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BENEFICIAL USE EVALUATION OF CCR MATERIAL FOR CROWN FILL AT AES/IPL PETERSBURG ASH POND SYSTEM

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Boston, Massachusetts

for AES US Services, LLC
Indianapolis, IN

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List of Acronyms

AES	AES US Services, LLC
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
COPC	Constituents of Potential Concern
CSM	Conceptual Site Model
DOI	U.S. Department of Interior
DUSR	Data Usability Summary Report
FGD	Flue Gas Desulfurization
Haley & Aldrich	Haley & Aldrich, Inc.
HI	Hazard Index
HQ	Hazard Quotient
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
IDEM	Indiana Department of Environmental Management
IWEM	Industrial Waste Management Evaluation Model
LEAF	Leaching Environmental Assessment Framework
LOI	Loss on Ignition
mg/kg	milligrams per kilogram
OSWER	Office of Solid Waste and Emergency Response
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RPD	Relative Percent Difference
RSL	Regional Screening Level
SDA	Spray-Dry Absorption
SL	Screening Level
SPLP	Synthetic Precipitation Leaching Procedure
TACO	Tiered Approach to Corrective Action
TCLP	Toxicity Characteristic Leaching Procedure
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USWAG	Utility Solid Waste Activity Group
VAP	Voluntary Action Program
WWT	Waste Water Treatment

1. Introduction

1.1 PURPOSE AND CONTEXT OF BENEFICIAL USE EVALUATION

AES US Services, LLC (AES) contracted Haley & Aldrich, Inc. (Haley & Aldrich) to provide beneficial use determinations as they relate to the unencapsulated beneficial uses of Coal Combustion Residuals (CCR) from the AES/IPL Petersburg facility (Petersburg) for use as pond closure structural (crown) fill. The beneficial use determinations are based on requirements contained in the U.S. Environmental Protection Agency (USEPA, 2015a) Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities[1] (CCR Rule).

In its approval of the Closure/Post-Closure Plan for the Ash Pond System, the IDEM Office of Land Quality approved the use of fresh plant-generated CCR material (AES Petersburg CCR) to be placed as crown fill in the Ash Pond System (APS) as part of the pond closure.

To comply with the CCR Rule, AES has requested Haley & Aldrich evaluate the following types of CCR materials for the un-encapsulated crown fill beneficial use application:

- Use of five (5) plant-generated CCR materials for crown fill within the Ash Pond System closure (see description of materials in Section 2), including the following with estimated percentages of each [2]:
  - Scrubber sludge and fly ash—40%
  - Gypsum—5%
  - Bottom ash – 5%
  - Conditioned fly ash – 40%
  - WWTP headworks – 10%

For CCR to be used in the un-encapsulated application listed above, the material must be evaluated for compliance with the requirements for "beneficial use of CCR", which is defined in the CCR Rule (40 CFR Section §257.53), as follows:

"Beneficial use of CCR means the CCR must meet all of the following conditions [or criteria]:

1. The CCR must provide a functional benefit;
2. The CCR must substitute for the use of a virgin material, conserving natural resources that would otherwise need to be obtained through practices, such as extraction;

[1] http://www2.epa.gov/coalash/coal-ash-rule

[2] Percentages applicable to placement in Pond A/A' only; Pond B and Pond C percentages do not include the use of WWTP Headworks material. Refer to **Section 2** for more details.

3. The use of the CCR must meet relevant product specifications, regulatory standards or design standards when available, and when such standards are not available, the CCR is not used in excess quantities; and

4. When un-encapsulated use of CCR involving placement on the land of 12,400 tons or more[3] in non-roadway applications, the user must demonstrate and keep records, and provide such documentation upon request, that environmental releases to groundwater, surface water, soil and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use."

CCR materials must be evaluated against the four criteria (as applicable) listed above for the project-specific beneficial use of CCR materials supporting crown fills associated with pond closures at Petersburg. The purpose of this report is to evaluate these four components of USEPA's definition of beneficial use in the context of the proposed project-specific beneficial use.

A project-specific beneficial use determination, using site/project-specific information, is required to make this determination (i.e., structural fills in support of pond closures at Petersburg). The following describes the activities completed to make the project-specific beneficial use determinations:

- Reviewed relevant project documentation including IDEM closure/post-closure submittals and permits, design drawings, quality assurance documents, specifications, testing results, and available reports;

- Identified parameters relevant to the use and placement of CCR, to support beneficial use determination against USEPA's beneficial use definition;

- Representative samples of AES Petersburg CCR were collected, and laboratory tested for various physical and geotechnical parameters to provide a basic physical characterization of the AES Petersburg CCR.

- Evaluated the beneficial uses of the AES Petersburg CCR in the context of the functional benefit the material provides, virgin materials that are conserved using AES Petersburg CCR, and application of AES Petersburg CCR according to regulatory and design specifications; and

- Evaluated the beneficial uses of the AES Petersburg CCR in the context of a conceptual site model (CSM) that describes how the use of the CCR could hypothetically result in releases to other media at the project site. Based on the CSM, appropriate screening levels were identified to evaluate whether the beneficial uses will result in environmental releases to groundwater, surface water, soil, and air that are above relevant regulatory and health-based benchmarks for human and ecological receptors.

[3] The reference of placement of CCR on the land in quantities greater than 12,400 tons is currently under reconsideration by USEPA based on pre-publication inquiries/challenges regarding the proper interpretation of a USEPA disposal data base used in developing the language in Title 40 (40 CFR) §257.53.

1.2 AVAILABLE GUIDANCE

USEPA has published the following technical document that provides guidance for evaluating beneficial uses of CCR and other industrial secondary materials.

> *<u>USEPA Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials:</u> In spring of 2016, USEPA released the Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials (USEPA, 2016a).[4] This methodology is general, and applies to a wide range of materials, including coal ash (EPA has specifically identified this methodology as appropriate for evaluating unencapsulated uses of CCR).[5] USEPA notes that the availability of the methodology does not preclude the use of any other available approaches. The methodology consists of three phases:*
>
> - *Phase I: Planning and Scoping – Develop a CSM and gather data to use in the assessment.*
> - *Phase II: Impact Analysis*
> - *Step 1: Existing Evaluations*
> - *Step 2: Comparison to Analogous Products*
> - *Step 3: Screening Analysis*
> - *Step 4: Risk Modeling*
> - *Phase III: Final Characterization – Summarize the key findings, assumptions, limitations, and uncertainties to develop a conclusion about the subject beneficial use. The beneficial use is either appropriate as proposed or is not. However, for the latter, additional site-specific evaluations can be conducted to further evaluate the use.*

USEPA released a companion document, the Beneficial Use Compendium (USEPA, 2016b).[6] In addition to a compendium of references and links to potentially applicable models, guidance documents, and other information, the Compendium also provides a detailed discussion on how to approach each step of the Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials.[7]

> *<u>Guidance for Structural Fills</u>*
> *In the Final Rule, USEPA cites two documents that address the use of CCR in structural fills: the American Society for Testing and Materials (ASTM) specification for coal ash fills found in ASTM E2277-14: "Standard Guide for Design and Construction of Coal Ash Structural Fills," (ASTM,*

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[4] Available at https://www.epa.gov/smm/methodology-evaluating-beneficial-uses-industrial-non-hazardous-secondary-materials-and

[5] See "EPA Frequent Questions About the Beneficial Use of Coal Ash" at https://www.epa.gov/coalash/frequent-questions-about-beneficial-use-coal-ash

[6] Available at https://www.epa.gov/smm/methodology-evaluating-beneficial-uses-industrial-non-hazardous-secondary-materials-and.

[7] The authors of this report acknowledge that USEPA has also issued guidance on evaluating encapsulated uses of CCR titled Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals. This guidance is consistent with the <u>USEPA Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials</u>. However, USEPA has stated that this document is not intended to be used to evaluate unencapsulated beneficial uses and, therefore, it was not considered as part of this demonstration. See USEPA Frequent Questions on Implementing the Final CCR Rule, available at https://www.epa.gov/coalash/frequent-questions-about-implementing-final-rule-regulating-disposal-coal-combustion.

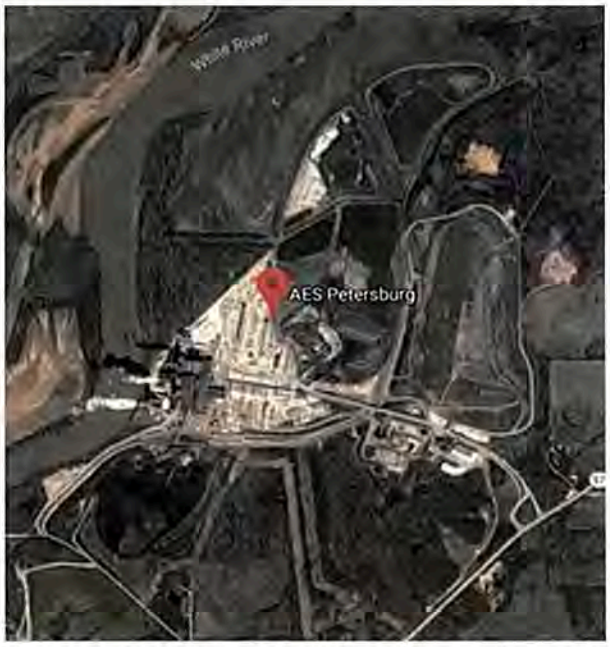
2014) and the Utility Solid Waste Activity Group (USWAG) Guidance on Engineered Structural Fill Projects (USWAG, 2009).

1.3 REPORT ORGANIZATION

This report documents analytical and environmental risk determinations as they relate to unencapsulated beneficial uses of CCRs. The process for evaluating beneficial use followed the methodology outlined in USEPA guidance (USEPA, 2016a; 2016b). Representative samples were collected for each of the five (5) materials used for crown fill for the purpose of physical/geotechnical testing only, the results of which are described herein, while results of previous chemical analyses were used for the Criteria #4 evaluation. The data and the utilization of the same to conduct the formal beneficial use evaluation are presented and discussed in the relevant sections of the report:

- Section 2 describes the beneficial use project that is the addressed in this report.
- Section 3 describes the physical/geotechnical properties of the CCR materials.
- Section 4 provides the Functional Benefit Assessment (Criteria 1 of 4).
- Section 5 provides the Substitution Assessment (Criteria 2 of 4).
- Section 6 provides the Product Specification, Regulatory/Design Standards Assessment (Criteria 3 of 4).
- Section 7 presents the Risk Characterization Assessment (Criteria 4 of 4).
- Section 8 presents the Conclusions and Recommendations.
- The final Section provides the references used.

2. Description of Petersburg Beneficial Use Evaluation of Crown Fill



AES submitted a Closure and Post Closure Plan for the Petersburg Ash Pond System (APS) located at the Petersburg Plant in Pike County, Washington Township, Indiana (See **Figure 1**). The Indiana Department of Environmental Management (IDEM) approved the Closure and Post Closure Plan for the APS in December 2014 and with subsequent modification approvals issued through July 2017. The Petersburg APS is located immediately east of the White River floodplain and is comprised of three connecting CCR ponds: Pond A/A', Pond B and Pond C (see **Figure 2**). An additional area within the APS, identified as Pond D houses a six acre +/- wastewater treatment plant. The APS is approximately 4,600 ft. long and 1,500 ft. wide and covers approximately 152 acres.

The original berms for the APS were constructed to a design height of EL 435ft+/- and the berms surrounding Ponds B and C were later raised to EL 455ft+/- to increase impoundment capacity. All three ponds were constructed with natural soils for the base material at an approximate elevation of EL 420ft+/- corresponding to the pre-development ground surface. The APS has received CCR consisting primarily of a combination of fly ash, bottom ash and FGD that was produced at Petersburg along with other wastewaters from the power plant and facility. As of the preparation of the IDEM Closure/Post-Closure Plan, the volume of CCR and related materials in place within the APS was estimated at approximately 5.7 million cubic yards.

The IDEM-approved Closure Plan for the APS includes closing the pond system in place with a combination geomembrane and earthen final cover system compliant with the CCR Rule for the ponds. To reach cover system subgrades, the approved plans include the beneficial use of plant-generated CCR to aid in achieving final subgrade elevations in preparation of final cover system placement. Additionally, AES has confirmed that the CCR crown fill material is placed above the groundwater elevation within the APS by design. Post closure activities will include groundwater monitoring and final cover system maintenance (see **Appendix A-2**). Final construction documents were prepared, and closure activities commenced at Pond B in spring 2017 including the placement of Petersburg CCR as crown fill above the high water table. Closure construction was completed for Pond B in 2018. Placement of Petersburg CCR crown fill above the high water table has also commenced at Pond C in preparation for the unit closure while Pond A/A' closure/crown fill placement has not begun. AES intends that this crown fill beneficial use evaluation will be applicable to all unencapsulated placement of AES Petersburg CCRs within the APS.

As noted above, the Petersburg CCR to be used for crown fill beneficial use will be limited to that which can be placed above the water table. Areas below the water table in Pond A and Pond A' will be filled with soil or other acceptable non-CCR material to an elevation corresponding to above the high water

table[8]. Placement of crown fill above the high water table limits the leaching potential of the CCR material to that resulting from infiltration through the final cover system as described later in this report. According to AES, the remaining crown fill beneficial use material volume to support construction of the IDEM permitted final cover design elevations is approximately 0.35MM cu. yds. for Pond B, 0.35MM cu. yds. for Pond C and 1.25MM cu. yds. for Pond A/A', respectively.

The five (5) Petersburg plant-generated materials that have been used or will be used for the crown fill beneficial use application are described below:

- Scrubber Sludge and Fly ash – air pollution control scrubber sludge that has been conditioned with plant fly ash.
- Gypsum – off-spec gypsum produced from the air pollution controls at the plant.
- Bottom Ash – dry handled bottom ash from plant production.
- Conditioned Fly Ash – dry handled fly ash from plant production that has been moisture conditioned with water.
- WWTP Headworks – Various solids that that have been recovered from the wastewater stream associated with the wet scrubber pollution control devices on site. These materials are currently handled in separate systems either wet or dry at the AES Petersburg plant and are then conveyed to the APS on an as-needed basis for use as liner subgrade crown fill. The grades and placement of the CCR materials as beneficial use crown fills are performed in accordance with IDEM approved closure plans.

[8] Water table elevations in the pond and relative references within this report are based on information provided by AES. Long-term water table peaks, trends and multi-seasonal effects were not reviewed. Haley & Aldrich assumes AES has and will continue to assess and evaluate water table elevations within the pond and to verify that that the CCR crown fill material is placed above the respective anticipated high water table elevation.

3. Physical/Geotechnical Material Properties

3.1 BASIS OF SAMPLING/TESTING

The screening level physical/geotechnical testing program utilized in this evaluation was designed to provide a basis for physical characterization to develop geotechnical properties for AES Petersburg CCR with the planned structural fill/crown fill in the APS closure. Since up to five (5) CCR streams are being used for the crown fill, a limited list of index/physical and geotechnical testing were performed on each respective material.

Conditioned Fly Ash – AES/IPL Petersburg
(see *Appendix D* for additional photos of CCR materials to be used in the crown fill beneficial use)

The physical characterization testing selected for this evaluation includes particle-size distribution (i.e., grain size/hydrometer), as-received moisture content, physical descriptions using the Unified Soil Classification System (USCS) and loose shipping weight (a representative bulk density assigned for truck transport evaluations). The geotechnical testing performed on the AES Petersburg CCR provides important benchmarking for material properties and expected behavior of the CCR including Standard Proctor Density (compaction testing), and related properties such as minimum shear strength index (as determined via the angle of repose determination) and finally, permeability of compacted samples.

