 | NA | NA | NA | NA | 0.0031 (o) | 0.13 | NA | 0.035 | NA | 0.13 | NA | 0.005 | 0.0031 |
| Thallium | 7440-28-0 | NA | NA | NA | NA | NA | NA | NA | NA | 0.01 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.01 | NA |
| **Radiological (pCi/L)** | | | | | | | | | | | | | | | | | | | | | | | |
| Radium-226 & 22 | 7440-14-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:

AAC - Acute Aquatic Criterion
CAC - Chronic Aquatic Criterion
CAS RN - Chemical Abstracts Service Registry Number.
CCC - Continuous Criterion Concentration
CMC - Criterion Maximum Concentration
IDEM - Indiana Department of Environmental Management
mg/L - micrograms/liter.
NA - Not Available
NRWQC - National Recommended Water Quality Criteria
ORSANCO - Ohio River Valley Water Sanitation Commission
pCi/L - picoCuries/liter.
USEPA - United States Environmental Protection Agency

**TABLE 4**
**ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

Notes:
(a) - Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision.
Chapter 3 Water Quality Criteria - Aquatic life. Aquatic Life criteria are protective of maintaining fish and other aquatic life.
http://www.orsanco.org/wp-content/uploads/2019/06/Final-Standards-Doc-2019-Revision.pdf
(b) - USEPA Water Quality Criteria. Current Water Quality Criteria Tables. National Recommended Water Quality Criteria - Aquatic Life Criteria Table.
http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
(c) - USEPA Archive Document. USEPA Region 5 Resource Conservation and Recovery Act (RCRA) - Ecological Screening Values. August 22, 2003.
https://archive.epa.gov/region5/waste/cars/web/pdf/ecological-screening-levels-200308.pdf
(d) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards. Active Projects - Planned Revisions to Metals Criteria for the Protection of Aquatic Life and Human Health.
Second Notice of Tables of Rulemaking. IDEM is providing notice of its intent to revise Indiana's Aquatic Life and Human Health Ambient Water Quality Criteria (WQC) for metals (total recoverable).
Aquatic Life Criteria Tables 1, 2, and 4. The screening levels for hardness-dependent metals are calculated for a default hardness value of 100 mg/L CaCO3.
Proposed revisions reflect updates to USEPA NRWQC at Section 304(a) of the Clean Water Act.
https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice.pdf
(e) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards.
http://www.in.gov/idem/cleanwater/2329.htm
(f) - IDEM Water Quality Standards. Title 327 of the IAC. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters of the State Within the Great Lakes System.
Part 327 IAC 2-1-6 Minimum Surface Water Quality Standards. Tables 6-1, 6-2, and 6-3. Surface Water Quality Standards for metals apply to total recoverable concentrations.
The screening levels for hardness-based metals are calculated for a default hardness value of 100 mg/L $CaCO_3$.
http://iac.iga.in.gov/iac//T03270/A00020.PDF?
(g) - The hierarchy for the selection of ecological screening levels is:
1) ORSANCO Aquatic Life Criterion.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
3) USEPA Region 5. Freshwater Screening Values.
4) IDEM Aquatic Life Criterion (proposed).
5) IDEM Aquatic Life Criterion (current).
(h) - USEPA Region 5, RCRA Ecological Screening Levels (archive 2003-08-22) for hardness-dependent metal, freshwater - chronic criteria. Value displayed corresponds to a soft water total hardness of 50 mg/L as $CaCO_3$.
(i) - Value for inorganic arsenic only.
(j) - Value for inorganic arsenic as arsenite, As(III).
(k) - Criterion expressed as a function of total hardness (mg/L). Value displayed is the site-specific total hardness of 100 mg/L.
(l) - Aquatic Life Criterion for metallic mercury (CAS RN 7439-97-6) and/or methylmercury (CAS RN 22967-92-6).
(m) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.
(n) - Value for chromium (III).
(o) - USEPA Office of Water. Final Criterion: Aquatic Life Ambient Water Quality Criterion for Selenium - Freshwater. 30 June 2016.
Freshwater value for chronic (30 day) water column concentration (mg/L) of dissolved selenium in lotic (flowing) surface water. The criterion is based on fish ovary concentrations, and in lieu of that, the water column values are used.
https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf

**TABLE 5**
**SELECTED SURFACE WATER SCREENING LEVELS**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| Constituent | CAS RN | HH DW SL (a) (mg/L) | HH REC SL - Consumption of Organism Only (b) (mg/L) | HH Recreational Calculated RBSL (c) (mg/L) | ECO SL - Total (acute) (d) (mg/L) | ECO SL - Dissolved (acute) (d) (mg/L) | ECO SL - Total (chronic) (d) (mg/L) | ECO SL - Dissolved (chronic) (d) (mg/L) |
|---|---|---|---|---|---|---|---|---|
| **Detection Monitoring - USEPA Appendix III Constituents (e)** | | | | | | | | |
| Boron | 7440-42-8 | 4 | NA | 114 | NA | NA | NA | NA |
| Fluoride | 16984-48-8 | 4 | 1 | 22.9 | NA | NA | NA | NA |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | |
| Antimony | 7440-36-0 | 0.006 | 0.0056 | 0.171 | NA | NA | 0.08 | NA |
| Arsenic | 7440-38-2 | 0.01 | 0.01 | 0.236 | 0.34 | 0.34 | 0.15 | 0.15 |
| Barium | 7440-39-3 | 2 | 1 | 63.7 | NA | NA | 0.22 | NA |
| Beryllium | 7440-41-7 | 0.004 | 0.00117 | 0.121 | NA | NA | 0.0036 | NA |
| Cadmium | 7440-43-9 | 0.005 | NA | 0.134 | 0.0021 | 0.0020 | 0.00027 | 0.00025 |
| Chromium (Total) | 7440-47-3 | 0.1 | 3433 | 155 | 1.8 | 0.57 | 0.086 | 0.074 |
| Cobalt | 7440-48-4 | 0.006 | NA | 0.178 | NA | NA | 0.024 | NA |
| Lead | 7439-92-1 | 0.015 | NA | 0.015 | 0.082 | 0.065 | 0.0032 | 0.0025 |
| Lithium | 7439-93-2 | 0.04 | NA | 1.14 | NA | NA | NA | NA |
| Mercury | 7439-97-6 | 0.002 | 0.000012 | 0.0956 | 0.0017 | 0.0014 | 0.00091 | 0.00077 |
| Molybdenum | 7439-98-7 | 0.1 | NA | 2.86 | NA | NA | NA | NA |
| Selenium | 7782-49-2 | 0.05 | 0.17 | 2.86 | 0.13 | NA | 0.005 | 0.0031 |
| Thallium | 7440-28-0 | 0.002 | 0.00024 | 0.00572 | NA | NA | 0.01 | NA |
| **Radiological (pCi/L)** | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | 5 | 4 | NA | NA | NA | NA | NA |

Notes:

CAS RN - Chemical Abstracts Service Registry Number.
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.
RBSL - Risk-Based Screening Level.

(a) - Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
1) USEPA MCL
2) USEPA RSL - Tap Water
3) IDEM Criteria for Drinking Water Class Groundwater

(b) - Human Health Published Screening Values for Surface Water - Consumption of Organism Only selected in Table 2 using the following hierarchy:
1) ORSANCO Human Health Water Quality Standards
2) USEPA NRWQC - Consumption of Organism Only.
3) IDEM CCC HLSC - Consumption of Organism Only (proposed).
4) IDEM CCC HLSC - Consumption of Organism Only (current).

(c) - The Human Health Calculated Screening Levels are presented in Table 3.
The minimum calculated value for the Off-Site Recreational Boater, Wader, and Swimmer was selected.

(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:
1) ORSANCO Aquatic Life Criterion.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
3) USEPA Region 5. Freshwater Screening Values.
4) IDEM Aquatic Life Criterion (proposed).
5) IDEM Aquatic Life Criterion (current).

(e) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

**TABLE 6**
**TEMPORAL AVERAGES - WELL WAP-3S**
**JUNE 2016 THROUGH MARCH 2020 SAMPLING EVENTS**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION**
**NEWBURGH, INDIANA**

| Monitoring Well ID | Date Sampled | pH (lab) | Boron, Total | Calcium, Total | Chloride | Fluoride | Sulfate | Total Dissolved Solids (TDS) | Antimony, Total | Arsenic, Total | Barium, Total | Beryllium, Total | Cadmium, Total | Chromium, Total | Cobalt, Total | Lead, Total | Lithium, Total | Mercury, Total | Molybdenum, Total | Selenium, Total | Thallium, Total | Radium-226 & 228 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L |
| | 03/23/2017 | 6.9 J | 12 | 240 | 130 J | 0.28 | 310 | 1200 | 0.002 U | 0.005 | 0.22 | 0.00019 J | 0.00016 J | 0.001 J | 0.0027 J | 0.0012 | 0.053 | 0.0002 U | 0.45 J | 0.005 U | 0.001 U | 1.28 ± 0.411 |
| | 03/15/2018 | 7.1 J | 7.8 | 160 | 62 | 0.43 | 150 | 760 | 0.002 U | 0.0038 | 0.35 | 0.000068 J | 0.00024 J | 0.0029 U | 0.0015 | 0.0018 | 0.04 | 0.0002 U | 0.72 | 0.005 U | 0.001 U | 1.00 J ± 0.299 |
| | 04/03/2018 | 7.3 J | 7.3 | 200 | 65 | 0.33 | 130 | 850 | 0.002 U | 0.0031 | 0.32 | 0.001 U | 0.001 U | 0.00099 J | 0.0011 | 0.0011 | 0.036 J | 0.0002 U | 0.41 | 0.005 U | 0.001 U | 1.07 ± 0.271 |
| | 05/03/2018 | 7 J | 7.7 | 140 | 45 | 0.6 | 110 | 630 | 0.002 U | 0.003 | 0.23 | 0.001 U | 0.00022 J | 0.002 U | 0.00053 | 0.001 U | 0.052 | 0.0002 U | 1.2 | 0.005 U | 0.001 U | 0.785 J ± 0.287 |
| | 05/24/2018 | 7.4 J | 6.9 | 130 | 52 | 0.77 | 190 | 620 | 0.002 U | 0.0032 | 0.1 | 0.001 U | 0.0003 J | 0.002 U | 0.00044 J | 0.0003 J | 0.061 | 0.0002 U | 1.5 | 0.005 U | 0.001 U | 0.199 UJ ± 0.29 |
| | 06/15/2018 | 7.2 J | 5.6 | 170 | 76 | 0.56 | 250 | 770 | 0.002 U | 0.003 | 0.2 | 0.001 UJ | 0.00022 J | 0.0021 U | 0.00071 | 0.00038 J | 0.062 | 0.0002 U | 0.98 | 0.005 U | 0.001 U | 1.08 R ± 0.325 |
| WAP-3S | 07/06/2018 | 7.3 J | 5.5 | 160 | 72 | 0.68 | 280 | 770 | 0.002 U | 0.0022 | 0.12 | 0.001 U | 0.00022 J | 0.002 U | 0.00034 J | 0.00023 J | 0.066 | 0.0002 UJ | 1.2 | 0.005 U | 0.001 U | 0.928 R ± 0.285 |
| | 07/26/2018 | 7 J | 5.2 | 160 | 66 | 0.53 | 180 | 730 | 0.002 U | 0.0018 | 0.22 | 0.001 U | 0.00017 J | 0.002 U | 0.00037 J | 0.00027 J | 0.044 | 0.0002 U | 0.78 | 0.005 U | 0.001 U | 1.28 R ± 0.416 |
| | 08/16/2018 | 7.3 J | 7.6 | 180 | 97 | 0.52 | 290 | 820 | 0.002 U | 0.0023 | 0.17 | 0.001 U | 0.00022 J | 0.002 U | 0.00048 J | 0.00037 J | 0.07 | 0.0002 U | 1 | 0.005 U | 0.001 U | 0.943 R ± 0.262 |
| | 12/05/2018 | 7.1 J | 13 | 190 | 120 | 0.55 | 450 | 1100 | 0.002 U | 0.0027 | 0.16 | 0.001 U | 0.00016 J | 0.002 U | 0.00067 | 0.00042 J | 0.08 | 0.0002 U | 0.86 | 0.005 U | 0.001 U | 0.751 ± 0.264 |
| | 10/28/2019 | 7 J | 14 | - | - | 0.39 J+ | - | - | 0.002 U | 0.002 | 0.25 | 0.001 U | 0.0002 J | 0.0024 | 0.00094 | 0.00094 J | 0.079 | 0.0002 U | 0.92 | 0.005 U | 0.001 U | 0.551 UJ ± 0.36 |
| | 02/19/2020 | 7 J | 9.9 | 200 | 89 J+ | 0.24 | 230 J+ | 920 | 0.002 U | 0.0014 | 0.39 | 0.001 U | 0.001 U | 0.002 U | 0.00043 J | 0.00071 J | 0.033 | - | 0.26 | - | 0.001 U | 1.09 J- ± 0.3 |
| | 03/30/2020 | 6.9 J | 13 | 280 | 130 | 0.48 | 550 | 1200 | 0.002 U | 0.0064 | 0.33 | 0.001 U | 0.001 U | 0.003 | 0.0016 | 0.0027 | 0.1 | - | 0.7 | - | 0.001 U | 1.15 ± 0.428 |
| **Temporal Averages (a)** | | NA | 8.88 | NA | NA | 0.49 | NA | NA | NC | 0.0031 | 0.24 | 0.00044 | 0.00028 | 0.0013 | 0.00091 | 0.00084 | 0.060 | NC | 0.84 | NC | NC | NC |

Notes:
Blank cells - Constituent not included in this analysis.
GW - Groundwater.
GWPS - Groundwater Protection Standard.
NC - Not calculated.

mg/L - milligrams per liter.
NA - Not Available.
pCi/L - picoCurie per liter.

Qualifiers:
J: Value is estimated
U: Not detected, value is the laboratory reporting limit

(a) - Temporal averages were only calculated for constituents detected in at least one sample and with risk-based toxicity values available. Averages were calculated using one-half of the laboratory reporting limit for non-detects.

**TABLE 7**
**TOTAL RISK FOR OFF-SITE WORKER GROUNDWATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| | | Exposure Medium | |
|---|---|---|---|
| | | Groundwater | |
| POTENTIAL RECEPTOR/ USE SCENARIO | EXPOSURE ROUTE AND MIGRATION PATHWAY | HAZARD INDEX | ELCR |
| Off-Site Worker (Adult) - MW-6S | Ingestion | 0.4 | 4.E-06 |
| | Dermal Contact | 0.01 | 6.E-08 |
| | Ambient Vapor Inhalation | NA | NA |
| | Total | 0.4 | 4.E-06 |
| Off-Site Worker (Adult) - MW-3I | Ingestion | 2 | 1.E-05 |
| | Dermal Contact | 0.04 | 2.E-07 |
| | Ambient Vapor Inhalation | NA | NA |
| | Total | 2 | 1.E-05 |

| | Target Organ | Hazard Quotient (MW-3I) |
|---|---|---|
| Arsenic | Cardiovascular, Dermal | 0.08 |
| Barium | Urinary | 0.01 |
| Beryllium | Gastrointestinal | 0.005 |
| Boron | Developmental | 0.3 |
| Cadmium | Urinary | 0.006 |
| Chromium(III) | Other | 0.00001 |
| Cobalt | Endocrine | 0.02 |
| Fluoride | Bones, Teeth | 0.09 |
| Lithium | General Toxicity | 0.2 |
| Molybdenum | Urinary | 1 |
| **Sum: Cardiovascular** | | 0.08 |
| **Sum: Dermal** | | 0.08 |
| **Sum: Gastrointestinal** | | 0.005 |
| **Sum: Other/General Toxicity** | | 0.2 |
| **Sum: Developmental** | | 0.3 |
| **Sum: Endocrine** | | 0.02 |
| **Sum: Bones** | | 0.09 |
| **Sum: Teeth** | | 0.09 |
| **Sum: Urinary** | | 1 |

**Notes:**
ELCR = Excess Lifetime Cancer Risk.

Risk calculations are provided in Attachment B.
The following sources have been utilized in identifying target organs:
USEPA Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/).
National Center for Environmental Assessment (NCEA) provisional peer reviewed toxicity values (PPRTVs) (http://hhpprtv.ornl.gov/).
California Environmental Protection Agency (CALEPA) (http://www.oehha.ca.gov/risk/chemicalDB//index.asp).

**TABLE 8**
**DERIVATION OF RISK-BASED TARGET SCREENING LEVELS FOR GROUNDWATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

| Constituent | CAS RN | HH DW SL (a) (mg/L) | HH REC SL - Consumption of Organism Only (b) (mg/L) | HH Recreational Calculated RBSL (c) (mg/L) | ECO SL - Total (acute) (d) (mg/L) | ECO SL - Dissolved (acute) (d) (mg/L) | ECO SL - Total (chronic) (d) (mg/L) | ECO SL - Dissolved (chronic) (d) (mg/L) | Lowest of the Human Health and Ecological Screening Levels (mg/L) | Target Groundwater Screening Level - Ohio River (f) (mg/L) | Maximum Groundwater Concentration (mg/L) | | Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Dilution Attenuation Factor - Ohio River (e) | 83,000 | | | |
| **Detection Monitoring - USEPA Appendix III Constituents (g)** | | | | | | | | | | | | | |
| Boron | 7440-42-8 | 4 | NA | 114 | NA | NA | NA | NA | 4 | 332,000 | 22 | WAP-2R | >15,000 |
| Fluoride | 16984-48-8 | 4 | 1 | 22.9 | NA | NA | NA | NA | 1 | 83,000 | 0.77 | WAP-3S | >100,000 |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | | | | | | |
| Antimony | 7440-36-0 | 0.006 | 0.0056 | 0.171 | NA | NA | 0.08 | NA | 0.0056 | 465 | 0.0011 | WAP-5D | >420,000 |
| Arsenic | 7440-38-2 | 0.01 | 0.01 | 0.236 | 0.34 | 0.34 | 0.15 | 0.15 | 0.01 | 830 | 0.097 | WAP-5D | >8,500 |
| Barium | 7440-39-3 | 2 | 1 | 63.7 | NA | NA | 0.22 | NA | 0.22 | 18,260 | 0.44 | WAP-5D | >41,000 |
| Beryllium | 7440-41-7 | 0.004 | 0.00117 | 0.121 | NA | NA | 0.0036 | NA | 0.00117 | 97 | 0.00044 | WAP-5D | >220,000 |
| Cadmium | 7440-43-9 | 0.005 | NA | 0.134 | 0.0021 | 0.0020 | 0.00027 | 0.00025 | 0.00025 | 20 | 0.001 | WAP-2R | >20,000 |
| Chromium (Total) | 7440-47-3 | 0.1 | 3433 | 155 | 1.8 | 0.57 | 0.086 | 0.074 | 0.074 | 6,152 | 0.015 | WAP-5D | >410,000 |
| Cobalt | 7440-48-4 | 0.006 | NA | 0.178 | NA | NA | 0.024 | NA | 0.006 | 498 | 0.0098 | WAP-5S | >50,000 |
| Lead | 7439-92-1 | 0.015 | NA | 0.015 | 0.082 | 0.065 | 0.0032 | 0.0025 | 0.0025 | 209 | 0.011 | WAP-5D | >18,000 |
| Lithium | 7439-93-2 | 0.04 | NA | 1.14 | NA | NA | NA | NA | 0.04 | 3,320 | 0.1 | WAP-3S | >33,000 |
| Mercury | 7439-97-6 | 0.002 | 0.000012 | 0.0956 | 0.0017 | 0.0014 | 0.00091 | 0.00077 | 0.000012 | 1.0 | 0.0002 U | | NA |
| Molybdenum | 7439-98-7 | 0.1 | NA | 2.86 | NA | NA | NA | NA | 0.1 | 8,300 | 1.5 | WAP-3S | >5,500 |
| Selenium | 7782-49-2 | 0.05 | 0.17 | 2.86 | 0.13 | NA | 0.005 | 0.0031 | 0.0031 | 257 | 0.0013 | WAP-5D | >190,000 |
| Thallium | 7440-28-0 | 0.002 | 0.00024 | 0.00572 | NA | NA | 0.01 | NA | 0.00024 | 20 | 0.00047 | WAP-2R | >42,000 |
| **Radiological (pCi/L)** | | | | | | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | 5 | 4 | NA | NA | NA | NA | NA | 4 | 332,000 | 1.28 ± 0.411 | WAP-3S | >190,000 |

Notes:

CAS RN - Chemical Abstracts Service Registry Numb
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screenin
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.
RBSL - Risk-Based Screening Level.

**TABLE 8**
**DERIVATION OF RISK-BASED TARGET SCREENING LEVELS FOR GROUNDWATER**
**SOUTHERN INDIANA GAS AND ELECTRIC COMPANY**
**F.B. CULLEY GENERATING STATION - WEST ASH POND**
**NEWBURGH, INDIANA**

(a) - Drinking Water Screening Levels selected in Table 2 using the following hierarchy:

1) USEPA MCL
2) USEPA RSL - Tap Water
3) IDEM Criteria for Drinking Water Class Groundwater

(b) - Human Health Published Screening Values for Surface Water - Consumption of Organism Only selected in Table 2 using the following hierarchy:

1) ORSANCO Human Health Water Quality Standards
2) USEPA NRWQC - Consumption of Organism Only.
3) IDEM CCC HLSC - Consumption of Organism Only (proposed).
4) IDEM CCC HLSC - Consumption of Organism Only (current).

(c) - The Human Health Calculated Screening Levels are presented in Table 3.
The minimum calculated value for the Off-Site Recreational Boater, Wader, and Swimmer was selected.

(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:

1) ORSANCO Aquatic Life Criterion.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
3) USEPA Region 5. Freshwater Screening Values.
4) IDEM Aquatic Life Criterion (proposed).
5) IDEM Aquatic Life Criterion (current).

(e) - Estimated value, see DAF calculation documents in Appendix B for derivation.

(f) - The Target Groundwater Screening Level = Minimum SL x Dilution Factor.

(g) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

# FIGURES


**LEGEND**

- UPGRADIENT MONITORING WELL
- DOWNGRADIENT MONITORING WELL
- APPROXIMATE LOCATION OF CLOSED WEST ASH POND
- EAST ASH POND
- WEST ASH POND
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 360 720

APPROXIMATE SCALE IN FEET

HALEY ALDRICH

F.B. CULLEY GENERATING STATION
WEST ASH POND
NEWBURGH, INDIANA

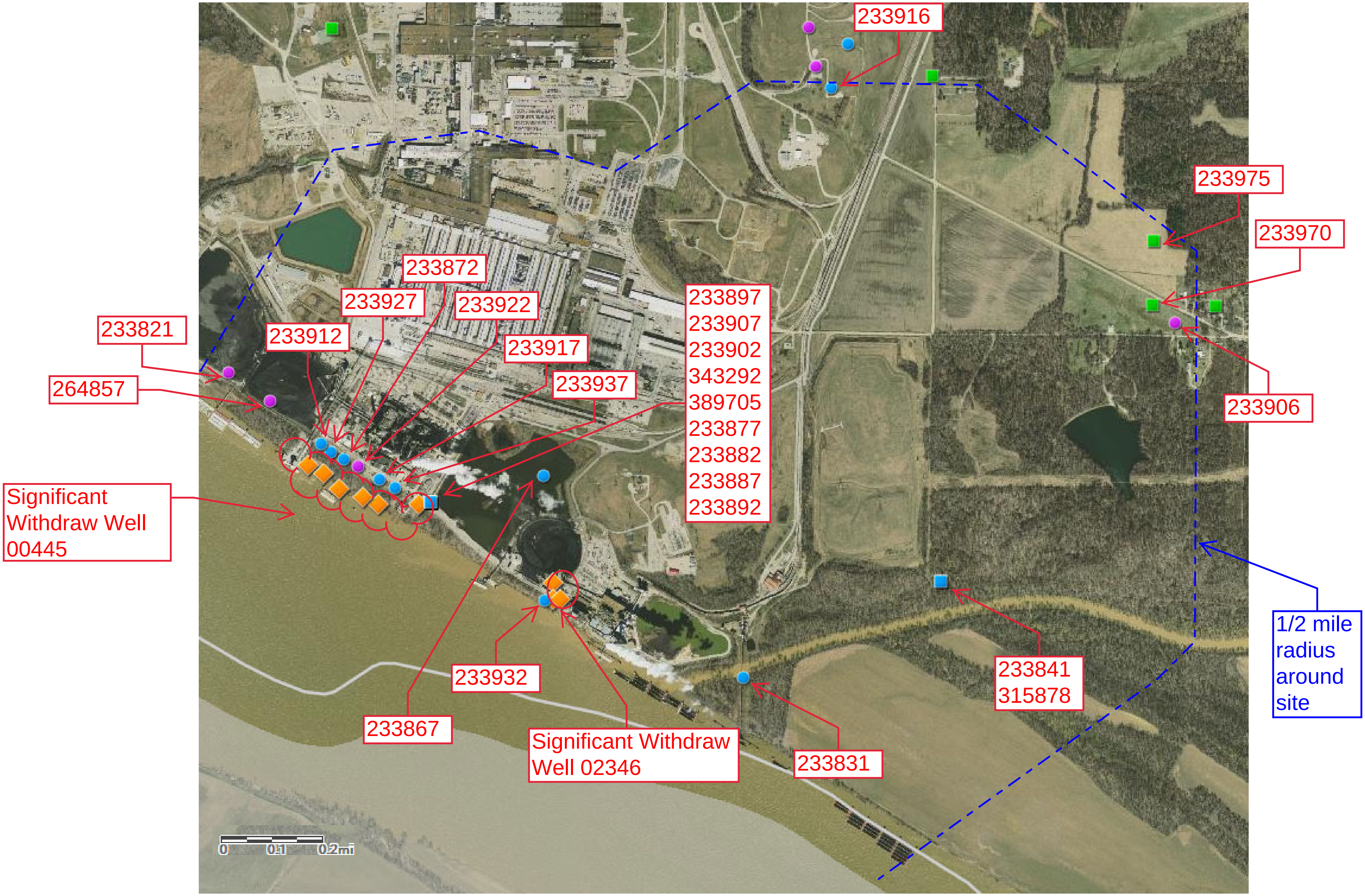
SITE FEATURES

NOVEMBER 2020

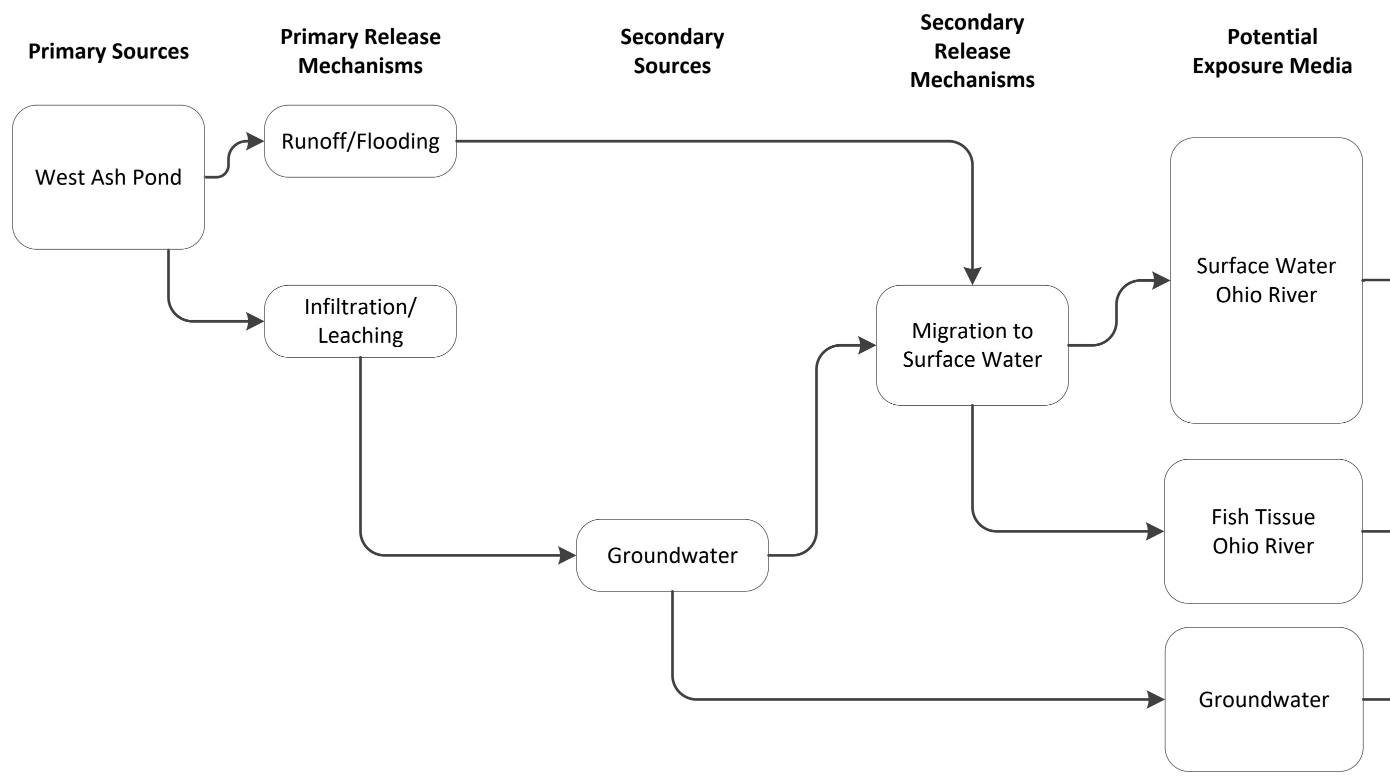
FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2020_09\129420_001_0001_SITE_FEATURES.mxd — USER: hwachholz — LAST SAVED: 9/9/2020 2:23:09 PM