The list of specific laboratory tests and the respective test methods performed for the screening level testing program is provided in the table below (taken from Table 3-1, attached).

Test Parameter	Units	Method
Loose Shipping Weight/Density (Unit Weight)	-	ASTM D7263
Bulk Density (total unit weight)	lb/ft^3	-
Dry Density (dry unit weight)	lb/ft^3	-
Moisture Content	%	ASTM D2216
USCS Soil Classification	-	ASTM D2487
Grain Size Analysis - Sieve and Hydrometer	-	ASTM D422
Gravel	%	-
Sand	%	-
Fines	%	-
Atterberg Limits	-	ASTM D4318
Plastic Limit	%	-
Plastic Index	%	-
pH	-	ASTM D4972
Standard Proctor	-	ASTM D698
Max. Dry Density	lb/ft^3	-
Optimum Moisture	%	-
Angle of Repose	degrees	(1)
Flexible Wall Permeability (@95% Compaction & Opt. Moisture Content)	cm/s	ASTM D5084

3.2 SAMPLING/TESTING AES PETERSBURG CCR

Representative CCR samples are those that consider coal/fuel source, operating levels, existing air pollution controls, and appropriate sampling points; they are meant to "represent" the same or similar CCR products from that facility that will be used for beneficial use applications. A representative sample of each of the five CCR materials [9] was collected by AES plant personnel on 9/14/18. Samples consisting of a single 5-gallon bucket of each material was labeled and shipped to the following lab:

Patriot Engineering and Environmental. Inc.
601 E. Sycamore St.
Evansville, IN 47713

Once received, laboratory technicians homogenized and prepared the individual samples for the prescribed physical/geotechnical testing regime.

3.3 PHYSICAL/GEOTECHNICAL TEST RESULTS

A list of the physical/geotechnical testing results completed on the AES Petersburg CCR material is summarized in the table below with testing method and reporting units as applicable. Supporting laboratory test results from Patriot Laboratories are provided in **Appendix D**.

[9] It is assumed that AES plant personnel are familiar with CCR material generation and handling, and that samples of the 5 CCR materials provided to the lab are representative as defined above.

TABLE 3-1
PHYSICAL & GEOTECHNICAL LABORATORY TESTING RESULTS SUMMARY
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

			CCR MATERIAL RESULTS/ USE APPLICABILITY				
Test Parameter	**Units**	**Method**	**Scrubber Sludge + Flyash**	**Gypsum**	**Bottom Ash**	**Conditioned Flyash**	**WWTP Headworks**
Loose Shipping Weight/Density (Unit Weight)	lb/ft^3	ASTM D7263	80.68	70.28	106.30	73.90	92.93
Moisture Content	%	ASTM D2216	24.75%	32.99%	57.77%	2.98%	47.16%
USCS Soil Classification	-	ASTM D2487	ML *Silt*	ML *Silt*	SW-SM *Well-graded sand with silt*	ML *Sandy silt*	ML *Silt*
AASHTO Soil Classification	-	AASHTO M145	A-4(0)	A-4(0)	A-1-b	A-4(0)	A-4(0)
Grain Size Analysis - Sieve and Hydrometer	-	ASTM D422					
Gravel	%	-	0.0%	0.0%	8.1%	0.0%	0.3%
Sand	%	-	9.5%	2.6%	80.2%	38.0%	1.6%
Fines	%	-	90.5%	97.4%	11.7%	62.0%	98.1%
Atterberg Limits	-	ASTM D4318					
Plastic Limit	%	-	NP	NP	NP	NP	NP
Plastic Index	%	-	NP	NP	NP	NP	NP
pH	-	ASTM D4972	8.87	7.63	8.07	9.06	8.03
Standard Proctor	-	ASTM D698					
Max. Dry Density	lb/ft^3	-	95.9	79.0	99.9	91.4	82.6
Optimum Moisture	%	-	22.5%	35.0%	13.0%	12.0%	32.5%
Angle of Repose	degrees	(1)	36.0	39.5	39.5	36.0	34.0
Flexible Wall Permeability (@95% Compaction & Opt. Moisture Content)	cm/s	ASTM D5084	2.3E-06	8.5E-05	7.7E-04	1.3E-04	1.4E-06

Notes:

NP - non-plastic

(1) Angle of repose test performed by Patriot Labs, Evansville, IN using approximately 400 grams of representative material. The material was prepared at the as-received moisture content, then loose-dumped (as a standard drop test) in a geometric pile and measured for height and diameter and the resulting average natural angle of repose was measured/calculated and recorded. Photos of each test were recorded with placard ID to document material physical appearance, color and pile configuration (and resultant angle of repose). See Appendix D for photo logs of angle of repose testing.

4. Functional Benefit Assessment (Criteria 1 of 4)

Criteria 1 of the CCR Rule definition for beneficial use states that "the CCR must provide a functional benefit." This means that the CCR must perform a "genuine function" in the beneficial use. To provide a "genuine function," the CCR does not have to provide better performance as compared to the material for which it substitutes. Rather, there must be a "legitimate reason" for using CCR. The functional benefit of AES Petersburg CCR as crown fill meets this criteria as evaluated below.

4.1 FUNCTIONAL BENEFIT EVALUATION

CCR used in crown fill will provide a functional benefit by providing a legitimate source of fill material necessary to achieve final subgrade elevations associated with closure of the APS and, therefore, has a demonstrated functional benefit. When placed and compacted in controlled lifts in accordance with the approved Closure Plan and associated Quality Assurance Manual, the AES Petersburg CCR can be used to achieve final subgrade elevations necessary to support the final cover system. This use has already been demonstrated by the CCR material used in Pond B to achieve design subgrade.

4.2 ANALYSIS OF CCR CHARACTERISTICS

As noted previously, AES has currently performed physical and geotechnical laboratory testing to be used to evaluate the suitability of the AES Petersburg CCR for the crown fill beneficial use. The subsections below provide a summary of the physical and geotechnical testing results and materials suitability evaluation process for this beneficial use.

4.2.1 Summary of Testing Results and Applicability of Planned Use

The use of AES Petersburg CCR as a subgrade crown fill material share the common installation/ construction specifications associated with a traditional controlled/ compacted fill operation. Regarding physical/ material properties, the following observations can be highlighted based on the summary of physical/ geotechnical tests completed for this evaluation:

- Compaction characteristics of the five AES Petersburg CCR materials as defined by the Standard Proctor Test were reported with values as follows:
  - Maximum dry density and optimum moisture content ranging from 79.0 to 99.9 pcf and 12.0 to 35.0%, respectively; with total unit weights ranging from 97.2 to 111.6 pcf (at 95% of maximum dry density and the optimum moisture content).
  - These results demonstrate compaction properties that are suitable for the planned APS use and fall into a comparable range of values attributed to natural soils that would be used for this type of crown fill.
- Minimum shear strength index (as determined via the angle of repose test) ranged from 34.0 to 39.5 degrees, which is comparable with expected minimum shear strength index values for common soil used in structural fill.
- Permeability (K) values of the five CCR materials ranged from 1.4×10^{-6} to 7.7×10^{-4} cm/sec of compacted samples, which are typical and comparable for in-place permeabilities of compacted earthen materials.

- Index testing, including grain-size distribution, hydrometer, and Atterberg Limits test results, demonstrated that the CCR material will perform comparably with traditional structural fills soils.

  Fugitive dust potential from AES's list of CCR materials indicates the need for management via moisture-conditioning[10] - not atypical of natural soils used for structural fills. AES implemented and follows a CCR Fugitive Dust Control Plan that meets the requirements of the CCR Rule, 40 CFR 257.80 to ensure responsible management of CCR materials handled at the site.
- Additional index testing (as it relates to material transport and hauling) indicates that loose shipping weight for the five CCR materials ranged from 70.3 to 106.3 pcf, which provides additional insight as a representative bulk density assigned for truck transport evaluations and is in the typical range of expected shipping/truck haul windows for loose dumped density.

Overall, it is concluded, based on the physical/ geotechnical testing results, that all five CCR materials satisfy Criteria 1 of the CCR Rule beneficial use evaluation in that the CCR provides a legitimate and defensible functional benefit. As cited previously, IDEM approved the Closure/Post-Closure Plans for the APS impoundments. These approved closure documents (See **Appendix A**, original submittal approved by IDEM 12/31/2014, with subsequent approvals by IDEM through Modification No. 3, dated 7/14/2017) include the allowance for beneficial use of CCR for achieving final subgrade/ crown fill. Since the state regulatory agency has acknowledged the use of CCR under these circumstances, this serves as evidence that this criteria has been met as suggested in the CCR Rule Preamble discussion associated with Criteria 1.

[10] Ongoing field water-conditioning and end of day smooth drum rolling of the placed lifts will result in a compacted and/or surface crust layer, thereby limiting fugitive dust.

5. Substitution for the Use of Virgin Material Assessment (Criteria 2 of 4)

Criteria 2 of the CCR Rule definition for beneficial use states that "CCR must substitute for the use of a virgin material, conserving natural resources that would otherwise need to be obtained through practices, such as extraction." This second criteria is intended to ensure that the use is truly beneficial from an environmental perspective, such as avoiding the need to use natural resources and conserving valuable energy that would otherwise be needed to mine and transport such resources.

Soil types by clay, silt and sand composition as used by the USDA

The subgrade crown fill beneficial use application targeted for AES Petersburg CCR would generally rely on common fill soils that would need to be obtained from a borrow area either on- or off-site. The use of soil from a borrow area for these purposes involves both the extraction of a natural resource and the associated use of energy and additional carbon footprint associated with such operations and transporting of the mined resource from an off-site location. Thus, the use of AES Petersburg CCR as a substitute for soil conserves natural resources that would otherwise need to be mined/extracted, and the associated use of energy.

6. Product Specifications, Regulatory/Design Standards Assessment (Criteria 3 of 4)

Criteria 3 of the CCR Rule definition for beneficial use states that "the use of CCR must meet relevant product specifications, regulatory standards, or design standards, when available, and where such specifications or standards have not been established, CCR may not be used in excess quantities."

The Preamble to the CCR Rule further describes that a large focus of Criteria 3, particularly relative to structural fill applications, is to necessitate the incorporation of engineering controls, design and construction guidance to "provide a basis on which to evaluate whether excessive quantities have been used in a particular application"[11]. Where there are not relevant standards or product specifications for a particular beneficial use, Criteria 3 imposes a general prohibition on the use of "excess quantities" of CCR for a specific project that would qualify the application as "disposal," which is prohibited by the CCR Rule.

In general, use of CCR for structural fill has been substantiated by historical applications over the past 5 decades. The industry at large has developed a list of "common" (most frequently executed and largest accumulated volumes of CCR use) beneficial uses that take into consideration CCR physical properties and the best fit for those materials in the design and engineering of those uses. Surveys like the "2016 Coal Combustion Product (CCP) Production & Use Survey Report" produced by ACAA (along with annual use surveys dating back to the 1980's) identify a wide variety of uses of CCR material based on tonnage and illustrate the common acceptance and industry knowledge in the arena of beneficial use of CCRs in both encapsulated and unencapsulated use. It is this industry-accepted list of common unencapsulated uses that were considered in AES's choice to use the CCR materials for ash pond closure crown fill for this study.

Appendix E provides a listing of the most common unencapsulated beneficial uses (e.g., structural fill, agricultural soil amendment, etc.) and the CCR materials that are typically utilized (e.g., fly ash, bottom ash, SDA/gypsum, etc.) in these various use applications.[12] The intended crown fill application being considered for the beneficial use has been employed on numerous occasions for impoundment closure and/or similar structural fill applications over recent decades and is therefore consistent with common uses for these CCR materials. Haley & Aldrich has first-hand knowledge and has actively supported the design and permitting of these types of engineered applications across the country. Based on our industry expertise in the management of CCRs, we have been able to support beneficial uses like the AES Petersburg crown fill that have been demonstrated to consistently meet relevant product specifications, regulatory/ permitting requirements, and common engineering/ construction standards.

The IDEM-approved Closure and Post-Closure documents provide the relevant regulatory standards and use limitations to support the proposed CCR crown fill application. The beneficial use of AES Petersburg CCR for the APS crown fill is governed by the IDEM Closure/Post-Closure Plan for IPL Petersburg

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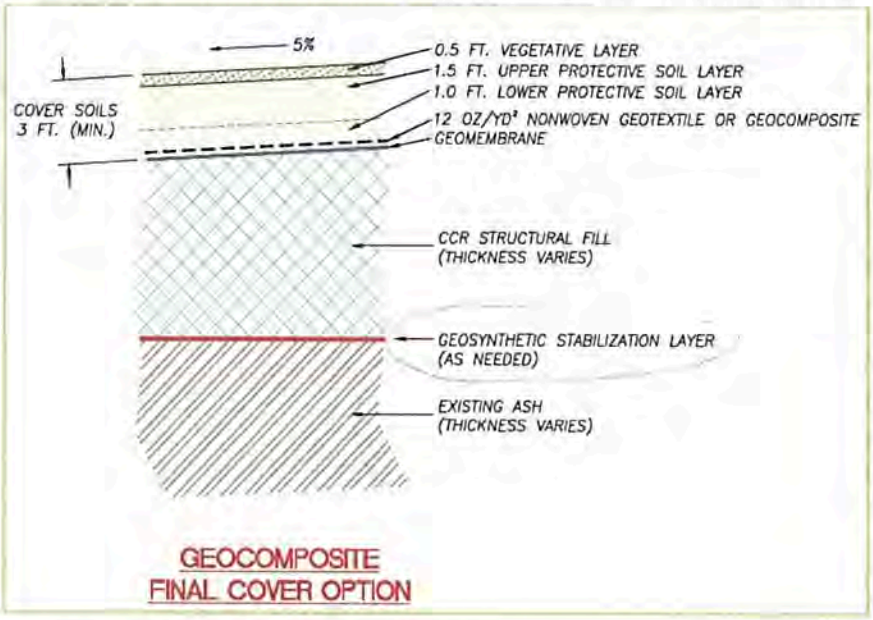
[11] Federal Register/Vol. 80, No. 74/Friday, April 17,2015/Rules and Regulations, p. 21350

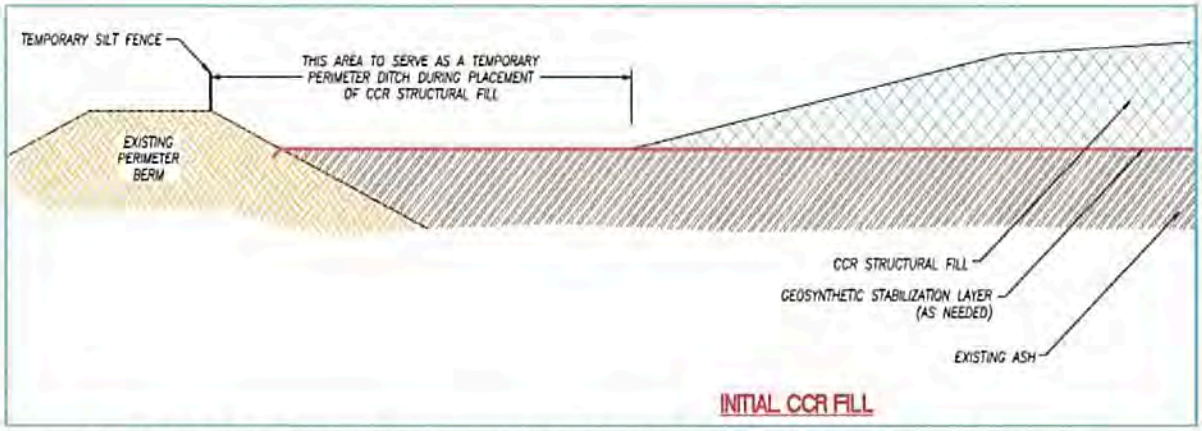
[12] The most common unencapsulated beneficial use applications (as referenced in this study) are discussed and supported technically in more detail in the document entitled "ACAA 2016 CCP Production & Use Survey Report" and in "Fly Ash Facts for Highway Engineers", American Coal Ash Association/Federal Highway Administration; https://www.fhwa.dot.gov/pavement/recycling/fach00.cfm

Generating Station Ash Pond System 63-UP-08 (IDEM Approval, December 2014 with subsequent amendments). The IDEM approval contains regulatory and design standards and use limitations enforceable by IDEM.