FIGURE 2
PRIVATE WELL LOCATIONS WITHIN A HALF-MILE RADIUS OF FACILITY BOUNDARY
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION, NEWBURGH, IN



# FIGURE 3
# CONCEPTUAL SITE MODEL
## SOUTHERN INDIANA GAS & ELECTRIC COMPANY – WEST ASH POND
## F.B. CULLEY GENERATING STATION, NEWBURGH, IN




| | Potential Human Health Receptors | | | | Potential Ecological Receptors |
|---|---|---|---|---|---|
| **Potential Exposure Route** | **Current/Future Off-Site Resident Adult/Child** | **Current/Future Off-Site Recreational User (Swimmer, Wader,Boater)** | **Current/Future Off-Site Facility Worker (b)** | **Current/Future Off-Site Recreational Fisher** | **Aquatic Receptors** |
| Drinking Water Use | ⊙ (a) | ○ | ○ | ○ | NA |
| Incidental Ingestion | ○ | ⊙ | ⊙ | ⊙ | NA |
| Dermal Contact | ○ | ⊙ | ⊙ | ⊙ | NA |
| Aquatic Exposure | NA | NA | NA | NA | ⊙ |
| Ingestion | ○ | ○ | ○ | ⊙ | NA |
| Aquatic Exposure | NA | NA | NA | NA | ⊙ |
| Drinking Water Use/Showering | ○ (b) | ○ | ⊙ (b) | ○ | NA |
| Aquatic Exposure | NA | NA | NA | NA | ○ (c) |

Notes:

- ● Pathway potentially complete
- ⊙ Pathway potentially complete – pathway evaluated in this risk assessment; results indicate no risk to human health or the environment.
- ○ Pathway evaluated and found incomplete; results indicate no risk to human health or the environment.

(a) The Ohio River is used as a source of drinking water; the nearest downstream drinking water intake is 18.4 miles downstream at the City of Evansville, Indiana.
(b) Off-site facility worker exposure to groundwater as potable water was evaluated as a potentially complete pathway. There are no private wells downgradient of the West Ash Pond.
(c) Ecological Receptors are not exposed to groundwater.

NA – Not Applicable.

HALEY ALDRICH

# ATTACHMENT A

## Calculated Recreational Risk-Based Screening Levels

**TABLE A-1**
**HUMAN HEALTH EXPOSURE PARAMETERS FOR DERIVATION OF RISK BASED SCREENING LEVELS (RBSLs) - RECREATIONAL SURFACE WATER**

| Exposure Parameter | | Units | Current/Future Off-Site Recreational Swimmer | | | | Current/Future Off-Site Recreational Wader | | | | Current/Future Off-Site Recreational Boater |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Child (Age <6 ) | Adolescent (6-<16 years) | Adult | Child, Adolescent and Adult (Ages 1 - 26) | Child (Age <6 ) | Adolescent (6-<16 years) | Adult | Child, Adolescent and Adult (Ages 1 - 26) | Adult |
| **Standard Parameters** | | | | | | | | | | | |
| Body Weight | BW | kg | 15 USEPA, 2011 [1] | 44 USEPA, 2011 [1] | 80 USEPA, 2014a | NA | 15 USEPA, 2011 [1] | 44 USEPA, 2011 [1] | 80 USEPA, 2014a | NA | 80 USEPA, 2014a |
| Exposure Duration | ED | years | 6 Ages <6 | 10 Ages 6 - <16 | 10 Balance of 26-yr exposure | 26 | 6 Ages <6 | 10 Ages 6 - <16 | 10 Balance of 26-yr exposure | 26 | 10 Balance of 26-yr exposure |
| Non–carcinogenic Averaging Time | Atnc | days | 2190 ED expressed in days | 3650 ED expressed in days | 3650 ED expressed in days | 9490 ED expressed in days | 2190 ED expressed in days | 3650 ED expressed in days | 3650 ED expressed in days | 9490 ED expressed in days | 3650 ED expressed in days |
| Carcinogenic Averaging Time | Atc | days | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime | 25550 70 year lifetime |
| **Incidental Ingestion of Surface Water** | | | | | | | | | | | |
| Exposure Frequency | EF | days/year | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | NA |
| Water Ingestion Rate | IR | L/day | 0.10 USEPA, 2014b [2] | 0.10 USEPA, 2014b [2] | 0.10 USEPA, 2014b [2] | NA | 0.10 USEPA, 2014b [2] | 0.02 USEPA, 2014b [2] | 0.02 USEPA, 2014b [2] | NA | NA |
| Fraction Ingested | FI | unitless | 1.0 Assumption | 1.0 Assumption | 1.0 Assumption | 1.0 Assumption | 1.0 Assumption | 1.0 Assumption | 1.0 Assumption | 1.0 Assumption | NA |
| Age-Adjusted Water Ingestion Factor | IFWadj | L/kg | NA | NA | NA | 3.39 | NA | NA | NA | 2.12 | NA |
| Age-Adjusted Water Ingestion Factor-Mutagenic | IFWM | L/kg | NA | NA | NA | 13.23 | NA | NA | NA | 10.33 | NA |
| **Dermal Exposure with Surface Water** | | | | | | | | | | | |
| Exposure Frequency | EF | days/year | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b | 45 USEPA, 2014b |
| Exposed Skin Surface Area | SA | $cm^2$ | 6365 USEPA, 2014a | 13350 USEPA, 2011 [3] | 19652 USEPA, 2014a | NA | 1770 USEPA, 2011 [4] | 3820 USEPA, 2011 [4] | 5790 USEPA, 2011 [4] | NA | 5790 USEPA, 2011 [4] |
| Exposure Time | t-event | hr/event | 2 Site-specific [5] | 2 Site-specific [5] | 2 Site-specific [5] | 2 Site-specific [5] | 2 Site-specific [5] | 2 Site-specific [5] | 2 Site-specific [5] | 2 Site-specific | 2 Site-specific [5] |
| Events per Day | EV | event/day | 1.0 Site-specific [5] | 1.0 Site-specific [5] | 1.0 Site-specific [5] | 1.0 Site-specific [5] | 1.0 Site-specific [5] | 1.0 Site-specific [5] | 1.0 Site-specific [5] | 1.0 Site-specific | 1 Site-specific [5] |
| Age-Adjusted Dermal Contact Factor | DFWadj | events-$cm^2$/kg | NA | NA | NA | 361647 | NA | NA | NA | 103497 | NA |
| Age-Adjusted Dermal Contact Factor-Mutagenic | DFWM | events-$cm^2$/kg | NA | NA | NA | 1131185 | NA | NA | NA | 319693 | NA |

**NOTES AND ABBREVIATIONS**

USEPA, 2002 - Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OWSWER 9355.4-24
USEPA, 2011 - Exposure Factors Handbook. USEPA/600/R-10/030. October, 2011.
USEPA, 2014a - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER 9200.1-120. February 6, 201.
USEPA, 2014b - Region 4 Human Health Risk Assessment Supplemental Guidance. January 2014. Draft Final.
[1] - Table 8-1 of USEPA (2011).
[2] - Ingestion rate of 50 ml/hour of surface water is used for exposures to water during swimming. Intake rates for exposure to surface water during wading are 50 ml/hour for children 1-6, and 10 ml/hour for adolescents and adults.
The water ingestion rate in liters/day is calculated as follows: ingestion (ml/hr) x exposure time (hr/event)/1000 (ml/L).
[3] - Based on weighted average of mean values for 6-<16 years.
[4] - Based on surface area of hands, forearms, lower legs, and feet.
[5] - Assumes 2 hours per event and that on days when recreation in water occurs, all daily exposure to water is derived from locations at the Site.

Values based on a time-weighted average of child, adolescent, and adult exposure values are calculated as follows:
Water
IFWadj = (child ED [0-2] x child EF [0-2] x child IR [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] / child BW [2-6]) + (older child ED [6-16] x older child EF [6-16] x older child IR [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR / adult BW)
DFWadj = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] / older child BW [6-16]) + (adult EF x adult ED x adult SA x adult EV / adult BW)
Water - mutagenic
IFWM = (child ED [0-2] x child EF [0-2] x child IR [0-2] x ADAF [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] x ADAF [2-6] / child BW [2-6]) + (older child ED [6-16] x child EF [6-16] x older child IR [6-16] x ADAF [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR x adult ADAF / adult BW)
DFWM = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] x ADAF [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] x ADAF [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] x ADAF [6-16] / older child BW [6-16]) +
(adult EF x adult ED x adult SA x adult EV x adult ADAF / adult BW)

USEPA guidance for early life exposure to carcinogens (USEPA, 2005) requires that risks for potentially carcinogenic constituents that are presumed to act by a mutagenic mode of action be calculated differently than for constituents that do not act via a mutagenic mode of action.
Therefore, the age-dependent adjustment factors (ADAF) will be applied for calculations involving children under the age of 16. The ADAFs are as follows:

Age 0 to 2 years (2 year interval from birth until 2nd birthday) – ADAF = 10
Ages 2 to 16 years (14 year interval from 2nd birthday to 16th birthday) – ADAF = 3
Ages 16 and up (after 16th birthday) – no adjustment - ADAF = 1

The exposure parameters for children ages <6 are applied to children 0 - 2 and 2- 6.

**Current/Future Off-Site Recreational Boater**

# Site-specific

## Recreator Equation Inputs for Surface Water

*** Inputted values different from Recreator defaults are highlighted.**

| Variable | Recreator Surface Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (body weight) kg | 15 | 0 |
| $BW_{2-6}$ (body weight) kg | 15 | 0 |
| $BW_{6-16}$ (body weight) kg | 80 | 0 |
| $BW_{16-30}$ (body weight) kg | 80 | 80 |
| $BW_{a}$ (body weight - adult) kg | 80 | 80 |
| $BW_{rec-a}$ (body weight - adult) kg | 80 | 80 |
| $DFW_{rec-adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 0 | 32568.75 |
| $DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 0 | 32568.75 |
| $ED_{rec}$ (exposure duration - recreator) years | 26 | 10 |
| $ED_{0-2}$ (exposure duration) years | 2 | 0 |
| $ED_{2-6}$ (exposure duration) years | 4 | 0 |
| $ED_{6-16}$ (exposure duration) years | 10 | 0 |
| $ED_{16-30}$ (exposure duration) years | 10 | 10 |
| $ED_{rec-a}$ (exposure duration - adult) years | 20 | 10 |
| $EF_{rec-w}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{2-6}$ (exposure frequency) days/year | 0 | 0 |
| $EF_{6-16}$ (exposure frequency) days/year | 0 | 0 |
| $EF_{16-30}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{rec-a}$ (adult exposure frequency) days/year | 0 | 45 |
| $ET_{0-2}$ (exposure time) hours/event | 0 | 0 |
| $ET_{2-6}$ (exposure time) hours/event | 0 | 0 |
| $ET_{6-16}$ (exposure time) hours/event | 0 | 0 |
| $ET_{16-30}$ (exposure time) hours/event | 0 | 2 |
| $ET_{rec-a}$ (adult exposure time) hours/event | 0 | 2 |
| $EV_{0-2}$ (events) events/day | 0 | 0 |
| $EV_{2-6}$ (events) events/day | 0 | 0 |
| $EV_{6-16}$ (events) events/day | 0 | 0 |
| $EV_{16-30}$ (events) events/day | 0 | 1 |
| $EV_{rec-a}$ (adult) events/day | 0 | 1 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg | 0 | 0 |
| $IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg | 0 | 0 |
| $IRW_{0-2}$ (water intake rate) L/hour | 0.12 | 0 |
| $IRW_{2-6}$ (water intake rate) L/hour | 0.12 | 0 |
| $IRW_{6-16}$ (water intake rate) L/hour | 0.124 | 0 |
| $IRW_{16-30}$ (water intake rate) L/hour | 0.0985 | 0 |
| $IRW_{rec}$ (water intake rate - adult) L/day | 0.11 | 0 |
| $IRW_{rec-a}$ (water intake rate - adult) L/hr | 0.11 | 0 |
| LT (lifetime - recreator) years | 70 | 70 |
| $SA_{0-2}$ (skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{2-6}$ (skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{6-16}$ (skin surface area) $cm^2$ | 19652 | 0 |
| $SA_{16-30}$ (skin surface area) $cm^2$ | 19652 | 5790 |
| $SA_{rec}$ (skin surface area - adult) $cm^2$ | 19652 | 5790 |
| $SA_{rec-a}$ (skin surface area - adult) $cm^2$ | 19652 | 5790 |
| Apparent thickness of stratum corneum (cm) | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.0001 |

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## Site-specific

### Recreator Regional Screening Levels (RSL) for Surface Water

**Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.**

| Chemical | CAS Number | Mutagen? | Volatile? | Chemical Type | $SF_o$(mg/kg-day)$^{-1}$ | $SF_o$ Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | RAGSe GIABS (unitless) | $K_p$ (cm/hr) | MW | FA (unitless) | In EPD? | $DA_{event(ca)}$ | $DA_{event(ncchild)}$ | $DA_{event(nc\ adult)}$ | Ingestion SL TR=0.0001 (ug/L) | Dermal SL TR=0.0001 (ug/L) | Carcinogenic SL TR=0.0001 (ug/L) | Ingestion SL (Child) THQ=1 (ug/L) | Dermal SL (Child) THQ=1 (ug/L) | Noncarcinogenic SL (Child) THQ=1 (ug/L) | Ingestion SL (Adult) THQ=1 (ug/L) | Dermal SL (Adult) THQ=1 (ug/L) | Noncarcinogenic SL (Adult) THQ=1 (ug/L) | Screening Level (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | 7440-36-0 | No | No | Inorganics | - | | 0.0004 | I | 0.0003 | A | 0.1500 | 0.0010 | 121.7600 | 1.0000 | Yes | - | - | 0.0067 | - | - | - | - | - | - | - | 3360.0000 | 3360.0000 | 3.36E+03nc |
| Arsenic, Inorganic | 7440-38-2 | No | No | Inorganics | 1.5000 | I | 0.0003 | I | 0.0000 | C | 1.0000 | 0.0010 | 74.9220 | 1.0000 | Yes | 0.0523 | - | 0.0336 | - | 26100.0000 | 26100.0000 | - | - | - | - | 16800.0000 | 16800.0000 | 1.68E+04nc |
| Barium | 7440-39-3 | No | No | Inorganics | - | | 0.2000 | I | 0.0005 | H | 0.0700 | 0.0010 | 137.3300 | 1.0000 | Yes | - | - | 1.5690 | - | - | - | - | - | - | - | 784000.0000 | 784000.0000 | 7.84E+05nc |
| Beryllium and compounds | 7440-41-7 | No | No | Inorganics | - | | 0.0020 | I | 0.0000 | I | 0.0070 | 0.0010 | 9.0100 | 1.0000 | Yes | - | - | 0.0016 | - | - | - | - | - | - | - | 784.0000 | 784.0000 | 7.84E+02nc |
| Boron And Borates Only | 7440-42-8 | No | No | Inorganics | - | | 0.2000 | I | 0.0200 | H | 1.0000 | 0.0010 | 13.8400 | 1.0000 | Yes | - | - | 22.4141 | - | - | - | - | - | - | - | 11200000.0000 | 11200000.0000 | 1.12E+07nc |
| Cadmium (Water) | 7440-43-9 | No | No | Inorganics | - | | 0.0005 | I | 0.0000 | A | 0.0500 | 0.0010 | 112.4000 | 1.0000 | Yes | - | - | 0.0028 | - | - | - | - | - | - | - | 1400.0000 | 1400.0000 | 1.40E+03nc |
| Chromium(III), Insoluble Salts | 16065-83-1 | No | No | Inorganics | - | | 1.5000 | I | - | | 0.0130 | 0.0010 | 52.0000 | 1.0000 | Yes | - | - | 2.1854 | - | - | - | - | - | - | - | 1090000.0000 | 1090000.0000 | 1.09E+06nc |
| Cobalt | 7440-48-4 | No | No | Inorganics | - | | 0.0003 | P | 0.0000 | P | 1.0000 | 0.0004 | 58.9300 | 1.0000 | Yes | - | - | 0.0336 | - | - | - | - | - | - | - | 42000.0000 | 42000.0000 | 4.20E+04nc |
| Fluoride | 16984-48-8 | No | No | Inorganics | - | | 0.0400 | C | 0.0130 | C | 1.0000 | 0.0010 | 38.0000 | 1.0000 | Yes | - | - | 4.4828 | - | - | - | - | - | - | - | 2240000.0000 | 2240000.0000 | 2.24E+06nc |
| Lithium | 7439-93-2 | No | No | Inorganics | - | | 0.0020 | P | - | | 1.0000 | 0.0010 | 6.9400 | 1.0000 | Yes | - | - | 0.2241 | - | - | - | - | - | - | - | 112000.0000 | 112000.0000 | 1.12E+05nc |
| Mercuric Chloride | 7487-94-7 | No | No | Inorganics | - | | 0.0003 | I | 0.0003 | G | 0.0700 | 0.0010 | 271.5000 | 1.0000 | Yes | - | - | 0.0024 | - | - | - | - | - | - | - | 1180.0000 | 1180.0000 | 1.18E+03nc |
| Molybdenum | 7439-98-7 | No | No | Inorganics | - | | 0.0050 | I | - | | 1.0000 | 0.0010 | 95.9400 | 1.0000 | Yes | - | - | 0.5604 | - | - | - | - | - | - | - | 280000.0000 | 280000.0000 | 2.80E+05nc |
| Selenium | 7782-49-2 | No | No | Inorganics | - | | 0.0050 | I | 0.0200 | C | 1.0000 | 0.0010 | 78.9600 | 1.0000 | Yes | - | - | 0.5604 | - | - | - | - | - | - | - | 280000.0000 | 280000.0000 | 2.80E+05nc |
| Thallium (Soluble Salts) | 7440-28-0 | No | No | Inorganics | - | | 0.0000 | X | - | | 1.0000 | 0.0010 | 204.3800 | 1.0000 | Yes | - | - | 0.0011 | - | - | - | - | - | - | - | 560.0000 | 560.0000 | 5.60E+02nc |

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## Current/Future Off-Site Recreational Swimmer

# Site-specific

## Recreator Equation Inputs for Surface Water

### * Inputted values different from Recreator defaults are highlighted.

| Variable | Recreator Surface Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0\text{-}2}$ (body weight) kg | 15 | 15 |
| $BW_{2\text{-}6}$ (body weight) kg | 15 | 15 |
| $BW_{6\text{-}16}$ (body weight) kg | 80 | 44 |
| $BW_{16\text{-}30}$ (body weight) kg | 80 | 80 |
| $BW_{a}$ (body weight - adult) kg | 80 | 62 |
| $BW_{rec\text{-}a}$ (body weight - adult) kg | 80 | 62 |
| $DFW_{rec\text{-}adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 0 | 354100.645 |
| $DFWM_{rec\text{-}adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 0 | 1131184.77 |
| $ED_{rec}$ (exposure duration - recreator) years | 26 | 26 |
| $ED_{0\text{-}2}$ (exposure duration) years | 2 | 2 |
| $ED_{2\text{-}6}$ (exposure duration) years | 4 | 4 |
| $ED_{6\text{-}16}$ (exposure duration) years | 10 | 10 |
| $ED_{16\text{-}30}$ (exposure duration) years | 10 | 10 |
| $ED_{rec\text{-}a}$ (exposure duration - adult) years | 20 | 20 |
| $EF_{rec\text{-}w}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{2\text{-}6}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{6\text{-}16}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{16\text{-}30}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{rec\text{-}a}$ (adult exposure frequency) days/year | 0 | 45 |
| $ET_{0\text{-}2}$ (exposure time) hours/event | 0 | 2 |
| $ET_{2\text{-}6}$ (exposure time) hours/event | 0 | 2 |
| $ET_{6\text{-}16}$ (exposure time) hours/event | 0 | 2 |
| $ET_{16\text{-}30}$ (exposure time) hours/event | 0 | 2 |
| $ET_{rec\text{-}a}$ (adult exposure time) hours/event | 0 | 2 |
| $EV_{0\text{-}2}$ (events) events/day | 0 | 1 |
| $EV_{2\text{-}6}$ (events) events/day | 0 | 1 |
| $EV_{6\text{-}16}$ (events) events/day | 0 | 1 |
| $EV_{16\text{-}30}$ (events) events/day | 0 | 1 |
| $EV_{rec\text{-}a}$ (adult) events/day | 0 | 1 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{rec\text{-}adj}$ (age-adjusted water intake rate) L/kg | 0 | 6.503 |
| $IFWM_{rec\text{-}adj}$ (mutagenic age-adjusted water intake rate) L/kg | 0 | 26.461 |
| $IRW_{0\text{-}2}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{2\text{-}6}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{6\text{-}16}$ (water intake rate) L/hour | 0.124 | 0.1 |
| $IRW_{16\text{-}30}$ (water intake rate) L/hour | 0.0985 | 0.1 |
| $IRW_{rec}$ (water intake rate - adult) L/day | 0.11 | 0.1 |
| $IRW_{rec\text{-}a}$ (water intake rate - adult) L/hr | 0.11 | 0.1 |
| LT (lifetime - recreator) years | 70 | 70 |
| $SA_{0\text{-}2}$ (skin surface area) $cm^2$ | 6365 | 6365 |
| $SA_{2\text{-}6}$ (skin surface area) $cm^2$ | 6365 | 6365 |
| $SA_{6\text{-}16}$ (skin surface area) $cm^2$ | 19652 | 13350 |
| $SA_{16\text{-}30}$ (skin surface area) $cm^2$ | 19652 | 19652 |
| $SA_{rec}$ (skin surface area - adult) $cm^2$ | 19652 | 16501 |
| $SA_{rec\text{-}a}$ (skin surface area - adult) $cm^2$ | 19652 | 16501 |
| Apparent thickness of stratum corneum (cm) | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.0001 |

Output generated 28AUG2020:09:43:37

## Site-specific

### Recreator Regional Screening Levels (RSL) for Surface Water

**Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.**

| Chemical | CAS Number | Mutagen? | Volatile? | Chemical Type | $SF_o$(mg/kg-day)$^{-1}$ | $SF_o$ Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | RAGSe GIABS (unitless) | $K_p$ (cm/hr) | MW | FA (unitless) | In EPD? | $DA_{event(ca)}$ | $DA_{event(nc\ child)}$ | $DA_{event(nc\ adult)}$ | Ingestion SL TR=0.0001 (ug/L) | Dermal SL TR=0.0001 (ug/L) | Carcinogenic SL TR=0.0001 (ug/L) | Ingestion SL (Child) THQ=1 (ug/L) | Dermal SL (Child) THQ=1 (ug/L) | Noncarcinogenic SL (Child) THQ=1 (ug/L) | Ingestion SL (Adult) THQ=1 (ug/L) | Dermal SL (Adult) THQ=1 (ug/L) | Noncarcinogenic SL (Adult) THQ=1 (ug/L) | Screening Level (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | 7440-36-0 | No | No | Inorganics | - | | 0.0004 | I | 0.0003 | A | 0.1500 | 0.0010 | 121.7600 | 1.0000 | Yes | - | 0.0011 | 0.0018 | - | - | - | 243.0000 | 573.0000 | 171.0000 | 1010.0000 | 914.0000 | 479.0000 | 1.71E+02nc |
| Arsenic, Inorganic | 7440-38-2 | No | No | Inorganics | 1.5000 | I | 0.0003 | I | 0.0000 | C | 1.0000 | 0.0010 | 74.9220 | 1.0000 | Yes | 0.0048 | 0.0057 | 0.0091 | 262.0000 | 2410.0000 | 236.0000 | 183.0000 | 2870.0000 | 172.0000 | 754.0000 | 4570.0000 | 647.0000 | 1.72E+02nc |
| Barium | 7440-39-3 | No | No | Inorganics | - | | 0.2000 | I | 0.0005 | H | 0.0700 | 0.0010 | 137.3300 | 1.0000 | Yes | - | 0.2676 | 0.4267 | - | - | - | 122000.0000 | 134000.0000 | 63700.0000 | 503000.0000 | 213000.0000 | 150000.0000 | 6.37E+04nc |
| Beryllium and compounds | 7440-41-7 | No | No | Inorganics | - | | 0.0020 | I | 0.0000 | I | 0.0070 | 0.0010 | 9.0100 | 1.0000 | Yes | - | 0.0003 | 0.0004 | - | - | - | 1220.0000 | 134.0000 | 121.0000 | 5030.0000 | 213.0000 | 205.0000 | 1.21E+02nc |
| Boron And Borates Only | 7440-42-8 | No | No | Inorganics | - | | 0.2000 | I | 0.0200 | H | 1.0000 | 0.0010 | 13.8400 | 1.0000 | Yes | - | 3.8230 | 6.0953 | - | - | - | 122000.0000 | 1910000.0000 | 114000.0000 | 503000.0000 | 3050000.0000 | 432000.0000 | 1.14E+05nc |
| Cadmium (Water) | 7440-43-9 | No | No | Inorganics | - | | 0.0005 | I | 0.0000 | A | 0.0500 | 0.0010 | 112.4000 | 1.0000 | Yes | - | 0.0005 | 0.0008 | - | - | - | 304.0000 | 239.0000 | 134.0000 | 1260.0000 | 381.0000 | 292.0000 | 1.34E+02nc |
| Chromium(III), Insoluble Salts | 16065-83-1 | No | No | Inorganics | - | | 1.5000 | I | - | | 0.0130 | 0.0010 | 52.0000 | 1.0000 | Yes | - | 0.3727 | 0.5943 | - | - | - | 913000.0000 | 186000.0000 | 155000.0000 | 3770000.0000 | 297000.0000 | 275000.0000 | 1.55E+05nc |
| Cobalt | 7440-48-4 | No | No | Inorganics | - | | 0.0003 | P | 0.0000 | P | 1.0000 | 0.0004 | 58.9300 | 1.0000 | Yes | - | 0.0057 | 0.0091 | - | - | - | 183.0000 | 7170.0000 | 178.0000 | 754.0000 | 11400.0000 | 708.0000 | 1.78E+02nc |
| Fluoride | 16984-48-8 | No | No | Inorganics | - | | 0.0400 | C | 0.0130 | C | 1.0000 | 0.0010 | 38.0000 | 1.0000 | Yes | - | 0.7646 | 1.2191 | - | - | - | 24300.0000 | 382000.0000 | 22900.0000 | 101000.0000 | 610000.0000 | 86300.0000 | 2.29E+04nc |
| Lithium | 7439-93-2 | No | No | Inorganics | - | | 0.0020 | P | - | | 1.0000 | 0.0010 | 6.9400 | 1.0000 | Yes | - | 0.0382 | 0.0610 | - | - | - | 1220.0000 | 19100.0000 | 1140.0000 | 5030.0000 | 30500.0000 | 4320.0000 | 1.14E+03nc |
| Mercuric Chloride | 7487-94-7 | No | No | Inorganics | - | | 0.0003 | I | 0.0003 | G | 0.0700 | 0.0010 | 271.5000 | 1.0000 | Yes | - | 0.0004 | 0.0006 | - | - | - | 183.0000 | 201.0000 | 95.6000 | 754.0000 | 320.0000 | 225.0000 | 9.56E+01nc |
| Molybdenum | 7439-98-7 | No | No | Inorganics | - | | 0.0050 | I | - | | 1.0000 | 0.0010 | 95.9400 | 1.0000 | Yes | - | 0.0956 | 0.1524 | - | - | - | 3040.0000 | 47800.0000 | 2860.0000 | 12600.0000 | 76200.0000 | 10800.0000 | 2.86E+03nc |
| Selenium | 7782-49-2 | No | No | Inorganics | - | | 0.0050 | I | 0.0200 | C | 1.0000 | 0.0010 | 78.9600 | 1.0000 | Yes | - | 0.0956 | 0.1524 | - | - | - | 3040.0000 | 47800.0000 | 2860.0000 | 12600.0000 | 76200.0000 | 10800.0000 | 2.86E+03nc |
| Thallium (Soluble Salts) | 7440-28-0 | No | No | Inorganics | - | | 0.0000 | X | - | | 1.0000 | 0.0010 | 204.3800 | 1.0000 | Yes | - | 0.0002 | 0.0003 | - | - | - | 6.0800 | 95.6000 | 5.7200 | 25.1000 | 152.0000 | 21.6000 | 5.72E+00nc |