The Quality Assurance Manual (QAM) (**Appendix A-3**) specifically identifies the use of CCR materials (QAM, Sections 1.1 and 4.0), details requirements for completion of Daily Reports (**Section 2.1.1**), engagement of a Soil Quality Assurance Consultant to observe and document soil placement activities (Section 1.2.6), the requirement to prepare a Soils Record Drawing (**Section 2.3.1 & 5.5**), requirements for Subgrade Preparation (**Section 4.3 & 5.5**). The QAM also includes guidance on ash stabilization methods and ash bridging lift thickness (**Section 5.5.1**). The Proposed Closure of Petersburg Station Ash Pond System design drawings (**Appendix A-1**) include final cover slopes and grades on the Proposed Final Grading Plan (Sheet 6), a defined 3' thick final cover section (Sheet 10 – see insert to left[13]), multiple sections showing use and location of CCR Structural Fill (Sheet 9 & 10) as well as an Initial CCR Fill section (Sheet 10) that provides initial placement limitations around perimeter dikes to protect against erosion (see insert below). These standards ensure that AES uses only the amount of Petersburg CCR necessary for the crown fill beneficial use, consistent with Criteria 3 of the CCR Rule's beneficial use criteria. Lastly, Cardno ATC prepared a post-closure slope stability analysis as part of the IDEM application (**Appendix A-4**) that incorporated the CCR crown fill material as part of the evaluation with resulting acceptable factors of safety demonstrating that the use of the CCR material will satisfy slope stability needs for the APS closure.



[13] The inserted Proposed Closure of Petersburg Station Ash Pond System design drawing, Sheet 10 Geocomposite Final Cover Option detail includes a "Geosynthetic Stabilization Layer (as needed)" between the existing ash layer and the CCR Structural Fill layer. This layer was not required prior to crown fill placement at Pond B or Pond C, but is anticipated to be used in Pond A, where needed.



In addition to the IDEM approval documents for the entire APS, the Pond B Closure Construction documents include additional design standards applicable to the use of CCR for crown fill. AES has confirmed that the requirements, guidelines and procedures used for the placement of AES Petersburg CCR for Pond B closure are also being incorporated in closure efforts for Pond C and for Pond A/A' and are therefore applicable to all uses of CCR material for structural fill at the APS. These closure documents include final cover construction technical specifications that include requirements particular to the placement and compaction of CCR crown fill. **Appendix B-2** (Section 02300, subpart 3.4.A.3 for Filling, Backfilling and Compacting) includes defined maximum lift thickness for CCR material used as structural fill as follows:

> *d. CCR materials utilized as structural fill at locations in excess of 5 ft from the final cover geomembrane elevation shall be placed in two-foot lifts (maximum) and compacted with a minimum of three passes (back and forth) of a smooth drum compactor.*
>
> *e. CCR materials utilized as structural fill at locations within 5 ft of the final cover geomembrane elevation shall be placed in one-foot lifts (maximum). The required number of passes of the compaction equipment will be established by the construction of a test pad prior to the start of the Earthwork phase of the project. Contractor shall work with IPL and its representatives to prepare test pad, as directed by IPL, at no additional cost.*

AES completed test pads for both the one-foot and two-foot lifts and used those results to establish the final field requirements for placement and compaction of the CCR material for crown fill. The results of that work are illustrated below, which show good correlations with compactive effort and lift thickness when the AES Petersburg CCRs are blended and placed as a structural engineered material.

IPL Ash Pond B
12-inch Test Area - CCR Structural Fill - 9/5/17
Field Compaction and Lab Tests

Test Area No.	History	Test No.	Nuclear Gauge Measurement Moisture Content (%)	Lab Moisture Content (%)	Standard Proctor OMC (%)	Standard OMC Minus Lab MC (%)	Average MC Difference from Proctor OMC (%)	Field Wet Density (pcf)	Field Dry Density using Lab MC (pcf)	Standard Proctor MaxDD (pcf)	Percent of Standard Proctor MaxDD (%)	Average Percent of Standard Proctor MaxDD (%)
12-inch Compacted Lift Test Area 2	Dozer Placement plus 2 Roller Contacts (over & back once)	1	8.3	9.4	13.6	4.2	4.2	98.2	89.8	97.1	92.4	91.9
		1A	8.5	9.4	13.6	4.2		97.1	88.8	97.1	91.4	
		2	7.8	8.2	13.6	5.4	5.4	99.0	91.5	97.1	94.2	95.4
		2A	8.4	8.2	13.6	5.4		101.4	93.7	97.1	96.5	
		32	9.9	15.1	13.6	-1.5	-1.5	103.1	89.6	97.1	92.2	92.4
		3A	10.1	15.1	13.6	-1.5		103.4	89.8	97.1	92.5	
1 Pass/ 2 Rolls Average			**8.8**	**10.9**		**2.7**	**2.7**	**100.4**	**90.5**		**93.2**	**93.2**
12-inch Compacted Lift Test Area 2	Dozer Placement plus 4 Roller Contacts (over & back twice)	4	8.3	7.7	13.6	5.9	5.9	99.6	92.5	97.1	95.2	94.2
		4A	7.1	7.7	13.6	5.9		97.5	90.5	97.1	93.2	
		5	8.4	8.5	13.6	5.1	5.1	101.0	93.1	97.1	95.9	95.4
		5A	8.8	8.5	13.6	5.1		100.0	92.2	97.1	94.9	
		6	7.4	8.0	13.6	5.6	5.6	97.4	90.2	97.1	92.9	93.0
		6A	7.8	8.0	13.6	5.6		97.7	90.5	97.1	93.2	
2 Passes/ 4 Rolls Average			**8.0**	**8.1**		**5.5**	**5.5**	**98.9**	**91.5**		**94.2**	**94.2**
12-inch Compacted Lift Test Area 2	Dozer Placement plus 6 Roller Contacts (over & back thrice)	7	8.1	6.5	13.6	7.1	7.1	98.4	92.4	97.1	95.2	93.6
		7A	8.8	6.5	13.6	7.1		95.1	89.3	97.1	92.0	
		8	8.7	10.1	13.6	3.5	3.5	101.4	92.1	97.1	94.8	93.4
		8A	9.1	10.1	13.6	3.5		98.3	89.3	97.1	91.9	
		9	10.1	9.4	13.6	4.2	4.2	103.5	94.6	97.1	97.4	97.2
		9A	10.7	9.4	13.6	4.2		102.9	94.1	97.1	96.9	
3 Passes/ 6 Rolls Average			**9.3**	**8.7**		**4.9**	**4.9**	**99.9**	**92.0**		**94.7**	**94.7**

The specifications also identify the requirement for a Dust Control Plan and Erosion Control Plan (**Appendix B-2**, Division 1 subpart 13.1.d) that add further limitations and controls on the placement of CCR material. Lastly, the Final Closure of Ash Pond B drawings (**Appendix B-1**) include a Subgrade Plan (Sheet 5) that specifies final subgrade elevations that were to be established in preparation of receiving the final cover. These grades specify the maximum elevations (and associated maximum CCR structural fill volume) that were to be used in the closure construction.

Regarding the implementation of regulatory and/or design standards, the CCR Rule Preamble identifies ASTM E2277-03 (currently E2277-14) "Standard Guide for Design & Construction of Coal Ash Fills" as a source of standard guidance and methodology for using CCR in a structural fill application. This guidance document lays out the various stages and aspects of the engineering design and construction process for utilizing CCR material as structural fill which can be loosely summarized as follows:

- Identify site constraints via site investigation/ site characterization;
- Characterize the CCR material via field and/or laboratory analysis;
- Prepare an appropriate structural fill design;
- Develop construction specifications; and,
- Provide construction quality control to ensure the design and specification requirements have been satisfied during construction.

We have prepared a more complete list of the ASTM E2277 specification design and construction elements into a summary table/ checklist (**Table 6-7**) for which we have identified how all relevant elements of the specification have been incorporated into the AES Petersburg CCR crown fill application.

These elements combined provide the support and engineering framework from which Criteria 3 can be satisfied. Specifically, regulatory/ permitting requirements, and common engineering/ construction standards will be satisfied with AES's conformance to the closure design drawings/ specifications and construction quality assurance guidelines, as approved by IDEM and in conformance with the CCR Rule requirements.

It is understood that the total volume of required CCR material crown fill will exceed the 12,400-ton threshold, which then (according to the CCR Rule) mandates that Criteria 4 must also be satisfied. Analytical testing results and risk-based screening (as discussed and developed in the following sections of this report) evaluate the proposed unencapsulated uses for the AES Petersburg CCR crown fill, as defined in this beneficial use evaluation.

7. Risk Characterization (Criteria 4 of 4)

Sections 4, 5 and 6 of this report provide documentation that beneficial use of the CCR materials as crown fill meet Criteria 1, 2, and 3 of the CCR Rule definition of beneficial use. The purpose of the risk characterization is to demonstrate that the proposed beneficial use project will not cause environmental releases to groundwater, surface water, soil, and air that are above regulatory and health-based benchmarks. The risk characterization is completed using chemical analytical data for the CCR materials in the context of risk-based screening of the exposure pathways applicable to the beneficial use. The exposure pathways applicable to the beneficial use are described in a conceptual site model (CSM) in the following subsection.

7.1 CONCEPTUAL SITE MODEL

To best understand how unencapsulated beneficial uses of CCR may affect the environment (beneficial use Criteria 4), a conceptual site model (CSM) was developed (**Figure 5**). The CSM describes the sources and potential migration pathways through which CCR-derived constituents may be transported to other environmental media (receiving media), and the human and environmental receptors that may in turn contact the receiving media. The linkage between a receiving medium and potential exposure is called an exposure pathway. For an exposure pathway to be complete, the following conditions must exist (as defined by the USEPA [USEPA, 1989]):

1. A source and mechanism of chemical release to the environment;
2. An environmental transport medium (e.g., air, water, soil);
3. A point of potential contact with the receiving medium by a receptor; and
4. A receptor exposure route at the contact point (e.g., inhalation, ingestion, dermal contact).

To support the evaluations in this report, the CSM that was developed takes into account site-specific conditions and the project-specific beneficial use evaluation for AES Petersburg CCR. The CSM is meant to be a "living" model that can be updated and modified as additional data become available.

7.1.1 Source

In the context of the CSM, the AES Petersburg CCR used as crown fill represents a "source" (Criteria 1, above). The AES Petersburg CCR consists of a blend of Scrubber Sludge, Fly Ash, Gypsum, Bottom Ash, Conditioned Fly Ash, and WWTP Headworks materials.

The analytical data that provide characterization of constituents in the CCR materials listed above were provided by AES, and are based on quarterly sampling analyses conducted in October 2017, January 2018, March 2018, and July 2018 of the following CCR materials:

- Bottom Ash
- Filter cake (used to represent Scrubber Sludge)
- Fly Ash

- Gypsum

These materials were analyzed for the following parameters:

- Bulk (solids) for metals (aluminum, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, vanadium, and zinc) and inorganic parameters (acidity, chloride, fluoride, pH, sulfate, sulfide, and total organic carbon.)

- Leachate following 18-hour and 30-day shake extractions with deionized water, for the metals and inorganic parameters listed above, plus alkalinity and total dissolved solids.

Antimony, cobalt, lithium, and thallium were not reported by the laboratory in the quarterly sampling rounds. However, to resolve this potential data gap, the laboratory was requested to report analytical results for antimony, cobalt, and thallium from the July 2018 sampling event. Analytical data for lithium could not be obtained; this is addressed as an uncertainty (see **Section 8**).

In addition, one sample of WWTP Headworks solids from the July 2018 sampling event was provided. That sample was analyzed for the parameters listed above.

The analytical data for all sampling events were combined to create a statistical summary of the analytical data for each CCR material type for which analytical data were provided. The summary was conducted to establish the range of analytical reporting limits, and minimum, maximum, and arithmetic mean of the detected concentration for each parameter that was analyzed. The arithmetic mean concentrations were calculated by assigning a value equal to one-half the detectable limit for results reported as not detected, which is a common and conservative assumption made when evaluating data for risk assessment purposes.

7.1.2 Preliminary Migration Pathways

Migration pathways describe the mechanisms by which constituents may migrate from sources to other media.

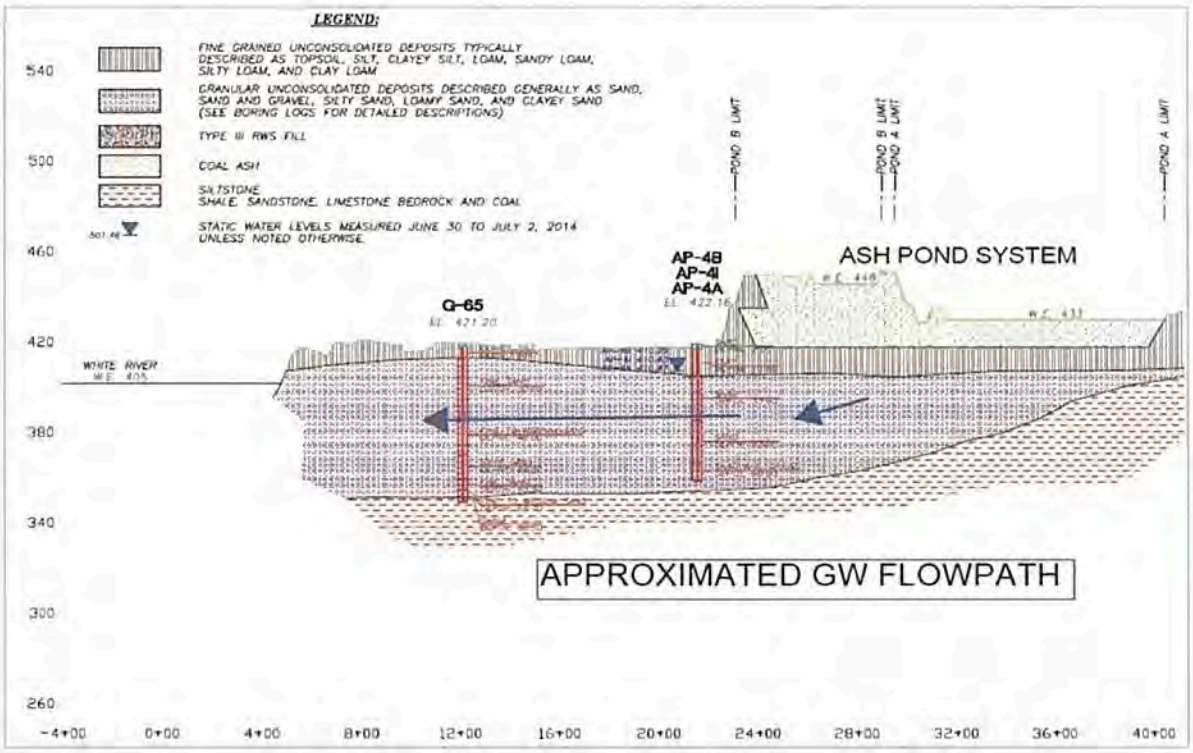
7.1.2.1 Site geology and hydrogeology

Development of the CSM is facilitated through an evaluation of the local geology and hydrogeology. The Site is located within a meander of the White River floodplain. The elevation varies across the Site by over 100 feet with the highest elevations to the east of the Site and lowest ground elevations along the White River to the west. Sediments at the Site consist of overbank deposits as summarized below.