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**Current/Future Off-Site Recreational Wader**

## Site-specific

## Recreator Equation Inputs for Surface Water

### * Inputted values different from Recreator defaults are highlighted.

| Variable | Recreator Surface Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (body weight) kg | 15 | 15 |
| $BW_{2-6}$ (body weight) kg | 15 | 15 |
| $BW_{6-16}$ (body weight) kg | 80 | 44 |
| $BW_{16-30}$ (body weight) kg | 80 | 80 |
| $BW_{a}$ (body weight - adult) kg | 80 | 62 |
| $BW_{rec-a}$ (body weight - adult) kg | 80 | 62 |
| $DFW_{rec-adj}$ (age-adjusted dermal factor) cm$^2$-event/kg | 0 | 101610 |
| $DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm$^2$-event/kg | 0 | 319693.295 |
| $ED_{rec}$ (exposure duration - recreator) years | 26 | 26 |
| $ED_{0-2}$ (exposure duration) years | 2 | 2 |
| $ED_{2-6}$ (exposure duration) years | 4 | 4 |
| $ED_{6-16}$ (exposure duration) years | 10 | 10 |
| $ED_{16-30}$ (exposure duration) years | 10 | 10 |
| $ED_{rec-a}$ (exposure duration - adult) years | 20 | 20 |
| $EF_{rec-w}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{2-6}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{6-16}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{16-30}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{rec-a}$ (adult exposure frequency) days/year | 0 | 45 |
| $ET_{0-2}$ (exposure time) hours/event | 0 | 2 |
| $ET_{2-6}$ (exposure time) hours/event | 0 | 2 |
| $ET_{6-16}$ (exposure time) hours/event | 0 | 2 |
| $ET_{16-30}$ (exposure time) hours/event | 0 | 2 |
| $ET_{rec-a}$ (adult exposure time) hours/event | 0 | 2 |
| $EV_{0-2}$ (events) events/day | 0 | 1 |
| $EV_{2-6}$ (events) events/day | 0 | 1 |
| $EV_{6-16}$ (events) events/day | 0 | 1 |
| $EV_{16-30}$ (events) events/day | 0 | 1 |
| $EV_{rec-a}$ (adult) events/day | 0 | 1 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg | 0 | 4.181 |
| $IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg | 0 | 20.652 |
| $IRW_{0-2}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{2-6}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{6-16}$ (water intake rate) L/hour | 0.124 | 0.02 |
| $IRW_{16-30}$ (water intake rate) L/hour | 0.0985 | 0.02 |
| $IRW_{rec}$ (water intake rate - adult) L/day | 0.11 | 0.02 |
| $IRW_{rec-a}$ (water intake rate - adult) L/hr | 0.11 | 0.02 |
| LT (lifetime - recreator) years | 70 | 70 |
| $SA_{0-2}$ (skin surface area) cm$^2$ | 6365 | 1770 |
| $SA_{2-6}$ (skin surface area) cm$^2$ | 6365 | 1770 |
| $SA_{6-16}$ (skin surface area) cm$^2$ | 19652 | 3820 |
| $SA_{16-30}$ (skin surface area) cm$^2$ | 19652 | 5790 |
| $SA_{rec}$ (skin surface area - adult) cm$^2$ | 19652 | 4805 |
| $SA_{rec-a}$ (skin surface area - adult) cm$^2$ | 19652 | 4805 |
| Apparent thickness of stratum corneum (cm) | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.0001 |

Output generated 28AUG2020:09:54:20

## Site-specific

### Recreator Regional Screening Levels (RSL) for Surface Water

**Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.**

| Chemical | CAS Number | Mutagen? | Volatile? | Chemical Type | $SF_o$(mg/kg-day)$^{-1}$ | $SF_o$ Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | RAGSe GIABS (unitless) | $K_p$ (cm/hr) | MW | FA (unitless) | In EPD? | $DA_{event(ca)}$ | $DA_{event(nc\ child)}$ | $DA_{event(nc\ adult)}$ | Ingestion SL TR=0.0001 (ug/L) | Dermal SL TR=0.0001 (ug/L) | Carcinogenic SL TR=0.0001 (ug/L) | Ingestion SL (Child) THQ=1 (ug/L) | Dermal SL (Child) THQ=1 (ug/L) | Noncarcinogenic SL (Child) THQ=1 (ug/L) | Ingestion SL (Adult) THQ=1 (ug/L) | Dermal SL (Adult) THQ=1 (ug/L) | Noncarcinogenic SL (Adult) THQ=1 (ug/L) | Screening Level (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | 7440-36-0 | No | No | Inorganics | - | | 0.0004 | I | 0.0003 | A | 0.1500 | 0.0010 | 121.7600 | 1.0000 | Yes | - | 0.0041 | 0.0063 | - | - | - | 243.0000 | 2060.0000 | 218.0000 | 5030.0000 | 3140.0000 | 1930.0000 | 2.18E+02nc |
| Arsenic, Inorganic | 7440-38-2 | No | No | Inorganics | 1.5000 | I | 0.0003 | I | 0.0000 | C | 1.0000 | 0.0010 | 74.9220 | 1.0000 | Yes | 0.0168 | 0.0206 | 0.0314 | 407.0000 | 8380.0000 | 389.0000 | 183.0000 | 10300.0000 | 179.0000 | 3770.0000 | 15700.0000 | 3040.0000 | 1.79E+02nc |
| Barium | 7440-39-3 | No | No | Inorganics | - | | 0.2000 | I | 0.0005 | H | 0.0700 | 0.0010 | 137.3300 | 1.0000 | Yes | - | 0.9623 | 1.4652 | - | - | - | 122000.0000 | 481000.0000 | 97100.0000 | 2510000.0000 | 733000.0000 | 567000.0000 | 9.71E+04nc |
| Beryllium and compounds | 7440-41-7 | No | No | Inorganics | - | | 0.0020 | I | 0.0000 | I | 0.0070 | 0.0010 | 9.0100 | 1.0000 | Yes | - | 0.0010 | 0.0015 | - | - | - | 1220.0000 | 481.0000 | 345.0000 | 25100.0000 | 733.0000 | 712.0000 | 3.45E+02nc |
| Boron And Borates Only | 7440-42-8 | No | No | Inorganics | - | | 0.2000 | I | 0.0200 | H | 1.0000 | 0.0010 | 13.8400 | 1.0000 | Yes | - | 13.7476 | 20.9319 | - | - | - | 122000.0000 | 6870000.0000 | 120000.0000 | 2510000.0000 | 10500000.0000 | 2030000.0000 | 1.20E+05nc |
| Cadmium (Water) | 7440-43-9 | No | No | Inorganics | - | | 0.0005 | I | 0.0000 | A | 0.0500 | 0.0010 | 112.4000 | 1.0000 | Yes | - | 0.0017 | 0.0026 | - | - | - | 304.0000 | 859.0000 | 225.0000 | 6290.0000 | 1310.0000 | 1080.0000 | 2.25E+02nc |
| Chromium(III), Insoluble Salts | 16065-83-1 | No | No | Inorganics | - | | 1.5000 | I | - | | 0.0130 | 0.0010 | 52.0000 | 1.0000 | Yes | - | 1.3404 | 2.0409 | - | - | - | 913000.0000 | 670000.0000 | 386000.0000 | 18900000.0000 | 1020000.0000 | 968000.0000 | 3.86E+05nc |
| Cobalt | 7440-48-4 | No | No | Inorganics | - | | 0.0003 | P | 0.0000 | P | 1.0000 | 0.0004 | 58.9300 | 1.0000 | Yes | - | 0.0206 | 0.0314 | - | - | - | 183.0000 | 25800.0000 | 181.0000 | 3770.0000 | 39200.0000 | 3440.0000 | 1.81E+02nc |
| Fluoride | 16984-48-8 | No | No | Inorganics | - | | 0.0400 | C | 0.0130 | C | 1.0000 | 0.0010 | 38.0000 | 1.0000 | Yes | - | 2.7495 | 4.1864 | - | - | - | 24300.0000 | 1370000.0000 | 23900.0000 | 503000.0000 | 2090000.0000 | 405000.0000 | 2.39E+04nc |
| Lithium | 7439-93-2 | No | No | Inorganics | - | | 0.0020 | P | - | | 1.0000 | 0.0010 | 6.9400 | 1.0000 | Yes | - | 0.1375 | 0.2093 | - | - | - | 1220.0000 | 68700.0000 | 1200.0000 | 25100.0000 | 105000.0000 | 20300.0000 | 1.20E+03nc |
| Mercuric Chloride | 7487-94-7 | No | No | Inorganics | - | | 0.0003 | I | 0.0003 | G | 0.0700 | 0.0010 | 271.5000 | 1.0000 | Yes | - | 0.0014 | 0.0022 | - | - | - | 183.0000 | 722.0000 | 146.0000 | 3770.0000 | 1100.0000 | 851.0000 | 1.46E+02nc |
| Molybdenum | 7439-98-7 | No | No | Inorganics | - | | 0.0050 | I | - | | 1.0000 | 0.0010 | 95.9400 | 1.0000 | Yes | - | 0.3437 | 0.5233 | - | - | - | 3040.0000 | 172000.0000 | 2990.0000 | 62900.0000 | 262000.0000 | 50700.0000 | 2.99E+03nc |
| Selenium | 7782-49-2 | No | No | Inorganics | - | | 0.0050 | I | 0.0200 | C | 1.0000 | 0.0010 | 78.9600 | 1.0000 | Yes | - | 0.3437 | 0.5233 | - | - | - | 3040.0000 | 172000.0000 | 2990.0000 | 62900.0000 | 262000.0000 | 50700.0000 | 2.99E+03nc |
| Thallium (Soluble Salts) | 7440-28-0 | No | No | Inorganics | - | | 0.0000 | X | - | | 1.0000 | 0.0010 | 204.3800 | 1.0000 | Yes | - | 0.0007 | 0.0010 | - | - | - | 6.0800 | 344.0000 | 5.9800 | 126.0000 | 523.0000 | 101.0000 | 5.98E+00nc |

Output generated 28AUG2020:09:54:20

# ATTACHMENT B

## Off-Site Worker Groundwater Risk Calculations

**TABLE B-1**
**HUMAN HEALTH EXPOSURE PARAMETERS FOR WORKER INGESTION OF DRINKING WATER AND DERMAL EXPOSURE WHILE BATHING**

| Exposure Parameter | | Units | Current/Future Construction Worker | |
|---|---|---|---|---|
| **Standard Parameters** | | | | |
| Body Weight | BW | kg | 80 | USEPA, 2014 |
| Exposure Duration | ED | years | 25 | USEPA, 2014 |
| Non–carcinogenic Averaging Time | Atnc | days | 9125 | ED expressed in days |
| Carcinogenic Averaging Time | Atc | days | 25550 | 70 year lifetime |
| **Ingestion of Groundwater** | | | | |
| Exposure Frequency | EF | days/year | 250 | USEPA, 2014 |
| Water Ingestion Rate | IR | L/day | 0.89 | USEPA, 2011 [1] |
| Fraction Ingested | FI | unitless | 1 | Assumption |
| **Dermal Exposure with Groundwater** | | | | |
| Exposure Frequency | EF | days/year | 250 | USEPA, 2014 |
| Exposed Skin Surface Area | SA | $cm^2$ | 19652 | USEPA, 2014 [2] |
| Exposure Time | t-event | hr/event | 0.71 | USEPA, 2014 [2] |
| Events per Day | EV | event/day | 1 | Assumption |

**NOTES AND ABBREVIATIONS**

USEPA, 2011 - Exposure Factors Handbook. USEPA/600/R-10/030. October, 2011.
USEPA, 2014 - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER 9200.1-120. February 6, 2014.
[1] - Table 3-1, Ingestion of Water and Other Select Liquids. Average ingestion rate for 21 to <70 years.
[2] - Assumes workers shower on-site, values are the residential adult water surface area and water exposure time for bathing/showering.

**Worker Groundwater Risk Output - WAP-3I**

Site-specific
Resident Tap Water Inputs
/HTML"<a href=/tmp/Resident_chem_rsl_04NOV2020_prg15833.xlsx>Output to Spreadsheet</a>
/HTML"<a href=/tmp/Resident_chem_rsl_04NOV2020_prg15833.pdf>Output to PDF</a></div>

| Variable | Resident Tap Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (mutagenic body weight) kg | 15 | 0 |
| $BW_{2-6}$ (mutagenic body weight) kg | 15 | 0 |
| $BW_{6-16}$ (mutagenic body weight) kg | 80 | 0 |
| $BW_{16-26}$ (mutagenic body weight) kg | 80 | 80 |
| $BW_{res-a}$ (body weight - adult) kg | 80 | 80 |
| $BW_{res-c}$ (body weight - child) kg | 15 | 0 |
| $DFW_{res-adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 2610650 | 1535312.5 |
| $DFWM_{res-adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 8191633 | 1535312.5 |
| $ED_{res}$ (exposure duration - resident) years | 26 | 25 |
| $ED_{0-2}$ (mutagenic exposure duration first phase) years | 2 | 0 |
| $ED_{2-6}$ (mutagenic exposure duration second phase) years | 4 | 0 |
| $ED_{6-16}$ (mutagenic exposure duration third phase) years | 10 | 0 |
| $ED_{16-26}$ (mutagenic exposure duration fourth phase) years | 10 | 25 |
| $ED_{res-a}$ (exposure duration - adult) years | 20 | 25 |
| $ED_{res-c}$ (exposure duration - child) years | 6 | 0 |
| $EF_{res}$ (exposure frequency) days/year | 350 | 250 |
| $EF_{0-2}$ (mutagenic exposure frequency first phase) days/year | 350 | 0 |
| $EF_{2-6}$ (mutagenic exposure frequency second phase) days/year | 350 | 0 |
| $EF_{6-16}$ (mutagenic exposure frequency third phase) days/year | 350 | 0 |
| $EF_{16-26}$ (mutagenic exposure frequency fourth phase) days/year | 350 | 250 |
| $EF_{res-a}$ (exposure frequency - adult) days/year | 350 | 250 |
| $EF_{res-c}$ (exposure frequency - child) days/year | 350 | 0 |
| $ET_{res}$ (exposure time) hours/day | 24 | 0 |
| $ET_{event-res-adj}$ (age-adjusted exposure time) hours/event | 0.67077 | 0.71 |
| $ET_{event-res-madj}$ (mutagenic age-adjusted exposure time) hours/event | 0.67077 | 0.71 |
| $ET_{0-2}$ (mutagenic dermal exposure time first phase) hours/event | 0.54 | 0 |
| $ET_{2-6}$ (mutagenic dermal exposure time second phase) hours/event | 0.54 | 0 |
| $ET_{6-16}$ (mutagenic dermal exposure time third phase) hours/event | 0.71 | 0 |
| $ET_{16-26}$ (mutagenic dermal exposure time fourth phase) hours/event | 0.71 | 0.71 |
| $ET_{res-a}$ (dermal exposure time - adult) hours/event | 0.71 | 0.71 |
| $ET_{res-c}$ (dermal exposure time - child) hours/event | 0.54 | 0 |
| $ET_{0-2}$ (mutagenic inhalation exposure time first phase) hours/day | 24 | 0 |
| $ET_{2-6}$ (mutagenic inhalation exposure time second phase) hours/day | 24 | 0 |
| $ET_{6-16}$ (mutagenic inhalation exposure time third phase) hours/day | 24 | 0 |
| $ET_{16-26}$ (mutagenic inhalation exposure time fourth phase) hours/day | 24 | 0 |
| $ET_{res-a}$ (inhalation exposure time - adult) hours/day | 24 | 0 |
| $ET_{res-c}$ (inhalation exposure time - child) hours/day | 24 | 0 |
| $EV_{0-2}$ (mutagenic events) per day | 1 | 0 |
| $EV_{2-6}$ (mutagenic events) per day | 1 | 0 |
| $EV_{6-16}$ (mutagenic events) per day | 1 | 0 |
| $EV_{16-26}$ (mutagenic events) per day | 1 | 1 |
| $EV_{res-a}$ (events - adult) per day | 1 | 1 |
| $EV_{res-c}$ (events - child) per day | 1 | 0 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{res-adj}$ (adjusted intake factor) L/kg | 327.95 | 69.531 |
| $IFWM_{res-adj}$ (mutagenic adjusted intake factor) L/kg | 1019.9 | 69.531 |
| $IRW_{0-2}$ (mutagenic water intake rate) L/day | 0.78 | 0 |
| $IRW_{2-6}$ (mutagenic water intake rate) L/day | 0.78 | 0 |
| $IRW_{6-16}$ (mutagenic water intake rate) L/day | 2.5 | 0 |
| $IRW_{16-26}$ (mutagenic water intake rate) L/day | 2.5 | 0.89 |
| $IRW_{res-a}$ (water intake rate - adult) L/day | 2.5 | 0.89 |
| $IRW_{res-c}$ (water intake rate - child) L/day | 0.78 | 0 |
| K (volatilization factor of Andelman) L/$m^3$ | 0.5 | 0.5 |
| LT (lifetime) years | 70 | 70 |
| $SA_{0-2}$ (mutagenic skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{2-6}$ (mutagenic skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{6-16}$ (mutagenic skin surface area) $cm^2$ | 19652 | 0 |
| $SA_{16-26}$ (mutagenic skin surface area) $cm^2$ | 19652 | 19652 |
| $SA_{res-a}$ (skin surface area - adult) $cm^2$ | 19652 | 19652 |
| $SA_{res-c}$ (skin surface area - child) $cm^2$ | 6365 | 0 |
| $l_{sc}$ (apparent thickness of stratum corneum) cm | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.000001 |

**Site-specific**
**Resident Risk for Tap Water**

| Chemical | $SF_o$(mg/kg-day)$^{-1}$ | $SF_o$ Ref | IUR (ug/m$^3$)$^{-1}$ | IUR Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | GIABS | $K_p$ (cm/hr) | MW | B (unitless) | $t^*$(hr) | $\tau_{event}$(hr/event) | FA (unitless) | In EPD? | $DA_{event\ (ca)}$ | $DA_{event}$ (nc child) | $DA_{event}$ (nc adult) | MCL (ug/L) | Concentration (ug/L) | Ingestion Risk | Dermal Risk | Inhalation Risk | Carcinogenic Risk | Ingestion Adult HQ | Dermal Adult HQ | Inhalation Adult HQ | Noncarcinogenic Adult HI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic, Inorganic | 1.50E+00 | U | 4.30E-03 | U | 3.00E-04 | U | 1.50E-05 | U | 1.00E+00 | 1.00E-03 | 7.49E+01 | 3.33E-03 | 6.63E-01 | 2.76E-01 | 1.00E+00 | Yes | 1.11E-05 | - | 1.78E-03 | 1.00E+01 | 3.10E+00 | 1.27E-05 | 1.98E-07 | - | 1.29E-05 | 7.87E-02 | 1.23E-03 | - | 8.00E-02 |
| Barium | - | | - | | 2.00E-01 | U | 5.00E-04 | U | 7.00E-02 | 1.00E-03 | 1.37E+02 | 4.51E-03 | 1.48E+00 | 6.18E-01 | 1.00E+00 | Yes | - | - | 8.32E-02 | 2.00E+03 | 2.35E+02 | - | - | - | - | 8.95E-03 | 2.01E-03 | - | 1.10E-02 |
| Beryllium and compounds | - | | 2.40E-03 | U | 2.00E-03 | U | 2.00E-05 | U | 7.00E-03 | 1.00E-03 | 9.01E+00 | 1.15E-03 | 2.83E-01 | 1.18E-01 | 1.00E+00 | Yes | - | - | 8.32E-05 | 4.00E+00 | 4.40E-01 | - | - | - | - | 1.68E-03 | 3.75E-03 | - | 5.43E-03 |
| Boron And Borates Only | - | | - | | 2.00E-01 | U | 2.00E-02 | U | 1.00E+00 | 1.00E-03 | 1.38E+01 | 1.43E-03 | 3.02E-01 | 1.26E-01 | 1.00E+00 | Yes | - | - | 1.19E+00 | - | 8.88E+03 | - | - | - | - | 3.38E-01 | 5.30E-03 | - | 3.44E-01 |
| Cadmium (Water) | - | | 1.80E-03 | U | 5.00E-04 | U | 1.00E-05 | U | 5.00E-02 | 1.00E-03 | 1.12E+02 | 4.08E-03 | 1.08E+00 | 4.48E-01 | 1.00E+00 | Yes | - | - | 1.49E-04 | 5.00E+00 | 2.80E-01 | - | - | - | - | 4.27E-03 | 1.34E-03 | - | 5.61E-03 |
| Chromium(III), Insoluble Salts | - | | - | | 1.50E+00 | U | - | | 1.30E-02 | 1.00E-03 | 5.20E+01 | 2.77E-03 | 4.93E-01 | 2.06E-01 | 1.00E+00 | Yes | - | - | 1.16E-01 | - | 1.30E+00 | - | - | - | - | 6.60E-06 | 7.96E-06 | - | 1.46E-05 |
| Cobalt | - | | 9.00E-03 | U | 3.00E-04 | U | 6.00E-06 | U | 1.00E+00 | 4.00E-04 | 5.89E+01 | 1.18E-03 | 5.40E-01 | 2.25E-01 | 1.00E+00 | Yes | - | - | 1.78E-03 | - | 9.10E-01 | - | - | - | - | 2.31E-02 | 1.45E-04 | - | 2.33E-02 |
| Fluoride | - | | - | | 4.00E-02 | U | 1.30E-02 | U | 1.00E+00 | 1.00E-03 | 3.80E+01 | 2.37E-03 | 4.12E-01 | 1.72E-01 | 1.00E+00 | Yes | - | - | 2.38E-01 | 4.00E+03 | 4.90E+02 | - | - | - | - | 9.33E-02 | 1.46E-03 | - | 9.48E-02 |
| Lead and Compounds | - | | - | | - | | - | | 1.00E+00 | 1.00E-04 | 2.07E+02 | 5.54E-04 | 3.65E+00 | 1.52E+00 | 1.00E+00 | Yes | - | - | - | 1.50E+01 | 8.40E-01 | - | - | - | - | - | - | - | - |
| Lithium | - | | - | | 2.00E-03 | U | - | | 1.00E+00 | 1.00E-03 | 6.94E+00 | 1.01E-03 | 2.76E-01 | 1.15E-01 | 1.00E+00 | Yes | - | - | 1.19E-02 | - | 6.00E+01 | - | - | - | - | 2.29E-01 | 3.58E-03 | - | 2.32E-01 |
| Molybdenum | - | | - | | 5.00E-03 | U | 2.00E-03 | U | 1.00E+00 | 1.00E-03 | 9.59E+01 | 3.77E-03 | 8.70E-01 | 3.62E-01 | 1.00E+00 | Yes | - | - | 2.97E-02 | - | 8.45E+02 | - | - | - | - | 1.29E+00 | 2.02E-02 | - | 1.31E+00 |
| **Total Risk/HI* | - | | - | | - | | - | | - | - | - | - | - | - | - | | - | - | - | - | - | *1.27E-05* | *1.98E-07* | - | *1.29E-05* | *2.06E+00* | *3.90E-02* | - | *2.10E+00* |

**Worker Groundwater Risk Output - WAP-6S**

Site-specific
Resident Tap Water Inputs
/HTML"<a href=/tmp/Resident_chem_rsl_04NOV2020_prg12313.xlsx>Output to Spreadsheet</a>
/HTML"<a href=/tmp/Resident_chem_rsl_04NOV2020_prg12313.pdf>Output to PDF</a></div>

| Variable | Resident Tap Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (mutagenic body weight) kg | 15 | 0 |
| $BW_{2-6}$ (mutagenic body weight) kg | 15 | 0 |
| $BW_{6-16}$ (mutagenic body weight) kg | 80 | 0 |
| $BW_{16-26}$ (mutagenic body weight) kg | 80 | 80 |
| $BW_{res-a}$ (body weight - adult) kg | 80 | 80 |
| $BW_{res-c}$ (body weight - child) kg | 15 | 0 |
| $DFW_{res-adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 2610650 | 1535312.5 |
| $DFWM_{res-adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 8191633 | 1535312.5 |
| $ED_{res}$ (exposure duration - resident) years | 26 | 25 |
| $ED_{0-2}$ (mutagenic exposure duration first phase) years | 2 | 0 |
| $ED_{2-6}$ (mutagenic exposure duration second phase) years | 4 | 0 |
| $ED_{6-16}$ (mutagenic exposure duration third phase) years | 10 | 0 |
| $ED_{16-26}$ (mutagenic exposure duration fourth phase) years | 10 | 25 |
| $ED_{res-a}$ (exposure duration - adult) years | 20 | 25 |
| $ED_{res-c}$ (exposure duration - child) years | 6 | 0 |
| $EF_{res}$ (exposure frequency) days/year | 350 | 250 |
| $EF_{0-2}$ (mutagenic exposure frequency first phase) days/year | 350 | 0 |
| $EF_{2-6}$ (mutagenic exposure frequency second phase) days/year | 350 | 0 |
| $EF_{6-16}$ (mutagenic exposure frequency third phase) days/year | 350 | 0 |
| $EF_{16-26}$ (mutagenic exposure frequency fourth phase) days/year | 350 | 250 |
| $EF_{res-a}$ (exposure frequency - adult) days/year | 350 | 250 |
| $EF_{res-c}$ (exposure frequency - child) days/year | 350 | 0 |
| $ET_{res}$ (exposure time) hours/day | 24 | 0 |
| $ET_{event-res-adj}$ (age-adjusted exposure time) hours/event | 0.67077 | 0.71 |
| $ET_{event-res-madj}$ (mutagenic age-adjusted exposure time) hours/event | 0.67077 | 0.71 |
| $ET_{0-2}$ (mutagenic dermal exposure time first phase) hours/event | 0.54 | 0 |
| $ET_{2-6}$ (mutagenic dermal exposure time second phase) hours/event | 0.54 | 0 |
| $ET_{6-16}$ (mutagenic dermal exposure time third phase) hours/event | 0.71 | 0 |
| $ET_{16-26}$ (mutagenic dermal exposure time fourth phase) hours/event | 0.71 | 0.71 |
| $ET_{res-a}$ (dermal exposure time - adult) hours/event | 0.71 | 0.71 |
| $ET_{res-c}$ (dermal exposure time - child) hours/event | 0.54 | 0 |
| $ET_{0-2}$ (mutagenic inhalation exposure time first phase) hours/day | 24 | 0 |
| $ET_{2-6}$ (mutagenic inhalation exposure time second phase) hours/day | 24 | 0 |
| $ET_{6-16}$ (mutagenic inhalation exposure time third phase) hours/day | 24 | 0 |
| $ET_{16-26}$ (mutagenic inhalation exposure time fourth phase) hours/day | 24 | 0 |
| $ET_{res-a}$ (inhalation exposure time - adult) hours/day | 24 | 0 |
| $ET_{res-c}$ (inhalation exposure time - child) hours/day | 24 | 0 |
| $EV_{0-2}$ (mutagenic events) per day | 1 | 0 |
| $EV_{2-6}$ (mutagenic events) per day | 1 | 0 |
| $EV_{6-16}$ (mutagenic events) per day | 1 | 0 |
| $EV_{16-26}$ (mutagenic events) per day | 1 | 1 |
| $EV_{res-a}$ (events - adult) per day | 1 | 1 |
| $EV_{res-c}$ (events - child) per day | 1 | 0 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{res-adj}$ (adjusted intake factor) L/kg | 327.95 | 69.531 |
| $IFWM_{res-adj}$ (mutagenic adjusted intake factor) L/kg | 1019.9 | 69.531 |
| $IRW_{0-2}$ (mutagenic water intake rate) L/day | 0.78 | 0 |
| $IRW_{2-6}$ (mutagenic water intake rate) L/day | 0.78 | 0 |
| $IRW_{6-16}$ (mutagenic water intake rate) L/day | 2.5 | 0 |
| $IRW_{16-26}$ (mutagenic water intake rate) L/day | 2.5 | 0.89 |
| $IRW_{res-a}$ (water intake rate - adult) L/day | 2.5 | 0.89 |
| $IRW_{res-c}$ (water intake rate - child) L/day | 0.78 | 0 |
| K (volatilization factor of Andelman) L/$m^3$ | 0.5 | 0.5 |
| LT (lifetime) years | 70 | 70 |
| $SA_{0-2}$ (mutagenic skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{2-6}$ (mutagenic skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{6-16}$ (mutagenic skin surface area) $cm^2$ | 19652 | 0 |
| $SA_{16-26}$ (mutagenic skin surface area) $cm^2$ | 19652 | 19652 |
| $SA_{res-a}$ (skin surface area - adult) $cm^2$ | 19652 | 19652 |
| $SA_{res-c}$ (skin surface area - child) $cm^2$ | 6365 | 0 |
| $l_{sc}$ (apparent thickness of stratum corneum) cm | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.000001 |