The shallow subsurface below the current ponds consists of clay and silty clay. This layer ranges in thickness from non-existent along the eastern boundary of the Site to 25 feet thick or more near the berms of the current pond structure. Underlying the clay, silty sand to sandy gravel is present to bedrock. The sand and gravel layer thickens toward the White River, and thins and pinches out to the east of the Site. Sand at the Site averages 60 feet thick between the ponds and the White River. This sand and gravel unit comprises the uppermost aquifer and is the primary pathway for groundwater flow from the Site to the White River. Bedrock at the Site consists of siltstone formation; the depth to

bedrock increases toward the White River. Along the eastern boundary of the Site, bedrock elevation rises, intersecting the sand and gravel unit and ultimately pinching out below the existing on-site Type III RWS Landfill.

The uppermost aquifer and primary pathway for groundwater at the Site is the sand and gravel formation located below the shallow fine-grained material and above the siltstone bedrock. Groundwater flow direction is radial from the western edge of the ponds at the Site toward the White River (**Figure 3 & 4**). The regional gradient during the August 2017 gauging event was approximately 0.0125 ft/ft and remained consistent across the pond area. An idealized geologic/ hydrogeologic cross-section through the Ash Pond System is illustrated below[14]



7.1.2.2 Summary of preliminary migration pathways

The possible migration pathways for constituents in AES Petersburg CCR beneficially used at the Petersburg facility, shown on **Figure 4**, could include:

- **Particulate transport (dust migration):** In the particulate transport pathway, CCR particles may be mobilized into the air during physical handling of the CCR materials or by wind erosion, during the placement of the CCR as crown fill. Once in the air, particulates may be transported to downwind locations and deposited on surfaces.

[14] Cross-sections A-A'/B-B' taken from "Proposed Closure of Petersburg Station Ash Pond System" July 2014, Cardno/ATC.

- **Runoff to surface water/soil (overland flow):** In the runoff pathway, precipitation or floodwaters could entrain CCR particles and move to off-site soils, and further off-site to the White River, located east of the Site. From there, CCR particles could move downstream, and could also settle out in the sediments of the White River.

- **Leaching:** Precipitation that infiltrates through CCR that has been beneficially used as crown fill could cause constituents in the CCR to leach out of ash and into the infiltrating water. The constituents could then be transported in the leachate. If no barrier is present, the constituents in the leachate could reach soils then groundwater underlying the Petersburg facility. Such CCR-derived constituents could move with groundwater in the subsurface, downgradient, and potentially migrate to the White River.

- **Uptake into aquatic biota:** In the aquatic biota pathway, constituents in CCR particles that may be released to surface water or sediment could be taken up in the food chain via ingestion of sediment or uptake from surface water across the gills or other body tissues for ecological receptors, and into fish and seafood for ingestion by humans.

The migration pathways listed above are meant to be inclusive of all possible pathways. In **Section 7.1.4**, the feasibility of these pathways is evaluated, and complete exposure pathways for AES Petersburg CCR beneficial uses at the Petersburg facility are then identified.

7.1.3 Preliminary Receptors and Exposure Routes

Both human and ecological receptors are included in this evaluation. Each are discussed below.

7.1.3.1 Preliminary Human Receptors

- **On-site Workers:** Adult on-site workers include plant works who are involved in operation and maintenance of the generating station, and plant workers who are involved in various CCR-related activities such as transportation of the CCR to the Petersburg APS, and placement of the CCR for its beneficial use as crown fill. Plant workers involved in CCR-related activities could directly contact CCR-related material used as crown fill. Exposure routes associated with direct contact include dermal absorption, which can occur if CCR adheres to the skin and constituents within the CCR are absorbed through the skin, and incidental ingestion, which can occur if CCR-covered fingers are placed in the mouth or contact food. Note that USEPA has determined that dermal absorption of metals and inorganics from soils is negligible (USEPA, 2017a). CCR that is entrained in the air by wind or mechanical action (i.e., fugitive dust) could be inhaled by both types of plant workers at the facility.

- **Trespassers:** Petersburg is a secure facility; thus, it is likely that only facility workers have the potential for exposure to the CCR on site. While trespassing could occur, workers would be exposed more frequently than an occasional trespasser; thus, the worker exposure evaluation is also protective of the trespasser.

- **Off-site Resident Adult and Child:** CCR that is entrained in the air by wind or mechanical action could be inhaled by adults and children off-site (or to workers on-site as noted above) if the entrained CCR is transported in the wind to off-site downwind locations. Fugitive dust that is

transported off-site may deposit onto the ground surface, and off-site residents (adult and children) could directly contact the CCR via dermal contact and incidental ingestion.

- **Off-site Recreational Receptors – Wader, Swimmer, Boater, Fisher:** Constituents in CCR particles released to the White River surface water and sediment, and constituents released from CCR particles to surface water (i.e., dissolved into the surface water) could be contacted by waders in the stream. Recreational fish or other recreationally-consumed aquatic species could uptake the CCR-derived constituents in surface water or sediment and could become a source of exposure via consumption by an angler.

7.1.3.2 Preliminary Ecological Receptors

Ecological receptors (e.g., invertebrates, fish, birds and mammals) that may occur in the vicinity of the Petersburg facility, and exposure pathways applicable to those receptors, include:

- **Benthic invertebrates:** Surface water and sediment are the principle exposure pathways for benthic invertebrates as these organisms are in intimate contact with these media.

- **Fish:** Surface water is a critical exposure pathway for fish as their gill membrane is also constantly exposed to this medium; metal toxicity to aquatic organisms is typically mediated through the surface water/gill interaction.

- **Aquatic birds and mammals (omnivore, piscivore):** Plants and benthic invertebrates are the primary exposure media via ingestion for ducks or gleaning birds and sediment may be inadvertently ingested when feeding off the bottom of the water body. Fish eating birds and mammals (piscivore) may be exposed to constituents that have accumulated in fish tissue via surface water.

- **Terrestrial birds and mammals (omnivore, carnivore):** For omnivores, ingestion of soil invertebrates and plants/berries are the primary component of the diet. Soil, mainly present in the gut of soil invertebrates, is inadvertently ingested when feeding. For a carnivore (e.g., raptor), ingestion of small mammals is the primary component of the diet (no incidental ingestion of soil).

For soil, the primary exposure pathway for ecological receptors is direct ingestion during feeding or indirect ingestion via consumption of plants or prey. For surface water and sediment, the primary exposure pathway is similar, i.e., direct ingestion of sediment or indirectly from consumption of plants or prey that have taken up metals/ inorganics that are CCR-derived. Ecological receptors are not directly exposed to groundwater. Air is not traditionally evaluated in ecological risk assessments as the exposure pathway is insignificant (i.e., air inhalation is not a significant exposure pathway for ecological receptors (USEPA, 2003)).

7.1.4 Potentially Complete Exposure Pathways for Petersburg Beneficial Uses

The information on the uses of CCR for crown fill in **Section 2** is used here to evaluate the range of potential receptors and exposure pathways identified in **Section 7.1.3** in the context of a complete exposure pathway as defined by USEPA and presented in **Section 7.1**.

It is assumed that AES Petersburg CCR is placed in the APS for use as crown fill as described in **Section 2**. During placement of the CCR, workers and/or trespassers could contact the CCR and be exposed via direct contact (incidental ingestion, dermal contact, and inhalation).

In addition, the CCR could become airborne during handling of the CCR material or by wind erosion and be inhaled by workers during placement as crown fill. However, the facility adheres to a fugitive dust plan which requires that operations involving dry CCR material (which is primarily limited to landfill operations) use measures such as water mists to mitigate migration of visible dusts (Sargent and Lundy, 2015). The most recent Fugitive Dust Control Report (SCS, 2017) documents that no visible dust crossed the Petersburg property boundary during the monitoring period. The nearest residence to the Ash Pond System is approximately 3,500 feet to the east. Given this distance and documentation that no visible dusts migrated beyond the facility property boundary, potential exposure to dust-entrained CCR by adults and children, as well as terrestrial ecological receptors, downwind of the Petersburg facility would be negligible.

Stormwater controls that are in place prevent overland flow from the Ash Pond System to surrounding soil and surface water. The cover system that will be in place after placement of the CCR as crown fill will prevent erosion and stormwater transport of CCR used as crown fill. Therefore, there are no complete exposure pathways to CCR in soil, surface water, and sediment via overland flow migration pathways.

The Ash Pond Closure final cover system is designed for little to no infiltration of precipitation, and therefore mitigate leachate generation and potential migration in groundwater. However, within the context of the CSM, leaching to groundwater is identified as a potentially complete migration pathway. There are no private water supply wells located downgradient of the Ash Pond System (i.e., between the Ash Ponds and the White River). Therefore, potential exposure to CCR-related constituents in groundwater used as drinking water is not a complete exposure pathway. Groundwater flowing beneath the Petersburg facility flows toward the White River, suggesting that groundwater migrates to and mixes with river surface water. However, groundwater fate and transport modeling, described in **Section 7.3**, demonstrates that migration of CCR-related constituents to groundwater adjacent to the White River is not a complete pathway. Therefore, there are no complete exposure pathways to CCR-related constituents that may migrate to groundwater, or from groundwater to surface water and sediment.

Thus, in **Figure 5**, direct contact with AES Petersburg CCR is identified as a potentially complete exposure pathway for the worker and trespasser receptors, and the dust inhalation pathway is identified as potentially complete for the worker and trespasser receptors. Since the fill will be covered with clean cover material once it is in-place, direct contact and inhalation pathways will not be complete in the future, and long-term exposures to workers, trespassers or terrestrial ecological receptors will not occur.

7.2 RISK-BASED SCREENING

Risk-based screening was used to characterize whether the CCR-related constituents would potentially pose risks of concern to human health or the environment through the exposure pathways identified in the CSM. Risk-based screening is performed by identifying risk-based screening levels that are

applicable for the pathways under consideration and then comparing appropriate analytical data to the screening levels.

Risk-based screening levels represent the constituent concentrations below which risks to public health or the environment are considered to be negligible and not of regulatory concern. Risk-based screening levels are derived by regulatory agencies using conservative assumptions about the potential toxicity of constituents and the potential for exposure to those constituents in environmental media. The goal is to over-estimate rather than under-estimate toxicity and exposure, and this is done by employing default parameters defined by USEPA or other agencies in the screening level derivation, that serves as the basis for this conservative approach.

Due to the conservative methods used to derive screening levels, it can be assumed with reasonable certainty that constituent concentrations in environmental media below screening levels will not result in adverse effects to human health or the environment and, therefore, no further evaluation is necessary. Concentrations above conservative risk-based screening levels, however, do not necessarily indicate that a potential risk exists, but rather that further evaluation may be warranted. USEPA provides this description of its regional screening levels (USEPA, 2018):

> *"They are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. SLs [screening levels] are considered by the Agency to be protective for humans (including sensitive groups) over a lifetime...Generally, at sites where contaminant concentrations fall below SLs, no further action or study is warranted under the Superfund program, so long as the exposure assumptions at a site match those considered by the SL calculations. Chemical concentrations above the SL would not automatically designate a site as 'dirty' or trigger a response action; however, exceeding a SL suggests that further evaluation of the potential risks by site contaminants is appropriate."*

This is expressly recognized by USEPA in their risk assessment used to support the CCR rule-making when they discuss the toxicity values upon which the screening levels are based (USEPA, 2014; Section E.2.1):

> "Reference doses (RfDs) and reference concentrations (RfCs) are used to evaluate noncancer effects from oral and inhalation exposures, respectively. RfDs and RfCs are estimates of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects. However, an average lifetime exposure above the RfD (or RfC) does not imply that an adverse health effect will necessarily occur."

Thus, risk-based screening levels are ***protective*** because they are concentrations at or below which we have reasonable confidence that there will be no adverse effects from exposure. However, risk-based screening levels are not ***predictive*** of adverse effects occurring. The presence of constituent concentrations in environmental media above risk-based screening levels does not mean that harm will occur, it only means that additional evaluation is needed to fully understand the potential for an adverse outcome.

7.2.1 Exposure Pathways

The exposure pathways that require evaluation to characterize compliance with beneficial use Criteria 4 are described below.

7.2.1.1 Direct Contact and Dust Inhalation (Solids)

Direct contact pathways (incidental ingestion, dermal contact, and dust inhalation) are evaluated using risk-based screening levels for solids (i.e., measured in units of milligrams per kilogram [mg/kg]). Screening levels for construction workers are applicable for evaluating direct contact pathways in this beneficial use evaluation, because:

- On-site workers engaged in movement and placement of CCR as crown fill are assumed to contact the CCR material each work day over the duration of the construction project, representing an exposure regime which aligns with the basis of construction worker risk-based screening levels.

- Given the nature of the work involved in use of CCR as crown fill, potential exposures to workers involved in placement of CCR material as crown fill would occur at a higher frequency and contact rate than potential exposures to trespassers or plant workers involved in generating station activities; therefore, screening levels for construction workers are protective for these other receptors.

- The earth-moving activities associated with placement of CCR as crown fill will potentially generate dust emissions. Even without adherence to the Fugitive Dust Control Plan (Sargent and Lundy, 2015) the dust concentrations that workers involved in placement of CCR as crown fill would potentially be exposed to would be much higher than the dust concentrations that on-site generating station workers or off-site downwind receptors would potentially be exposed to. Therefore, screening levels for construction workers are protective for all receptors.

7.2.1.2 Leaching to Groundwater (Leaching)

For the purposes of this report, the CSM conservatively assumes that CCR constituents may generate leachate, and that the leachate may migrate to groundwater beneath the Ash Pond System. To place the significance of leachate concentrations into context, leachate analytical data are compared to screening levels that are protective for groundwater use as both a drinking water resource and for migration to surface water.

A comparison of leachate data directly to groundwater standards incorporates the assumption that the constituent concentrations in groundwater directly beneath the CCR are equal to the leachate concentrations. In reality, leachate is diluted with infiltrating precipitation, and then again when the infiltrating precipitation mixes with groundwater, such that actual groundwater concentrations beneath CCR would be substantially lower than leachate concentrations. In fact, USEPA recommends the Industrial Waste Management Evaluation Model Version 3.1 (IWEM) (USEPA, 2015b) to evaluate the mixing of leachate with groundwater, rather than simple comparison of leachate analytical data to screening levels. In this beneficial use evaluation, the leaching pathway is evaluated in two steps:

- **Step 1:** Direct comparison analytical data representative of leaching potential to groundwater and surface water standards. Two methods were used to identify data representative of leaching potential:
  - Solids analytical data were divided by 20 to estimate leaching potential. This approach is highly conservative because it assumes that leachate concentrations will be 1/20th of the solids concentrations. This approach is typically used with environmental analytical data to determine when further evaluation of leaching potential, using more realistic leaching tests such as Synthetic Precipitation Leaching Procedure (SPLP), is required. If leachate concentrations estimated using this method are below applicable screening levels, then it can be concluded that the material will not produce leachate concentrations of concern, and that further testing of the material for leaching potential is not required.
  - Analytical results from the 18-hour and 30-day leachability tests were used to estimate leaching potential. These data provide a more realistic estimation of leaching potential than the extrapolation of solids analytical data described above. However, since these extraction tests use deionized water, as opposed to a leaching solution (e.g., as is used in SPLP testing), there is uncertainty in whether the test results reflect a conservative estimate of leaching potential.
- **Step 2:** Constituents with estimated leaching potential concentrations above drinking water and surface water screening levels are further evaluated by modeling the leachate transport in groundwater. The modeled concentrations are then compared to groundwater and surface water screening levels.

Although many state standards include leaching-based values that can be compared to totals data to make judgments about leaching potential, those standards are inherently highly conservative and often suggest that a constituent will pose a leaching concern when actual leaching data (e.g., SPLP) verify that leaching would not be of concern.

7.2.2 Indiana-Specific Screening Levels

The human health screening levels used to evaluate solids and estimated leaching potential used in this analysis are from Indiana state sources or, where unavailable, from federal sources. The screening levels for solids and estimated leaching potential are shown on **Tables 7-1** through **7-3.**

7.2.2.1 Direct Contact (Solids)

For solids measurements of materials, the hierarchy for selection of screening values, as published in the sources cited below, is:

- IDEM Screening and Closure Level Tables. Table A-6 2018 Screening Levels. Direct Contact Soil Exposure – Excavation. (IDEM, 2018)
- USEPA Risk-based Screening Levels (RSLs), May 2018, values for industrial soil (for constituents for which Indiana standards are not published), HI = 1. (USEPA, 2018a)

In accordance with the Indiana Department of Environmental Management (IDEM) Remediation Closure Guide (IDEM, 2012), IDEM screening levels are established for a target excess lifetime cancer risk of $1x10^{-5}$ and a target Hazard Index of 1.

7.2.2.2 Leaching to Groundwater (Leaching)

The following selected screening values were used for comparison with the leaching potential data (solids data divided by 20, 18-hour and 30-day leachate test data):

- Selected Human Health Screening Levels for Drinking Water.
- Selected Human Health Screening Levels for Surface Water – Consumption of Organism Only
- Selected Ecological Screening Levels (Acute and Chronic)

The selected human health screening levels for groundwater are from state and federal sources and address the drinking water exposure pathway. These sources, in the order in which they are to be used, are:

- IDEM Screening and Closure Level Tables. Table A-6 2018 Screening Levels. Groundwater Tap Residential. (IDEM, 2018)
- Indiana Administrative Code Title 327 - Water Pollution Control Division. 327 IAC 2-11-6(a)(1). Maximum Permissible Level (MPL) Criteria for Drinking Water Class Groundwater. (IWPCD, 2017a)
- USEPA Risk-based Screening Levels (RSLs), May 2018, values for tap water (for constituents for which Indiana standards are not published), HI = 1. (USEPA, 2018a)

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 human health screening levels for surface water are from federal and state sources and address the drinking water exposure pathway and the fish consumption pathway (where such values are available from the state). Where the surface water body is not within the Great Lakes System, and is a source of public drinking water, these sources, in the order in which they are to be used, are:

- 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 (NRWQC) at Section 304(a) of the Clean Water Act (CWA). 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. Human Health Consumption of Organism Only. (IN.gov, 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). Human Health Consumption of Organism Only. (IWPCD, 2017b).

- USEPA Ambient Water Quality Criteria (AWQC) for Human Health Consumption of Water Only. (USEPA, 2018b)

The ecological screening levels are from state and federal sources and address the aquatic exposure pathway. These sources, in the order in which they are to be used, are:

- 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. Aquatic Life Criterion (Acute and Chronic). (IN.gov, 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). Aquatic Life Criterion (Acute and Chronic). (IWPCD, 2017b).

- USEPA National Recommended Water Quality Criteria - Aquatic Life Criteria Table – Freshwater (Acute and Chronic). (USEPA, 2018c).

7.3 RISK-BASED SCREENING RESULTS

The risk-based screening consists of a comparison of solids and estimated leaching potential concentrations to the screening levels identified above. Specifically, the maximum detected concentrations for each of the CCR materials evaluated in this report were compared to the screening values identified in **Section 7.2**. This approach screens each CCR material separately, and the results of the screening reflect an assumption that the crown fill is comprised entirely of a single CCR material that is represented by the maximum concentrations reported in the analytical testing of that material.

In practice, as described in **Section 2**, the CCR materials will be combined for use as crown fill. Therefore, the actual CCR constituent concentrations in the crown fill will reflect the average concentrations of the blended CCR materials. Although the approach used for this screening is very conservative, it ensures that each CCR material is evaluated individually, and therefore allows flexibility in the blending of materials as they are beneficially used as crown fill. Tables documenting comparison of CCR material analytical data to the screening values are presented in **Appendix F**.

7.3.1 Direct Contact (Solids)

As shown in **Appendix F, Tables F1-F3**, all of the constituents detected in the CCR materials evaluated in this report are below screening values for direct contact pathways. This indicates that these materials can be used for crown fill beneficial use without causing an unacceptable risk to human health and the environment; no further evaluation of direct contact pathways is required to support Criteria 4 of the beneficial use definition of the CCR Rule.

7.3.2 Leaching to Groundwater

As shown in **Appendix F, Table F2**, estimated leachate concentrations, as represented by the 18-hour and 30-day extraction tests, for some metals and inorganic parameters are above human health and ecological screening values. Representative leachate concentrations for fly ash are associated with the greatest number of parameters above screening values, whereas representative leachate concentrations for Gypsum are associated with the least number of parameters above screening values.

Appendix F, Table F1, provides leachate concentrations estimated from the CCR materials solids data. The representative leachate concentrations derived using this methodology are above human health and ecological screening values for the majority of metals and inorganic parameters, in each of the CCR materials evaluated in this report.

The results of this screening indicate that leachate that may be generated by the CCR could contain metals and inorganic parameters at concentrations above screening levels applicable to groundwater and surface water. However, leachate concentrations are not representative of groundwater concentrations, which is why USEPA recommends fate and transport modeling to evaluate the mixing of leachate with groundwater, to estimate potential groundwater concentrations that may result from the leaching migration pathway.

Groundwater Modeling Using USEPA IWEM Software

Groundwater transport modeling was completed to determine the potential impact to the aquifer underlying the proposed structural fill area. As the EPA recommended model for evaluating the mixing of leachate with groundwater, the IWEM software Version 3.1 (USEPA, 2015b) was utilized to assess the proposed crown fill beneficial use application at the Site; the IWEM program estimates the potential impact to groundwater associated with the proposed crown structural fills. Groundwater to receptor models were configured for two receptor targets, one cited at the White River and the second at a closer/near term target, Outfall #001 located at the ash pond discharge channel which feeds into Lick Creek and then discharges into the White River (see **Figure 4**). Model documentation and outputs are provided in **Appendix C-1**.

The following model inputs were utilized in the IWEM model evaluation.

<u>IWEM Model Input Parameters</u>:

- **Distance to wells:**
  - **Target 1: Shortest distance from the Ash Pond System to the ash pond Discharge Channel** = 100 linear feet (30 meters)
  - **Target 2: Shortest distance from the Ash Pond System to the White River** = 1,000 linear feet (305 meters)
- **Structural Fill (SF) Depth:** 5.2 meters (approximate max. average thickness to be placed as beneficial use crown fill at the Site)
- **Fill Area:** 145 acres divided across three pond areas (approximately 48 acres per pond was modeled)

- **Depth of SF base below ground surface:** 0 meters (all material to be beneficially used will be placed above the upper limits of the groundwater table grade)
- **Density of SF:** 1.53g/cm^3 (95+/- lbs./cubic feet)
- **Effective Permeability (K) of SF:** 1 x 10^{-4} m/yr (Most conservative (highest) value from potential materials to be used for beneficial reuse)
- **Groundwater pH:** 7
- **Depth to water table:** 3.05 meters (10.0 ft)
- **Aquifer Permeability (K) value:** 1.05 x 10^{-3} cm/s (Geometric average of slug test data from CCR well network)
- **Regional gradient:** 0.0125 ft/ft (from ongoing CCR groundwater monitoring water levels)
- **Aquifer Thickness:** 18.3 meters (60.0 feet)
- **Regional Recharge Rate –** Default input from IWEM for Petersburg, IN (Indianapolis Metropolitan; using the lower recharge rate which results in a more conservative estimated downgradient concentration)
- **Infiltration rate –** 2.85 x 10^{-5} m/yr (Max value obtained from HELP model; the HELP model runs were completed utilizing the design parameters for the cover system prescribed in the IDEM approved pond closure plan. See **Appendices C-2 and C-3.**)

The IWEM requires a leachate concentration as an input variable. To ensure that the modeling was conservative for application to all of the CCR materials evaluated in this report, the representative leachate concentrations for fly ash, derived as 1/20th of the solids concentrations, were used in the modeling. These values represent the highest representative leachate concentrations among all CCR materials. To test the transport of boron and sulfate, proxy chemicals potassium and sodium were input into the model, respectively. Chemical properties and concentrations were modified to match boron and sulfate for this model simulation run.

The IWEM groundwater modeling was used to derive an estimated concentration of each CCR constituent in groundwater prior to groundwater intercepting both Targets 1 and 2, the ash pond Discharge Channel and the White River located approximately 100 and 1,000 feet, respectively, from the CCR Ash Pond System (see **Figure 4**). These locations were selected to represent the shortest path to surface water bodies along the groundwater flow path from the APS that could potentially include ecological receptors. As shown in **Appendix C-1**, the IWEM modeling runs demonstrate that CCR constituent concentrations in groundwater, at a point just prior to interception with the ash pond Discharge Channel (Target 1) are below analytical detection limits. The estimated resultant 90th percentile groundwater concentration for Target 1 following the onset of leaching, ranged from less than 2.22E-18 mg/L to 7.14E-13 mg/L. Similar results were also noted at Target 2, just prior to interception with White River. Specifically, the estimated resultant 90th percentile groundwater concentration for this target following the onset of leaching ranges from less than 1.53E-16 mg/L to 6.02E-13 mg/L.

For comparison, analytical detection limits for metals in water samples are not lower than 1E-03 mg/L. This indicates that if CCR constituents leach to groundwater, they will not be detectable in groundwater downgradient of the Ash Pond System. By analogy, the estimated groundwater concentrations are also well below both groundwater and surface water screening values.

Based on this analysis, it is concluded that use of AES Petersburg CCR materials beneficially as crown fill will not cause a release to groundwater or surface water at concentrations above relevant regulatory and health-based benchmarks for human and ecological receptors.

8. Conclusions and Recommendations

Based on the results of the beneficial use evaluation provided in this report, the following conclusions are drawn concerning beneficial use in accordance with the CCR Rule definition of beneficial use:

- ***Criteria 1: The CCR must provide a functional benefit.***

  Conclusion: AES Petersburg CCR provides a genuine function for crown fill at the APS by providing a source of fill material necessary to achieve final subgrade elevations associated with the closure of the APS. State regulatory guidance and closure plan approvals acknowledge use of CCR material as a crown fill source. As such, it has been established that the CCR provides a functional benefit.

- ***Criteria 2: The CCR must substitute for the use of a virgin material, conserving natural resources that would otherwise need to be obtained through practices, such as extraction.***

  Conclusion: AES Petersburg CCR replaces common fill soils on the anticipated order of thousands of tons, and conservatively, in excess of 12,400 tons. The soil being replaced would be virgin materials or contain virgin materials that are typically obtained via mining/ extraction or other conventional methods. Therefore, the beneficial use of AES Petersburg CCR for crown fill at the APS conserves natural resources and thereby meets Criteria 2.

- ***Criteria 3: The use of the CCR must meet relevant product specifications, regulatory standards or design standards when available, and where such specifications or standards have not been established, CCR may not be used in excess quantities.***

  Conclusion: Use of the five CCR materials from the Petersburg station in the crown fill for the Ash Pond Closure crown fill is consistent with common/ historic uses for these CCR materials. The combined elements of the approved IDEM closure/ post-closure documents, and Pond B construction documents, along with the satisfaction of engineering and design criteria associated with ASTM E2277, provide the support and engineering framework from which Criteria 3 is satisfied. Specifically, regulatory/ permitting requirements, and common engineering/ construction standards are satisfied with AES's conformance to the closure design drawings/ specifications and construction quality assurance guidelines as approved by IDEM and in conformance with the CCR Rule requirements.

- ***Criteria 4: When unencapsulated use of CCR involving placement on the land of 12,400 tons or more in non-roadway applications, the user must demonstrate and keep records, and provide such documentation upon request, that environmental releases to groundwater, surface water, soil and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use.***

Conclusion: Using CCR materials (Bottom Ash, Fly Ash, Gypsum, WWT Headworks, and/or Scrubber Sludge) from the Petersburg facility as crown fill at the Petersburg facility will not result in potential releases to the groundwater, surface water, soil or air above relevant regulatory and health-based benchmarks for human and ecological receptors. This conclusion is based on the following:

1) CCR-related constituents are not above health-based benchmarks for direct contact exposures that could potentially occur to the CCR materials during the placement of the material as crown fill. Direct contact pathways to the crown fill will not be complete after project completion because a soil cover will be placed over the fill.
2) Evaluation of the leaching pathway at the Petersburg facility using fate and transport modeling demonstrates that CCR used as crown fill at the Petersburg facility will not cause releases to groundwater that are above health-based benchmarks for human and ecological receptors. More specifically, the modeling indicates that migration of leachate to groundwater is not a complete pathway for groundwater immediately downgradient of the Ash Pond System.

The results of the CCR beneficial use evaluation provided in this report are based on the following assumptions and limitations:

- The focus of this evaluation was to establish whether the use of Petersburg CCR for APS closure crown fill satisfied the requirements of CCR Rule 257.53. The evaluation is separate and distinct from and excludes considerations associated with stability analysis, groundwater monitoring, location restrictions or any other CCR Rule conditions or requirements which are being addressed by AES in separate activities.
- It is assumed that the crown fill material placed previously in Pond B and Pond C is the same as that which was used for this evaluation.
- This crown fill beneficial use evaluation is based entirely on the information provided to Haley & Aldrich by AES associated with the ASE Petersburg facility, site operations and CCR material. As such, the reported conclusions are based on our understanding of current site operations, plant-generated CCR material and management practices at the Plant as provided by AES. Future site conditions or changes in Plant operation may result in conditions that would render these conclusions inaccurate.
- It is our assumption that the CCR crown fill material conditioning, handling, placement and compaction processes and procedures conveyed to Haley & Aldrich by AES have been and will continue to be implemented for all crown fill beneficial use related activities under the direction/ oversight of an AES certifying engineer.
- Variability in source material, operation of pollution control equipment, and weathering of CCR can contribute to variability in the chemistry of CCR materials. It is assumed that the samples of CCR material submitted for analysis and evaluated in this report are representative of the CCR material at the facilities. The analytical samples used in this analysis were collected in 2017 and 2018.