**Site-specific**
**Resident Risk for Tap Water**

| Chemical | $SF_o$(mg/kg-day)$^{-1}$ | $SF_o$ Ref | IUR (ug/m$^3$)$^{-1}$ | IUR Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | GIABS | $K_p$ (cm/hr) | MW | B (unitless) | $t^*$(hr) | $\tau_{event}$(hr/event) | FA (unitless) | In EPD? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic, Inorganic | 1.50E+00 | U | 4.30E-03 | U | 3.00E-04 | U | 1.50E-05 | U | 1.00E+00 | 1.00E-03 | 7.49E+01 | 3.33E-03 | 6.63E-01 | 2.76E-01 | 1.00E+00 | Yes |
| Barium | - | | - | | 2.00E-01 | U | 5.00E-04 | U | 7.00E-02 | 1.00E-03 | 1.37E+02 | 4.51E-03 | 1.48E+00 | 6.18E-01 | 1.00E+00 | Yes |
| Boron And Borates Only | - | | - | | 2.00E-01 | U | 2.00E-02 | U | 1.00E+00 | 1.00E-03 | 1.38E+01 | 1.43E-03 | 3.02E-01 | 1.26E-01 | 1.00E+00 | Yes |
| Cobalt | - | | 9.00E-03 | U | 3.00E-04 | U | 6.00E-06 | U | 1.00E+00 | 4.00E-04 | 5.89E+01 | 1.18E-03 | 5.40E-01 | 2.25E-01 | 1.00E+00 | Yes |
| Lithium | - | | - | | 2.00E-03 | U | - | | 1.00E+00 | 1.00E-03 | 6.94E+00 | 1.01E-03 | 2.76E-01 | 1.15E-01 | 1.00E+00 | Yes |
| Molybdenum | - | | - | | 5.00E-03 | U | 2.00E-03 | U | 1.00E+00 | 1.00E-03 | 9.59E+01 | 3.77E-03 | 8.70E-01 | 3.62E-01 | 1.00E+00 | Yes |
| **Total Risk/HI* | - | | - | | - | | - | | - | - | - | - | - | - | - | |

| Chemical | $DA_{event\ (ca)}$ | $DA_{event}$ (nc child) | $DA_{event}$ (nc adult) | MCL (ug/L) | Concentration (ug/L) | Ingestion Risk | Dermal Risk | Inhalation Risk | Carcinogenic Risk | Ingestion Adult HQ | Dermal Adult HQ | Inhalation Adult HQ | Noncarcinogenic Adult HI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic, Inorganic | 1.11E-05 | - | 1.78E-03 | 1.00E+01 | 9.20E-01 | 3.76E-06 | 5.89E-08 | - | 3.81E-06 | 2.34E-02 | 3.66E-04 | - | 2.37E-02 |
| Barium | - | - | 8.32E-02 | 2.00E+03 | 8.20E+01 | - | - | - | - | 3.12E-03 | 7.00E-04 | - | 3.82E-03 |
| Boron And Borates Only | - | - | 1.19E+00 | - | 1.20E+03 | - | - | - | - | 4.57E-02 | 7.17E-04 | - | 4.64E-02 |
| Cobalt | - | - | 1.78E-03 | - | 1.60E+00 | - | - | - | - | 4.06E-02 | 2.55E-04 | - | 4.09E-02 |
| Lithium | - | - | 1.19E-02 | - | 2.40E+00 | - | - | - | - | 9.14E-03 | 1.43E-04 | - | 9.29E-03 |
| Molybdenum | - | - | 2.97E-02 | - | 1.60E+02 | - | - | - | - | 2.44E-01 | 3.82E-03 | - | 2.48E-01 |
| **Total Risk/HI* | - | - | - | - | - | *3.76E-06* | *5.89E-08* | - | *3.81E-06* | *3.66E-01* | *6.00E-03* | - | *3.72E-01* |

# ATTACHMENT C

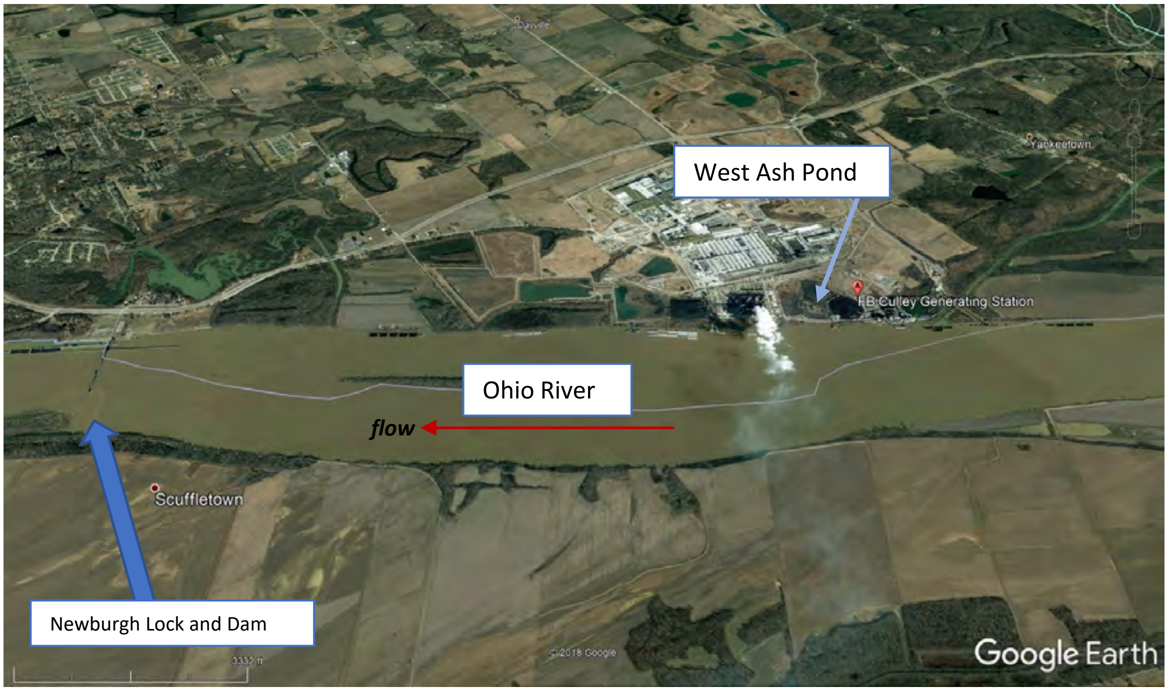
## West Ash Pond Dilution Attenuation Factor Calculations

HALEY ALDRICH

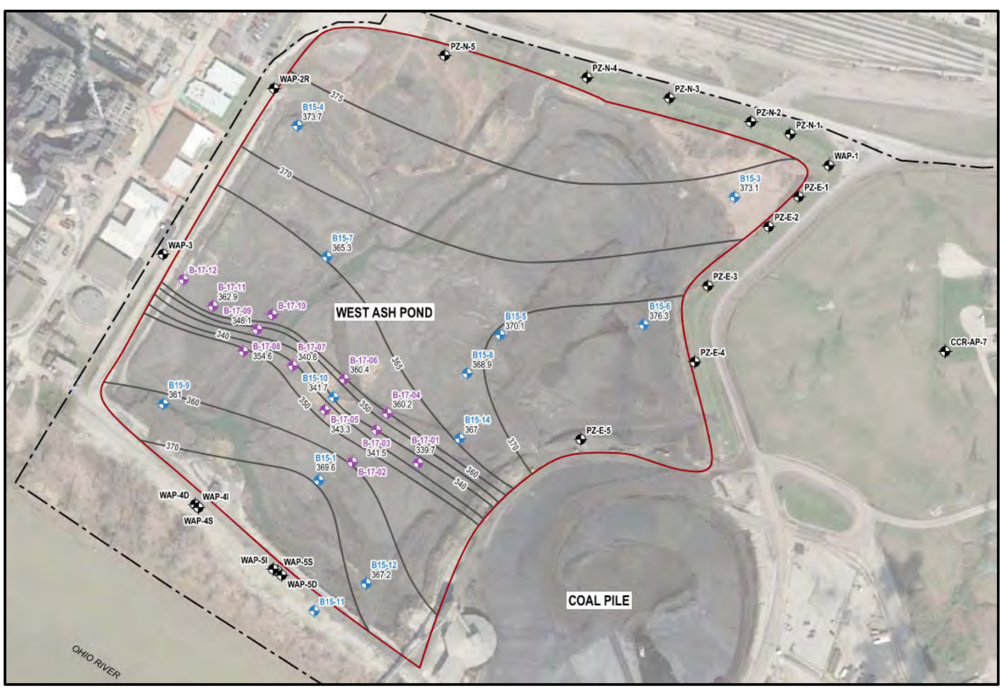
# CALCULATIONS

| | |
|---|---|
| Client | Vectren |
| Project | F.B. Culley Generation Station West Ash Pond |
| Subject | Dilution-Attenuation Factor Calculation |

| | |
|---|---|
| File No. | 129420-025 |
| Sheet | 1 of 5 |
| Date | 10 August 2020 |
| Computed By | Dimitri Quafisi |
| Checked By | JPB |




*Google Earth Perspective View, Facing North*




*Bottom of Ash from Groundwater Monitoring Program F.B Culley Generating Station – West Ash Pond Warrick County Indiana March 2019.*

\\haleyaldrich.com\share\grn_common\129420 Vectren\CMA - Culley WAP\202_0810_Culley_WAP_DAF_D1.pptx

HALEY ALDRICH

# CALCULATIONS

Client: Vectren

Project: F.B. Culley Generation Station West Ash Pond

Subject: Dilution-Attenuation Factor Calculation

File No. 129420-025

Sheet 2 of 5

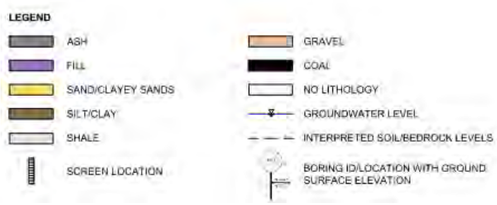
Date 10 August 2020

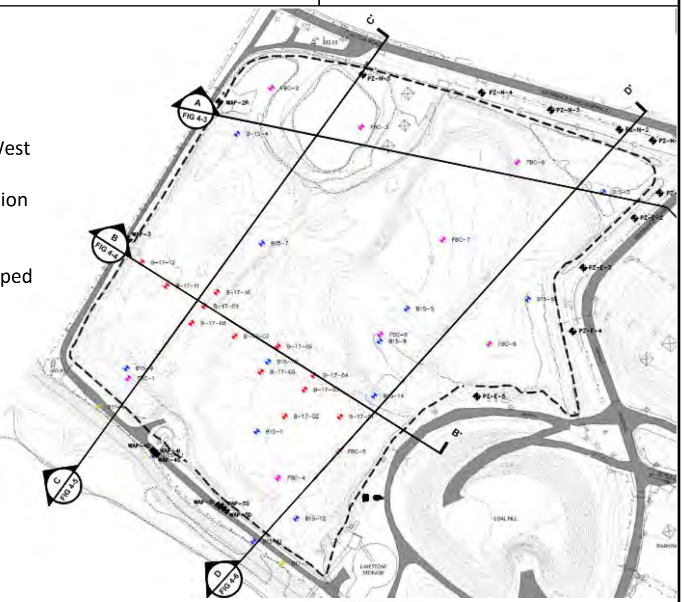
Computed By Dimitri Quafisi

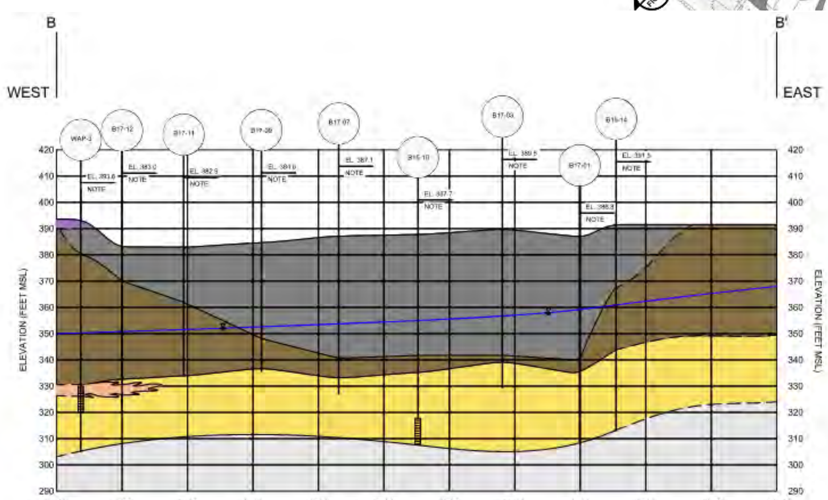
Checked By JPB

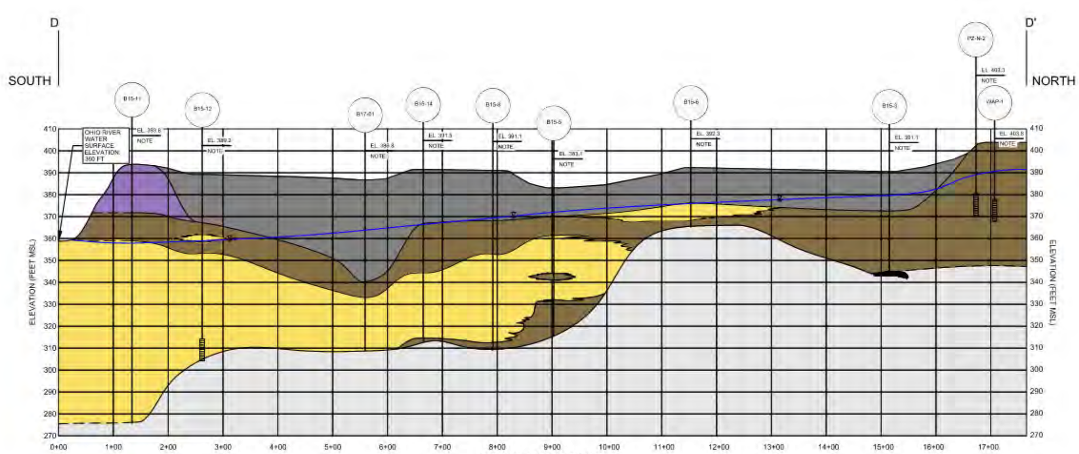
A Conceptual Model was developed for the West Ash Pond using subsurface cross sections interpreted from boring logs by Haley & Aldrich, and surveyed elevations and presented in the March 2019 Groundwater Monitoring Program F.B Culley Generating Station – West Ash Pond Warrick County Indiana. Four basic subsurface units were identified: bedrock, fine grained soils, sandy soils, and coal-combustion residuals (CCR, or "ash").

These unites were represented in a groundwater flow model developed for the Site.



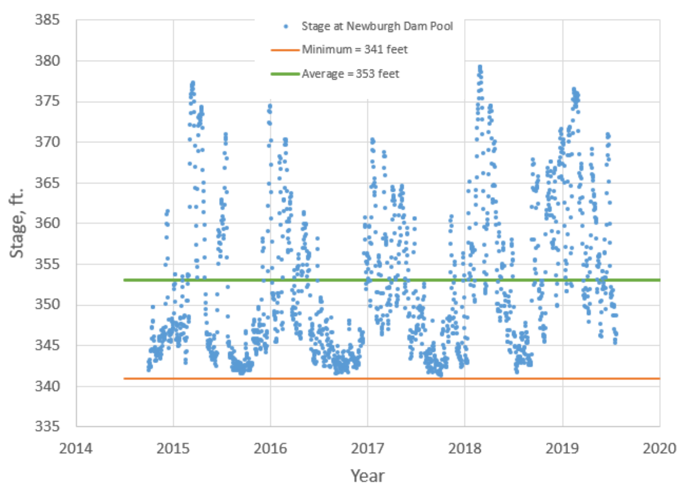



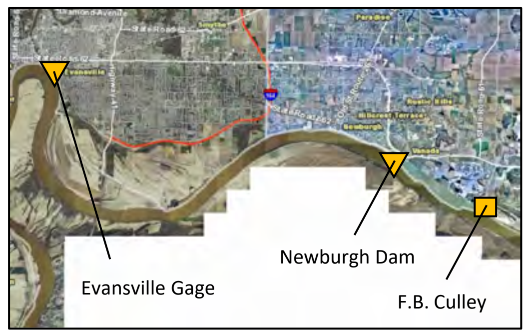

\\haleyaldrich.com\share\grn_common\129420 Vectren\CMA - Culley WAP\202_0810_Culley_WAP_DAF_D1.pptx

Based on gaging data, water surface elevation (stage) of the Newburgh Dam Pool ranges from 341 to 379 feet above the NGVD29 vertical datum. The average stage is 353 feet.

Discontinuous discharge data is available at the Evansville Gage (USGS 03322000; below the Newburgh Dam) from 1940-1996. Although minimum instantaneous flow was approximately 100,000 cfs after the dam was completed in 1975, flow durations will depend on operation of the Dam and Locks and are not presently known. The pre-1975 minimum of approximately 10,000 cfs is used as a most conservative assumption of low flow conditions on the Ohio River. This may be improved to less conservative values if information can be obtained from the Army Corps of Engineers hydrologic model or dam release data.

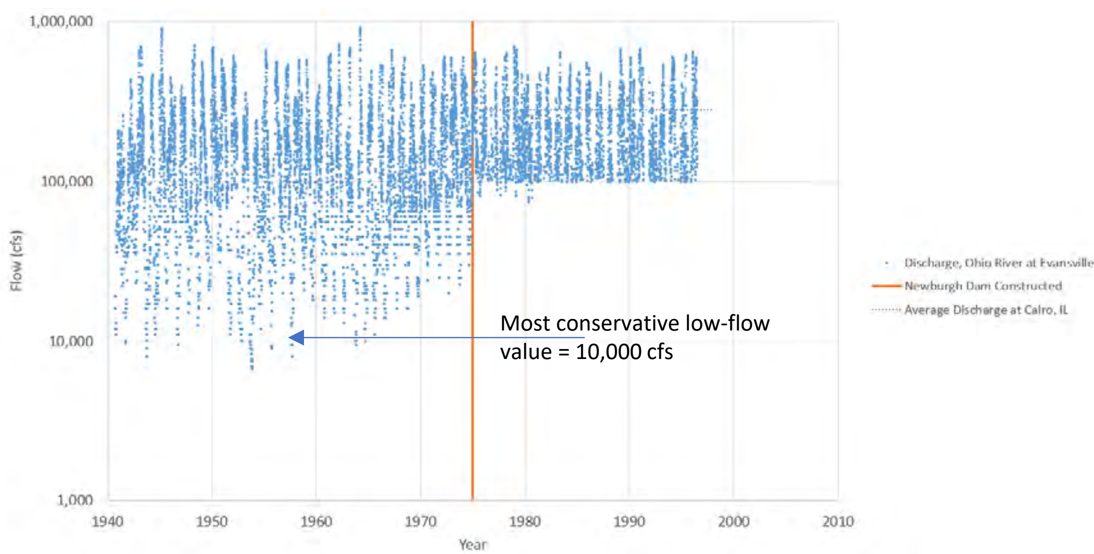



https://waterdata.usgs.gov/nwis/inventory/?site_no=03304300




https://maps.indiana.edu/previewMaps/Hydrology/Monitoring_Streamflow_Gauges.html

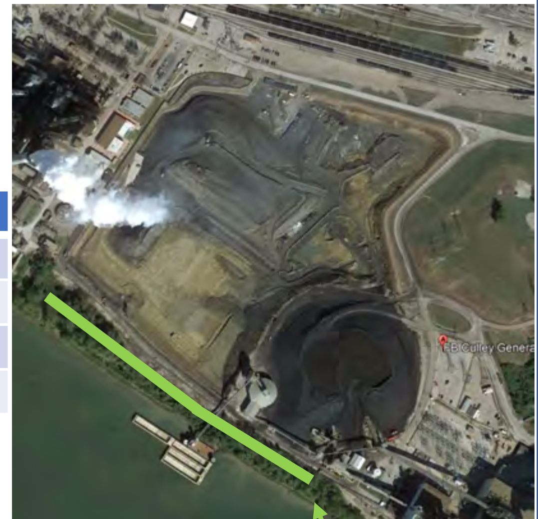
Datum = 329.18 feet NGVD29




https://waterdata.usgs.gov/nwis/inventory/?site_no=03322000

# CALCULATIONS

| | |
|---|---|
| Client | Vectren |
| Project | F.B. Culley Generation Station West Ash Pond |
| Subject | Dilution-Attenuation Factor Calculation |
| File No. | 129420-025 |
| Sheet | 4 of 5 |
| Date | 10 August 2020 |
| Computed By | Dimitri Quafisi |
| Checked By | JPB |



Location of Model Mass Balance Calculation for Flow in Layers 14 through 21.

## Scenario 1

•Typical measured values for site hydraulic conductivities (K), most conservative value for discharge of Ohio River

| Unit | Horizontal K (ft/day) | Vertical K (ft/day) |
|---|---|---|
| CCR | 0.15 | 0.015 |
| Fine grained soils | 0.15 | 0.015 |
| Sandy soils | 3.7 | 0.37 |
| Bedrock | 0.1 | 0.1 |

## Scenario 2

•Conservative (very high) values for site hydraulic conductivities (K), most conservative value for discharge of Ohio River

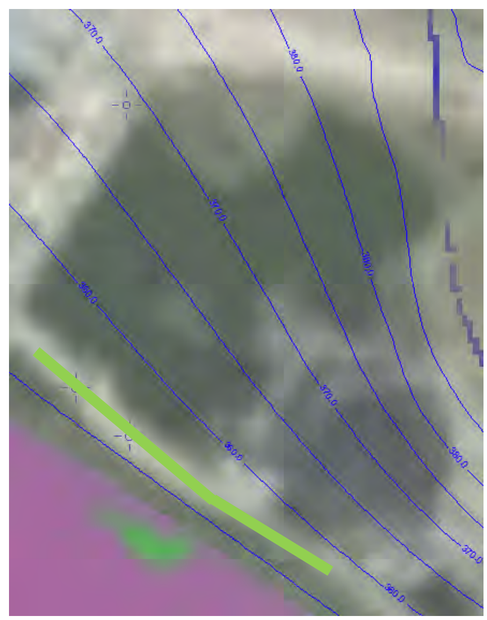
| Unit | Horizontal K (ft/day) | Vertical K (ft/day) |
|---|---|---|
| CCR | 1 | 1 |
| Fine grained soils | 10 | 1 |
| Sandy soils | 10 | 1 |
| Bedrock | 0.1 | 0.1 |

$$DAF = \frac{Q_R}{Q_G}$$

Where:

$Q_R =$ Discharge of Ohio River at West Ash Pond, at Low-Flow conditions.

$Q_G =$ Model Discharge from West Ash Pond to Ohio River



Groundwater Elevation Contours from Groundwater Model for Culley Site. Pink polygon depicts the Ohio River. Mass Balance calculation location shown for reference.

| Pond Elevation (feet)83, | River Stage (feet) | $Q_G$(cfs) | $Q_R$ (cfs) | DAF |
|---|---|---|---|---|
| Scenario 1 | 353 | 0.019 | 10,000 | **526,000** |
| Scenario 2 | 353 | 0.12 | 10,000 | **83,000** |

HALEY ALDRICH

# CALCULATIONS

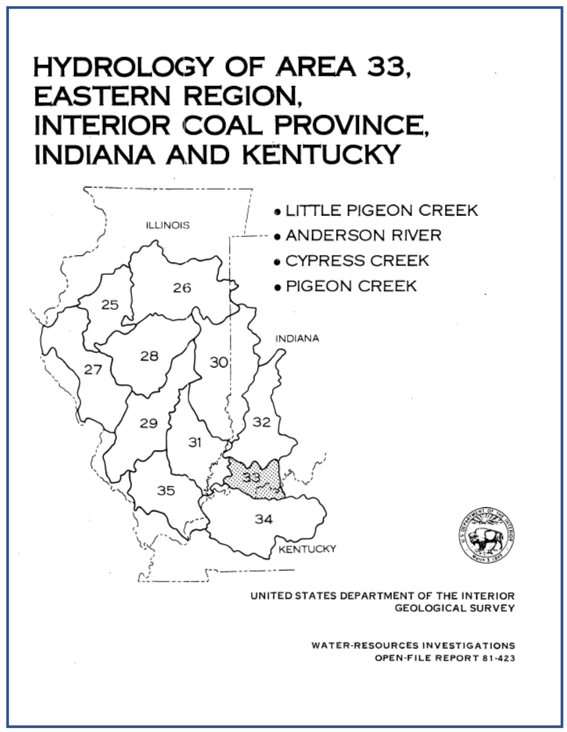
| | | | |
|---|---|---|---|
| Client | Vectren | File No. | 129420-025 |
| Project | F.B. Culley Generation Station West Ash Pond | Sheet | 5 of 5 |
| Subject | Dilution-Attenuation Factor Calculation | Date | 10 August 2020 |
| | | Computed By | Dimitri Quafisi |
| | | Checked By | JPB |

The confluence of Little Pigeon Creek and the Ohio River is adjacent to the east side of the Site. The lowest reach of the Creek runs parallel to the Ohio River.

As reported by the USGS, higher reaches of the Creek have weak aquifer support and are dry during periods of low precipitation (7Q10 flow is zero). Flow in the terminal reach of the Creek is controlled by fluctuations of the Newburgh Dam pool.

## Relevant Publications:


https://pubs.usgs.gov/sir/2014/5242/




https://pubs.usgs.gov/of/1981/0423/report.pdf