- Although lithium, which is a CCR Appendix IV constituent, was not analyzed in the samples used in this beneficial use analysis, lithium is generally not recognized as a CCR constituent that drives remedy decisions. In addition, the screening levels for lithium are higher than those associated with several other metals that were analyzed for. This information, combined with the IWEM

results which indicate that CCR constituents would not be detectable in groundwater downgradient of the Ash Pond System, suggest that the lack of analytical data for lithium does not contribute an uncertainty that has a bearing on the conclusions of this beneficial use evaluation.

- The results of the screening evaluations are presented in the context of the project-specific beneficial use evaluated in this report. The results of the beneficial use determination are not valid for beneficial use of the materials in applications other than those evaluated in this report.

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TABLE 3-1
PHYSICAL & GEOTECHNICAL LABORATORY TESTING RESULTS SUMMARY
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

Test Parameter	Units	Method	CCR MATERIAL RESULTS/ USE APPLICABILITY				
			Scrubber Sludge + Flyash	Gypsum	Bottom Ash	Conditioned Flyash	WWTP Headworks
Loose Shipping Weight/Density (Unit Weight)	lb/ft^3	ASTM D7263	80.68	70.28	106.30	73.90	92.93
Moisture Content	%	ASTM D2216	24.75%	32.99%	57.77%	2.98%	47.16%
USCS Soil Classification	-	ASTM D2487	ML *Silt*	ML *Silt*	SW-SM *Well-graded sand with silt*	ML *Sandy silt*	ML *Silt*
AASHTO Soil Classification	-	AASHTO M145	A-4(0)	A-4(0)	A-1-b	A-4(0)	A-4(0)
Grain Size Analysis - Sieve and Hydrometer	-	ASTM D422					
Gravel	%	-	0.0%	0.0%	8.1%	0.0%	0.3%
Sand	%	-	9.5%	2.6%	80.2%	38.0%	1.6%
Fines	%	-	90.5%	97.4%	11.7%	62.0%	98.1%
Atterberg Limits	-	ASTM D4318					
Plastic Limit	%	-	NP	NP	NP	NP	NP
Plastic Index	%	-	NP	NP	NP	NP	NP
pH	-	ASTM D4972	8.87	7.63	8.07	9.06	8.03
Standard Proctor	-	ASTM D698					
Max. Dry Density	lb/ft^3	-	95.9	79.0	99.9	91.4	82.6
Optimum Moisture	%	-	22.5%	35.0%	13.0%	12.0%	32.5%
Angle of Repose	degrees	(1)	36.0	39.5	39.5	36.0	34.0
Flexible Wall Permeability (@95% Compaction & Opt. Moisture Content)	cm/s	ASTM D5084	2.3E-06	8.5E-05	7.7E-04	1.3E-04	1.4E-06

Notes:

NP - non-plastic

(1) Angle of repose test performed by Patriot Labs, Evansville, IN using approximately 400 grams of representative material. The material was prepared at the as-received moisture content, then loose-dumped (as a standard drop test) in a geometric pile and measured for height and diameter and the resulting average natural angle of repose was measured/calculated and recorded. Photos of each test were recorded with placard ID to document material physical appearance, color and pile configuration (and resultant angle of repose). See Appendix D for photo logs of angle of repose testing.

TABLE 6-7
ASTM E2277 CHECKLIST - STANDARD GUIDE FOR DESIGN AND CONSTRUCTION OF COAL ASH STRUCTURAL FILLS
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

ASTM E2277-14 "Standard Guide for Design and Construction of Coal Ash Structural Fills"			Example/Clarification	ASTM Section Reference	Consideration Included?
CONSIDERATIONS FOR CCR STRUCTURAL FILL DESIGN	Site Characterization	Perform geologic/hydrologic investigation	i.e., perform subsurface investigation to classify/ test soil and rock samples & identify groundwater conditions	8.2.2	Yes
		Identify environmental resources	i.e., identify presence of wetlands, floodplains, endangered species, cultural resources, etc.	8.2.3	N/A
			comply with specific regulatory agency (i.e., IDEM, USACE) requirements	8.2.3	Yes
	Site Preparation to Promote Internal Drainage	General Considerations	prevent saturation by surface or ground water (i.e., consider specifying a min. separation between CCRs and groundwater)	8.3	Yes
		Site Preparation Considerations	i.e., develop grading and drainage plan for site prior to placement of CCRs	8.3.1	Yes
		Site Drainage Considerations	provide plan to accommodate drainage of seeps and springs encountered during construction (i.e., incorporate free draining drainage blanket or french drains)	8.3.2	N/A
	Erosion Control/ Drainage	General E&SC Considerations	obtain required stormwater/erosion permits	9.2.2	Yes
			CCRs typically do not require design of E&SC measures beyond those used for soil fills	9.2.2	Yes
		Surface Cover Design to Control Wind and Water Erosion Effects	i.e., compacted stone, pavement or soil cover	8.4.1	Yes
			dust control typically achieved via specifying proper moisture conditioning of ash and wetting of surface prior to placement of final cover	8.6.7	Yes
			surface grading & channels to promote drainage in a controlled manner (i.e., use mild slopes, suitable channel linings, etc.)	8.4.2 & 8.4.3	Yes
			specify appropriate min. cover/vegetative layer thicknesses	8.4.2	Yes
	Analyze Structural Performance of Structural Fill Material	Unit Weight	establish low unit weight of material	6.2	Yes
		Bearing Capacity	evaluate suitability of material to support structures, slabs, pavements, etc.	8.5.2	Yes
		Slope Stability	embankment stability should be considered (but not typically req'd for small sites/sites with flat to moderate slopes)	8.5.1 & Table 1	Yes
		Settlement Potential	conventional methods of analysis used with natural soils are appropriate	8.5.3	Yes
	Establish Compaction Requirements	General Placement Considerations	develop moisture and density relationships (i.e., Proctor curves)	8.6.4	Yes
			specify placement of CCRs in loose layers of uniform thickness with a specified max layer thickness	8.6.4	Yes
		Fly Ash (or mixture with bottom ash/boiler slag)	include requirements for moisture conditioning and compaction methods similar to that of natural soils	8.6.1	Yes
			specify compaction requirements; typically either 95-100% Standard Proctor or 90%-95% Modified Proctor	8.6.5.1	Yes
		Bottom Ash/Boiler Slag	represents non-cohesive material with compaction not greatly influenced by moisture content	8.6.2	Yes
			typical compaction standard is 70% relative density	8.6.5.2	
CONSIDERATIONS DURING CONSTRUCTION	Weather Restrictions	Severe Weather	suspend construction during severe weather	9.2	Yes
			operations may proceed during moderately wet periods if less water is added to material prior to placement	9.2	Yes
		Dust Control	employ typical measures common to earthwork projects (i.e., avoid hauling on completed CCR surfaces, construct wind screens, apply dust suppressant, wetting, covering of exposed surfaces, etc.); consider developing and implementing a CCR Fugitive Dust Control Plan per section 257.80 (b) of EPA CCR Rule	9.2.1	Yes
		Erosion Control	employ E&SC measures common to those used for soil fills and per state/local requirements	9.2.2	Yes
	On-site Storage	Limit on-site stockpile volume	maintain minimum stockpile quantity necessary and use perimeter E&SC controls	9.4	Yes
	Placement & Compaction	Thickness	apply in uniform layer not exceeding max thickness specified	9.6	Yes
		Equipment	typical compaction equipment consists of smooth drum vibratory or pneumatic-tired rollers	9.6	Yes
		Subsoil	avoid placing on saturated or frozen material	9.6	Yes
		Moisture Conditioning	apply water uniformly and allow time for lift to equilibrate	9.6	Yes
	Quality Control	General Considerations	QC program will be similar to that of earthwork project	9.8	Yes
		Visual Observations	i.e., lift thickness, number of compactor lift passes, behavior of CCRs under weight of compaction equipment, etc.	9.8.1	Yes
		Testing	conduct field unit weight and water content tests regularly on compacted lifts to verify compaction has been achieved	9.81	Yes
			take tests as specified by design engineer and when visual observations suggest desired compaction is not being achieved	9.8.2	Yes
		Daily Job Logs	maintain daily logs to document site conditions, weather, and work activities	9.8.2	Yes

Acronyms:
- ASTM - American Society for Testing and Materials
- CCRs - Coal Combustion Residuals
- E&SC - Erosion and Sediment Control
- IDEM - Indiana Department of Environmental Management
- N/A - Not Applicable
- USACE - U.S. Army Corps of Engineers

TABLE 7-1
HUMAN HEALTH SCREENING LEVELS - BULK MATERIAL
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

		Human Health Screening Levels - Soil		
Constituent	CAS	IDEM Soil Exposure Direct Contact - Excavation (a) (mg/kg)	May 2018 USEPA Industrial Soil RSLs HI = 1 (b) (mg/kg)	Selected Construction Worker Soil Screening Level (c) (mg/kg)
Aluminum	7429-90-5	100,000 (f)	1,100,000	100,000
Antimony	7440-36-0	790	470 (d)	790
Arsenic	7440-38-2	920	3	920
Barium	7440-39-3	100,000 (f)	220,000	100,000
Boron	7440-42-8	100,000 (f)	230,000	100,000
Cadmium	7440-43-9	1,900	980	1,900
Chloride	7647-14-5	NA	NA	NA
Chromium, Total	7440-47-3	100,000 (e, f)	1,800,000 (e)	100,000
Chromium, Trivalent	16065-83-1	100,000 (f)	1,800,000	100,000
Chromium, Hexavalent	18540-29-9	2,700	1,390 (g)	2,700
Cobalt	7440-48-4	590	350	590
Copper	7440-50-8	79,000	47,000	79,000
Fluoride	16984-48-8	79,000	47,000	79,000
Iron	7439-89-6	100,000 (f)	820,000	100,000
Lead	7439-92-1	1000	800	1000
Lithium	7439-93-2	3,900	2,300	3,900
Magnesium	7439-95-4	NA	NA	NA
Manganese	7439-96-5	26,000	26,000	26,000
Mercury	7487-94-7	590 (h)	350 (h)	590
Molybdenum	7439-98-7	9,800	5,800	9,800
Nickel	7440-02-0	38,000 (i)	22,000 (i)	38,000
pH (std)	PH	NA	NA	NA
Potassium	7440-09-7	NA	NA	NA
Selenium	7782-49-2	9,800	5,800	9,800
Silver	7440-22-4	9,800	5,800	9,800
Sodium	7440-23-5	NA	NA	NA
Sulfate	7757-82-6	NA	NA	NA
Thallium	7440-28-0	20 (j)	12 (j)	20
Vanadium	7440-62-2	9,900	5,800	9,900
Zinc	7440-66-6	100,000 (f)	350,000	100,000

Notes:
CAS - Chemical Abstracts Service.
CCR - Coal Combustion Residuals.
HI - Hazard Index.
IDEM - Indiana Department of Environmental Management.
mg/kg - milligrams per kilogram.
NA - Not Available.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.

TABLE 7-1
HUMAN HEALTH SCREENING LEVELS - BULK MATERIAL
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG

(a) - IDEM (IN.gov). IDEM Screening and Closure Level Tables. Table A-6 2018 Screening Levels. Accessed September 2018
https://www.in.gov/idem/cleanups/2392.htm
(b) - USEPA Risk Based Screening Levels (May 2018). Values for industrial soil. Accessed September 2018.
http://www2.epa.gov/risk/risk-based-screening-table-generic-tables
(c) - The hierarchy for selection among the Human Health Screening Levels for Soil is:
1) IDEM Soil Exposure Direct Contact - Excavation.
2) May 2018 USEPA Industrial Soil RSLs HI = 1.
(d) - Value for Antimony (metallic) used for Antimony.
(e) - Value for Chromium (III), Insoluble Salts used for Chromium.
(f) - Screening level capped at 100,000 mg/kg.
(g) - Alternative screening level calculated for hexavalent chromium using RSL calculator (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and current dose-response data from the USEPA's Integrated Risk Information System. Available at: http://www.epa.gov/IRIS/. The basis of the draft oral cancer toxicity value used in the calculation of the RSL has been questioned by USEPA's Science Advisory Board; therefore, RSL for Chromium (VI) is based on the noncancer values developed by USEPA.
(h) - Value for Mercuric Chloride used for Mercury.
(i) - Value for Nickel Soluble Salts used for Nickel.
(j) - Value for Thallium (Soluble Salts) used for Thallium.

TABLE 7-2
HUMAN HEALTH SCREENING LEVELS - DRINKING WATER AND SURFACE WATER
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

		Human Health Screening Levels - Drinking Water			Human Health Screening Levels - Surface Water			Selected Human Health Screening Levels	
Constituent	CAS	IDEM Groundwater Tap Residential (a) (mg/L)	IDEM MPL (b) (mg/L)	May 2018 USEPA Tapwater RSLs HI = 1 (c) (mg/L)	USEPA NRWQC Consumption of Organism Only (d) (mg/L)	IDEM CCC HLSC Consumption of Organism Only (current) (e) (mg/L)	IDEM CCC HLSC Consumption of Organism Only (proposed) (f)(g) (mg/L)	Selected Screening Level - Drinking Water (h) (mg/L)	Selected Screening Level - Surface Water Consumption of Organism Only (i) (mg/L)
Aluminum	7429-90-5	20	NA	20	NA	NA	NA	20	NA
Antimony	7440-36-0	0.006	0.006	0.0078 (k)	0.64	45	0.64	0.006	0.64
Arsenic	7440-38-2	0.01	0.01	0.000052	0.0014 (j, q)	0.000175 (r)	NP	0.01	0.000175
Barium	7440-39-3	2	2	3.8	NA	NA	NA	2	NA
Boron	7440-42-8	4	NA	4	NA	NA	NA	4	NA
Cadmium	7440-43-9	0.005	0.005	0.0092	NA	NA	NP	0.005	NA
Chloride	7647-14-5	NA	250	NA	NA	NA	NA	250	NA
Chromium, Total	7440-47-3	0.1	0.1	22 (l)	NA	NA	NA	0.1	NA
Chromium, Trivalent	16065-83-1	22	NA	22	NA	3433	NP	22	3433
Chromium, Hexavalent	18540-29-9	0.00035	NA	0.0445 (m)	NA	NA	NP	0.00035	NA
Cobalt	7440-48-4	0.006	NA	0.006	NA	NA	NA	0.006	NA
Copper	7440-50-8	1.3	NA	0.8	NA	NA	NP	1.3	NA
Fluoride	16984-48-8	0.8	4	0.8	NA	NA	NA	0.8	NA
Iron	7439-89-6	14	NA	14	NA	NA	NA	14	NA
Lead	7439-92-1	0.015	0.015	0.015	NA	NA	NP	0.015	NA
Lithium	7439-93-2	0.04	NA	0.04	NA	NA	NA	0.04	NA
Magnesium	7439-95-4	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	0.43	NA	0.43	0.1	NA	NP	0.43	0.1
Mercury	7487-94-7	0.002	0.002	0.0057 (n)	NA	0.00015	0.00015	0.002	0.00015
Molybdenum	7439-98-7	0.1	NA	0.1	NA	NA	NA	0.1	NA
Nickel	7440-02-0	0.39	NA	0.39 (o)	4.6	0.1	4.6	0.39	4.6
pH (std)	PH	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	7440-09-7	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	7782-49-2	0.05	0.05	0.1	4.2	NA	4.2	0.05	4.2
Silver	7440-22-4	0.094	NA	0.094	NA	NA	NA	0.094	NA
Sodium	7440-23-5	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	7757-82-6	NA	250	NA	NA	NA	NA	250	NA
Total Dissolved Solids	TDS	NA	500	NA	NA	NA	NA	500	NA
Thallium	7440-28-0	0.002	0.002	0.0002 (p)	0.00047	0.048	0.048	0.002	0.048
Vanadium	7440-62-2	0.086	NA	0.086	NA	NA	NA	0.086	NA
Zinc	7440-66-6	6	NA	6	26	NA	26	6	26

Notes:
CAS - Chemical Abstracts Service.
CCC HLSC - Continuous Criterion Concentration. Human Life-Cycle Safe Concentration.
CCR - Coal Combustion Residuals.
HI - Hazard Index.
IDEM - Indiana Department of Environmental Management.
mg/L - milligrams per liter.
MPL - Maximum Permissible Level.
NA - Not Available.
NP - (NRWQC) Not Proposed. Criteria to be deleted.
NRWQC - National Recommended Water Quality Criteria.
RSL - Regional Screening Level.
TR - Target Cancer Risk.
USEPA - United States Environmental Protection Agency.

TABLE 7-2
HUMAN HEALTH SCREENING LEVELS - DRINKING WATER AND SURFACE WATER
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

(a) - IDEM (IN.gov). IDEM Screening and Closure Level Tables. Table A-6 2018 Screening Levels. Accessed September 2018.
https://www.in.gov/idem/cleanups/2392.htm

(b) - 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. (MPL) Criteria for Drinking Water Class Ground Water. Accessed May 2018.
http://www.in.gov/legislative/iac/T03270/A00020.PDF?

(c) - USEPA, 2018. Regional Screening Levels (May 2018). Values for Tap Water, Hazard Index = 1.0. TR = 1E-06. Accessed September 2018.
https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

(d) - USEPA National Recommended Water Quality Criteria - Human Health Criteria Table. Accessed September 2018.
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

(e) - 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. Accessed September 2018.
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://www.in.gov/legislative/iac/T03270/A00020.PDF?

(f) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards. Accessed May 2018.
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. Table 3A: Water Quality Criteria for the Protection of Human Health
for Waters Outside of the Great Lakes System. Accessed May 2018.
https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice.pdf

(h) - The hierarchy for selection among the Human Health Screening Levels for Drinking Water is:
1) IDEM Groundwater Tap Residential.
2) IDEM MPL.
3) USEPA RSL - Tap Water.

(i) - The hierarchy for selection among the Human Health Screening Levels for Surface Water - Consumption of Organism Only is:
1) IDEM CCC HLSC - Consumption of Organism Only (proposed).
2) IDEM CCC HLSC - Consumption of Organism Only (current).
3) USEPA NRWQC - Consumption of Organism Only.

(j) - This criterion adjusted to a carcinogenicity of 1E-05 risk.

(k) - RSL for Antimony (metallic) used for Antimony.

(l) - Value for Chromium (III), Insoluble Salts used for Chromium, Total.

(m) - Alternative screening level calculated for hexavalent chromium using RSL calculator (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and current dose-response data from the USEPA's Integrated Risk Information System. Available at: http://www.epa.gov/IRIS/. The RSL for hexavalent chromium is not a drinking water standard, and the basis of the draft oral cancer toxicity value used in the calculation of the RSL has been questioned by USEPA's Science Advisory Board; therefore, RSL for Chromium (VI) is based on the noncancer values developed by USEPA.

(n) - RSL for Mercuric Chloride used for Mercury.

(o) - RSL for Nickel Soluble Salts used for Nickel.

(p) - RSL for Thallium (Soluble Salts) used for Thallium.

(q) - Value for inorganic arsenic only.

(r) - Value for inorganic arsenic as arsenite, As(III).

TABLE 7-3
ECOLOGICAL SCREENING LEVELS - SURFACE WATER
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

		Ecological Screening Levels - Surface Water							
		USEPA NRWQC Aquatic Life Criteria CMC - Freshwater (acute) (a) (mg/L)	USEPA NRWQC Aquatic Life Criteria CCC - Freshwater (chronic) (a) (mg/L)	IDEM AAC Aquatic Life Criterion (acute) (current) (b) (mg/L)	IDEM CAC Aquatic Life Criterion (chronic) (current) (b) (mg/L)	IDEM AAC Aquatic Life Criterion (acute) (proposed) (c)(d) (mg/L)	IDEM CAC Aquatic Life Criterion (chronic) (proposed) (c)(d) (mg/L)	Selected Ecological Screening Level (acute) (e) (mg/L)	Selected Ecological Screening Level (chronic) (e) (mg/L)
Constituent	CAS	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
Aluminum	7429-90-5	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	7440-36-0	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	7440-38-2	0.34 (i)	0.15 (i)	0.36 (j)	0.19 (j)	0.34 (j)	0.15 (j)	0.34	0.15
Barium	7440-39-3	NA	NA	NA	NA	NA	NA	NA	NA
Boron	7440-42-8	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	7440-43-9	0.002 (g)	0.0007 (g)	0.0037 (g)	0.0010 (g)	0.0018 (g)	0.0007 (g)	0.002	0.001
Chloride	7647-14-5	860	230	NA	NA	NA	NA	860	230
Chromium, Total	7440-47-3	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, Trivalent	16065-83-1	0.57	0.07	0.0003 (g)	0.18 (g)	0.57 (g)	0.0741 (g)	0.57	0.07
Chromium, Hexavalent	18540-29-9	0.02	0.01	0.016 (g)	0.011 (g)	0.016 (g)	0.011 (g)	0.02	0.01
Cobalt	7440-48-4	NA	NA	NA	NA	NA	NA	NA	NA
Copper	7440-50-8	0.013 (g)	0.009 (g)	0.017 (g)	0.011 (g)	0.013 (g)	0.009 (g)	0.01	0.01
Fluoride	16984-48-8	NA	NA	NA	NA	NA	NA	NA	NA
Iron	7439-89-6	NA	1	NA	NA	NA	NA	NA	1.00
Lead	7439-92-1	0.06 (g)	0.003 (g)	0.065 (g)	0.003 (g)	0.097 (g)	0.008 (g)	0.10	0.01
Lithium	7439-93-2	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	7439-95-4	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	7487-94-7	0.001 (f)	0.0008 (f)	NA	NA	NA	NA	0.001	0.001
Molybdenum	7439-98-7	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	7440-02-0	0.47 (g)	0.05 (g)	1.42 (g)	0.16 (g)	0.47 (g)	0.05 (g)	0.47	0.05
pH (std)	PH	NA	6.5 – 9	NA	NA	NA	NA	NA	6.5 – 9
Potassium	7440-09-7	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	7782-49-2	NA	0.0031 (h)	NA	NA	NA	0.0031	NA	0.003
Silver	7440-22-4	0.003 (g)	NA	0.003 (g)	NA	0.003 (g)	NA	0.003	NA
Sodium	7440-23-5	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	7757-82-6	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	TDS	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	7440-28-0	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	7440-62-2	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	7440-66-6	0.117 (g)	0.118 (g)	0.114 (g)	0.105 (g)	0.117 (g)	0.118 (g)	0.12	0.12

Notes:
AAC - Acute Aquatic Criterion.
CAC - Chronic Aquatic Criterion.
CAS - Chemical Abstracts Service.
CCC - Continuous Criterion Concentration.
CCR - Coal Combustion Residuals.
CMC - Criterion Maximum Concentration.
IDEM - Indiana Department of Environmental Management.
mg/L - milligrams per liter.
NA - Not Available.
NRWQC - National Recommended Water Quality Criteria.
ug/L - micrograms/liter.
USEPA - United States Environmental Protection Agency.

TABLE 7-3
ECOLOGICAL SCREENING LEVELS - SURFACE WATER
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

(a) - USEPA Water Quality Criteria. Current Water Quality Criteria Tables. National Recommended Water Quality Criteria - Aquatic Life Criteria Table. Accessed May 2018.
http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

(b) - 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. Accessed May 2018. The screening levels for hardness-based metals are calculated for a default hardness value of 100 mg/L $CaCO_3$.
http://www.in.gov/legislative/iac/T03270/A00020.PDF?

(c) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards. Aquatic Life Criteria Tables 1, 2, and 4. Accessed May 2018. The screening levels for hardness-dependent metals are calculated for a default hardness value of 100 mg/L $CaCO_3$.
http://www.in.gov/idem/cleanwater/2329.htm

(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). Proposed revisions reflect updates to USEPA NRWQC at Section 304(a) of the Clean Water Act. Accessed May 2018.
https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice.pdf

(e) - The hierarchy for the selection of ecological screening levels is:
1) IDEM Aquatic Life Criterion (proposed).
2) IDEM Aquatic Life Criterion (current).
3) USEPA NRWQC. Aquatic Life Criteria - Freshwater.

(f) - Aquatic Life Criterion for metallic mercury (CAS 7439-97-6) and/or methylmercury (CAS 22967-92-6).

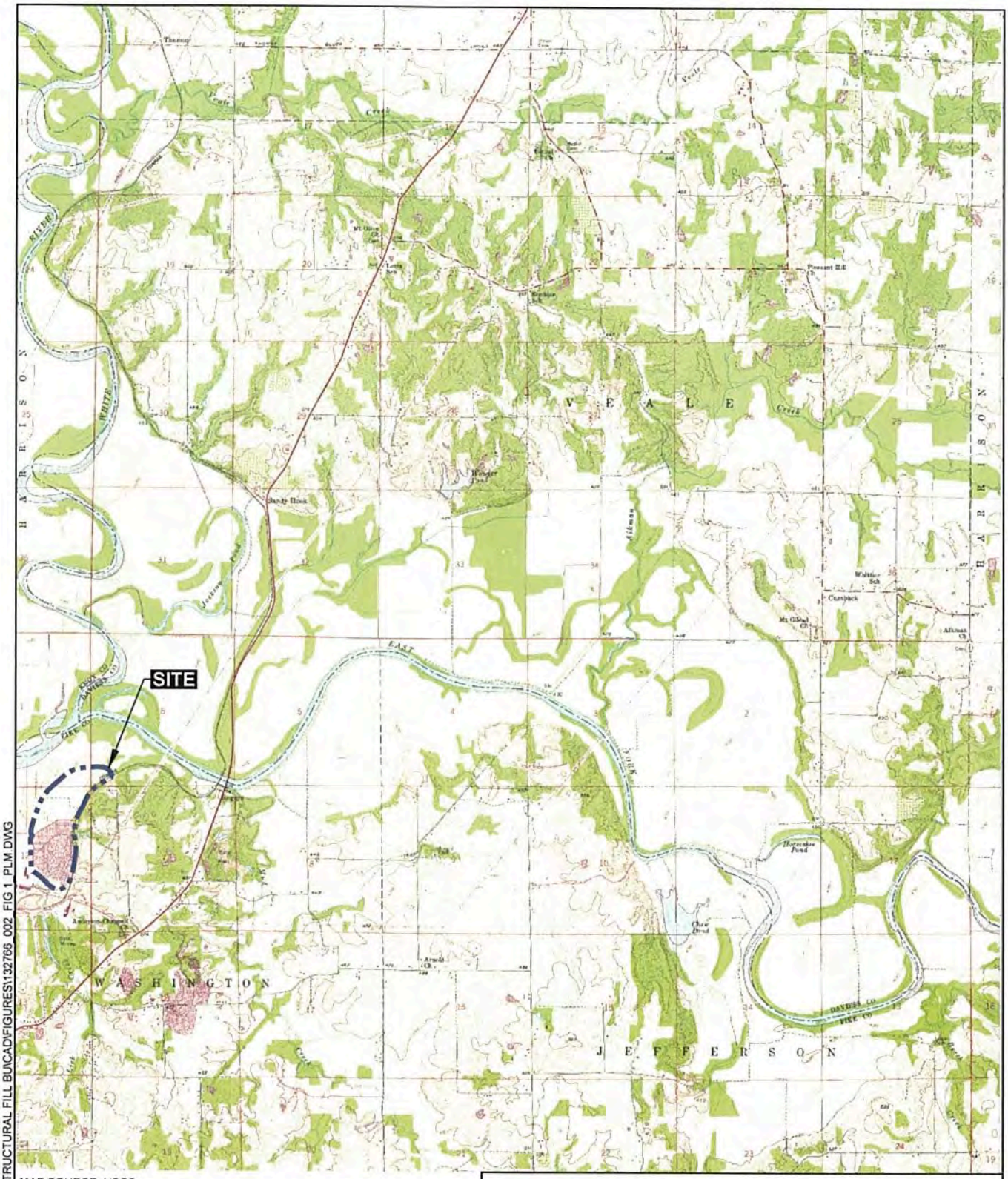
(g) - Criterion expressed as a function of total hardness (mg/L). Value displayed is the site-specific total hardness of mg/L.

(h) - USEPA Office of Water. Final Criterion: Aquatic Life Ambient Water Quality Criterion for Selenim - Freshwater. 30 June 2016. Accessed July 2017. Freshwater value for chronic (30 day) water column concentration (ug/L) of dissolved selenium in lotic (flowing) surface water.
https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf

(i) - Value for inorganic arsenic only.

(j) - Value for inorganic arsenic as arsenite, As(III).

FIGURES



MAP SOURCE: USGS
SANDY HOOK QUADRANGLE, INDIANA, 1958, REVISED 1980.

QUADRANGLE LOCATION

HALEY ALDRICH

CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

PROJECT LOCATION MAP

APPROXIMATE SCALE: 1 IN = 5000 FT
NOVEMBER 2018

FIGURE 1

Saved by: SAUNDERS, LEE Printed: 11/7/2018 4:09 PM Sheet: 1
G:\132766 AES IPL PETERSBURG STRUCTURAL FILL BU\CAD\FIGURES\132766_002_FIG 1_PLM.DWG

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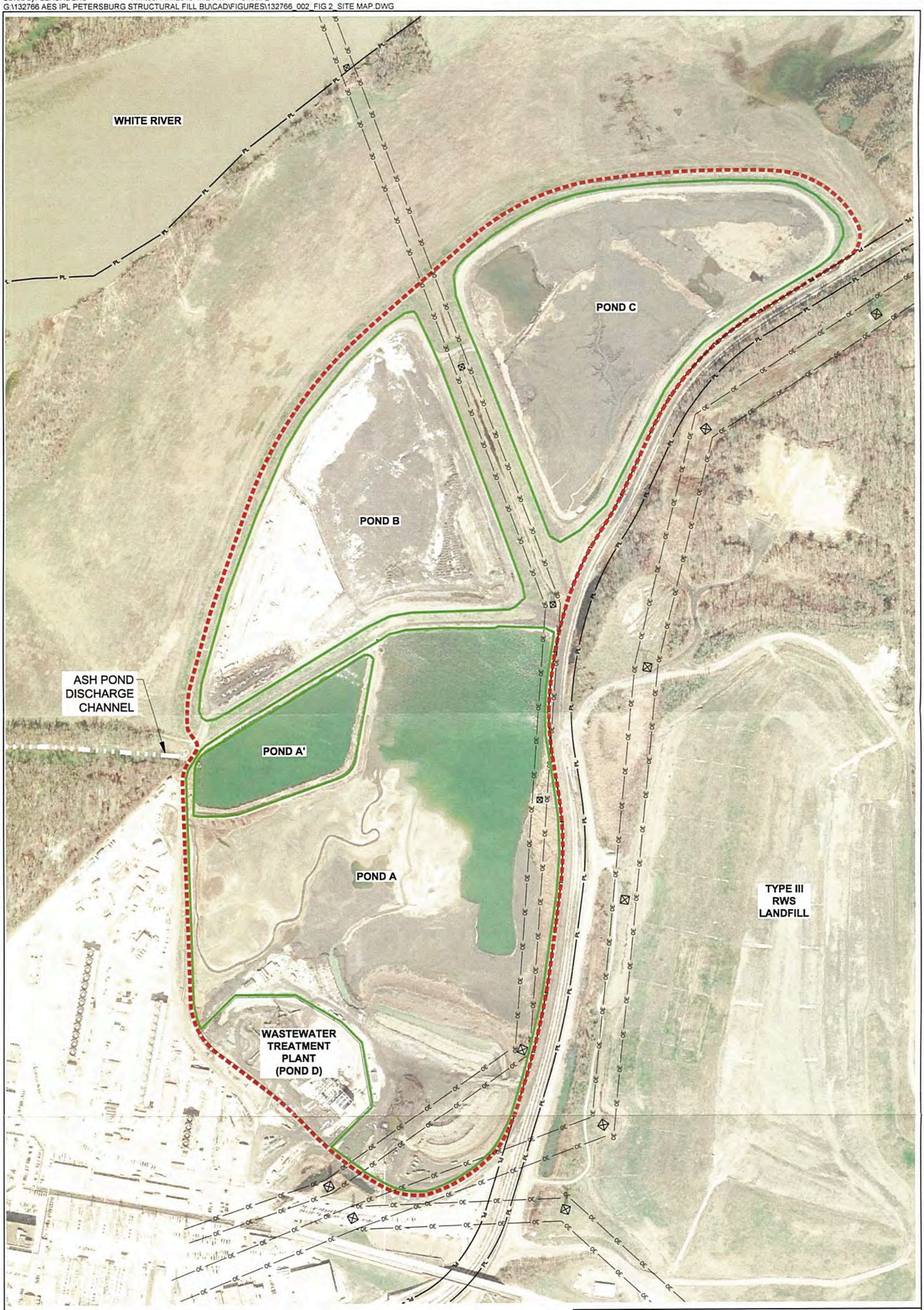

LEGEND

- PL — PROPERTY LINE
- ASH POND SYSTEM WASTE BOUNDARY
- POND BOUNDARY
- OE — OVERHEAD ELECTRIC LINES
- TRANSMISSION TOWER

NOTES

1. IMAGE FROM GOOGLE EARTH PRO, DATED 03/2016.
2. ALL LOCATIONS ARE APPROXIMATE.

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

SITE PLAN

SCALE: AS SHOWN
NOVEMBER 2018

FIGURE 2

Saved by: LSAUNDERS Printed: 11/7/2018 4:13 PM Sheet: 3
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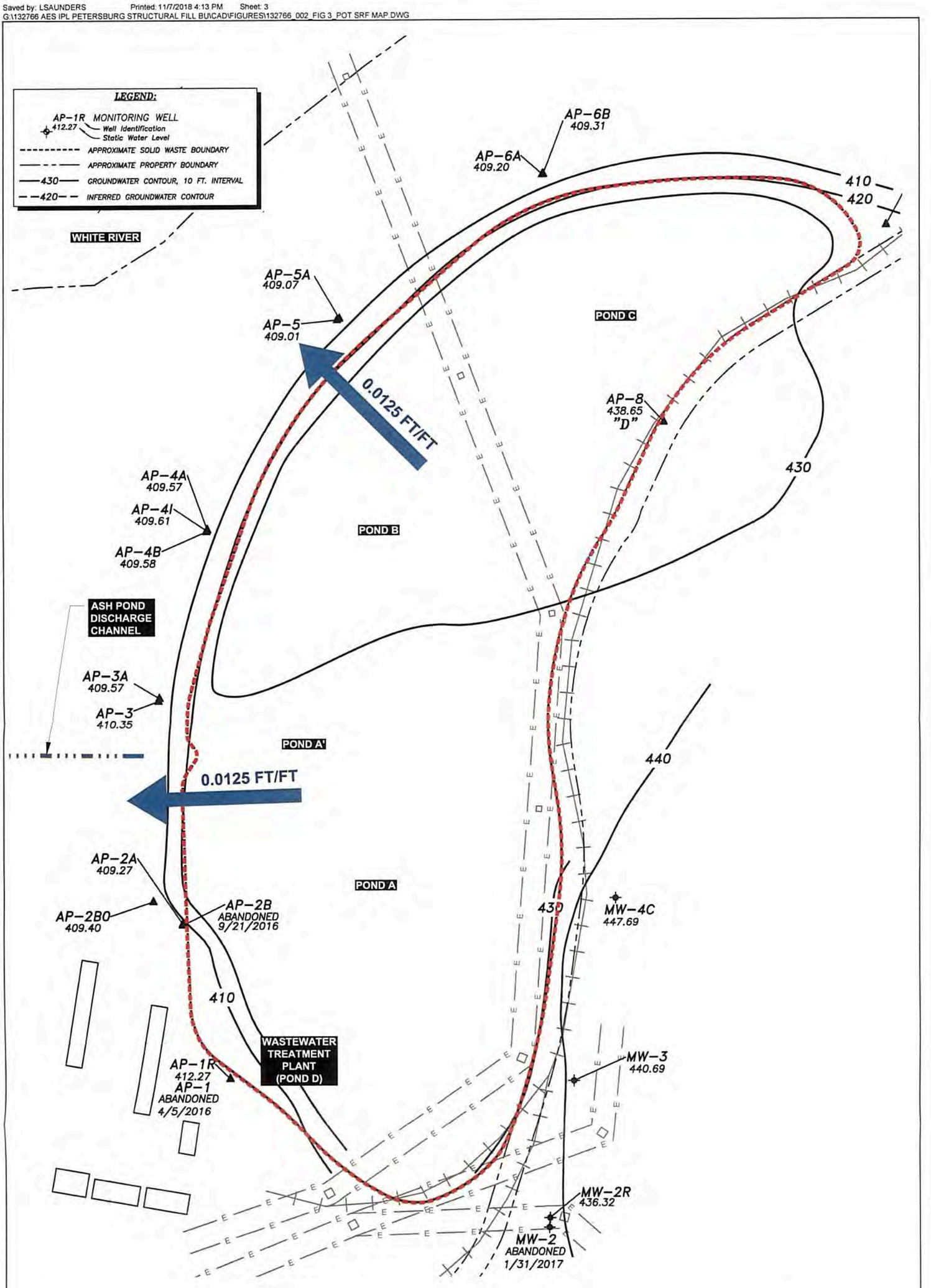


LEGEND

- ASH POND SYSTEM WASTE BOUNDARY
- 0.0125 FT/FT GROUNDWATER FLOW GRADIENT
- GENERALIZED GROUNDWATER FLOW DIRECTION

NOTES

1. POTENTIOMETRIC SURFACE MAP PREPARED BY ATC, PROJECT NUMBER 170LF00307, DATED 9/2017.
2. ALL LOCATIONS ARE APPROXIMATE.

N

0 400 800
SCALE IN FEET

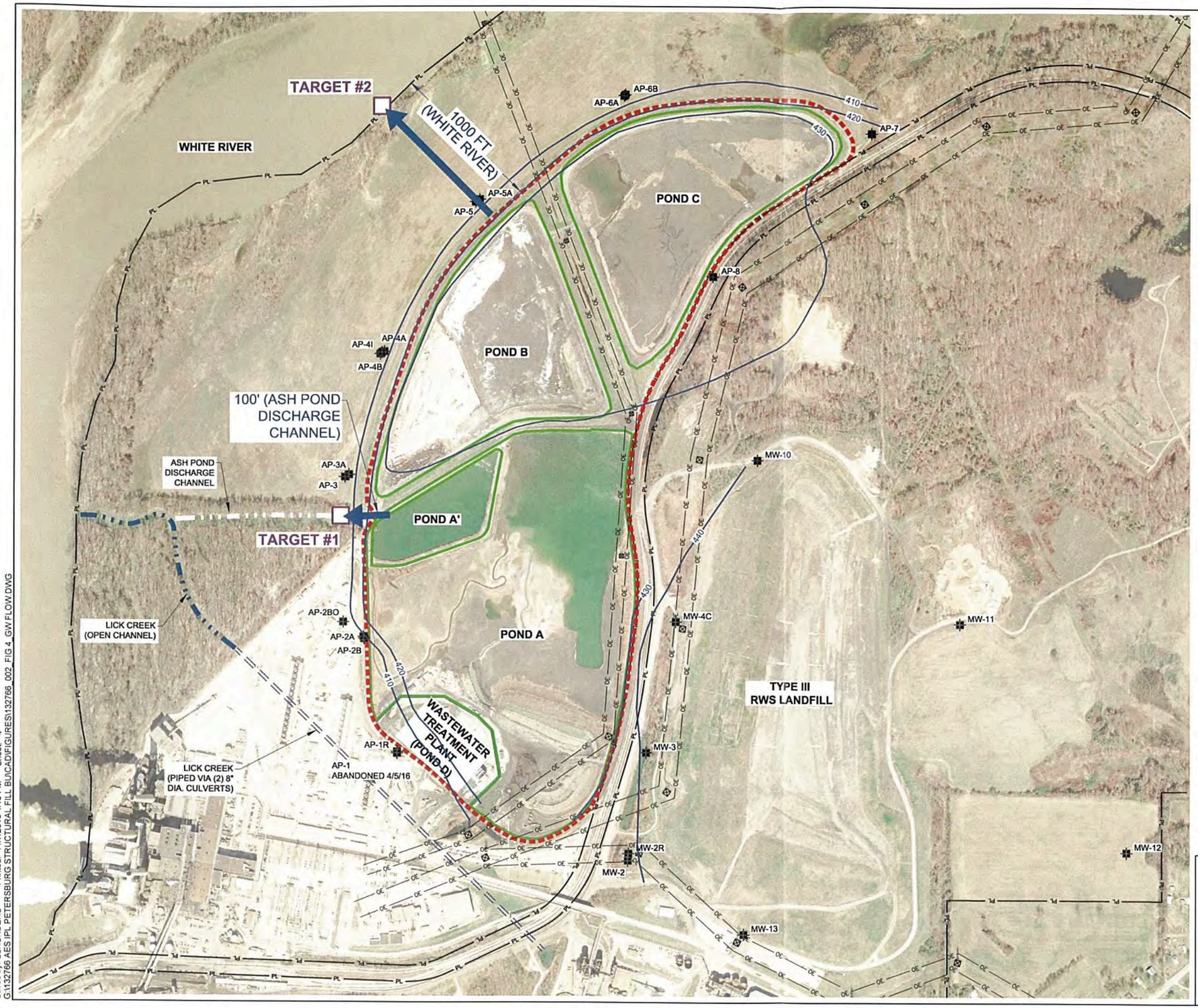
HALEY ALDRICH

CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

POTENTIOMETRIC SURFACE MAP

SCALE: AS SHOWN
NOVEMBER 2018

FIGURE 3



LEGEND

- PROPERTY LINE
- ASH POND SYSTEM WASTE BOUNDARY
- POND BOUNDARY
- OVERHEAD ELECTRIC LINES
- TRANSMISSION TOWER
- APPROXIMATE GROUNDWATER FLOW PATH
- AP-7 MONITORING WELLS
- 410 POTENTIOMETRIC CONTOUR AND ELEVATION
- GROUNDWATER FLOW PATH TARGET

NOTES

1. IMAGE FROM GOOGLE EARTH PRO, DATED 03/2016.
2. ALL LOCATIONS ARE APPROXIMATE.

N

0 600 1200
SCALE IN FEET

HALEY ALDRICH

CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG
PETERSBURG, INDIANA

GENERALIZED GROUNDWATER FLOW PATH AND MODELING TARGETS

SCALE: AS SHOWN
NOVEMBER 2018

FIGURE 4

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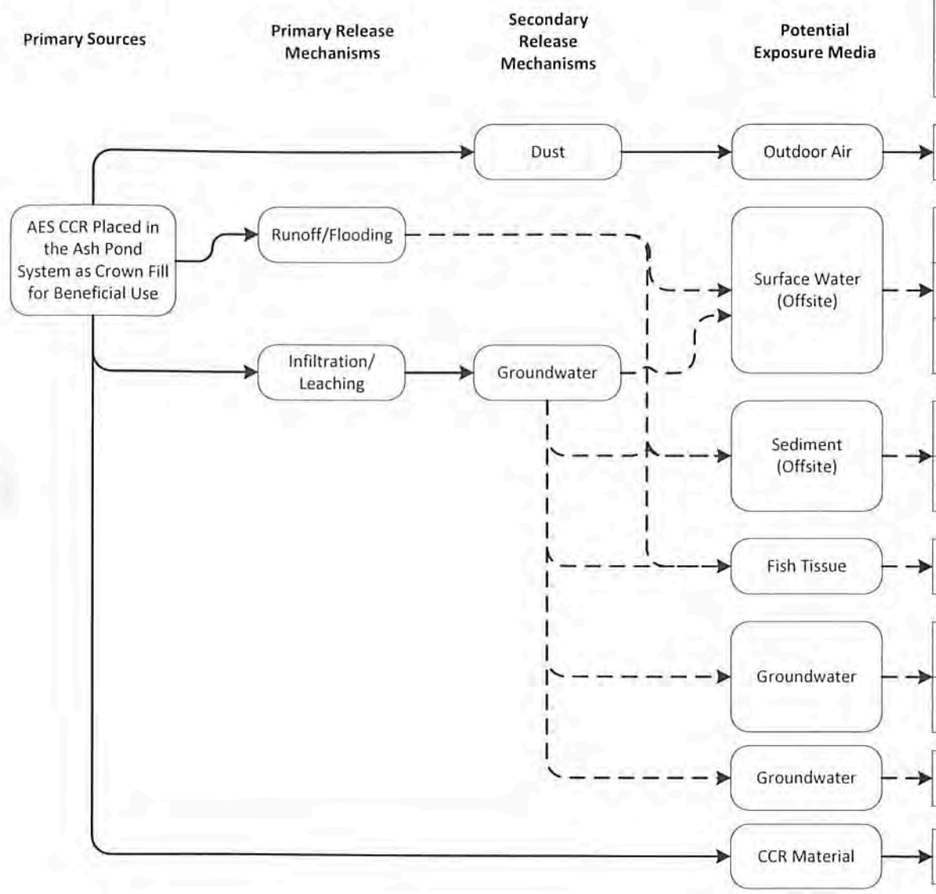
G:\132766 AES IPL PETERSBURG STRUCTURAL FILL BU\CAD\FIGURES\132766_002_FIG 4_GW FLOW.DWG

FIGURE 5
CONCEPTUAL SITE MODEL
CCR BENEFICIAL USE ASSESSMENT
AES/IPL PETERSBURG



Potential Exposure Media	Potential Exposure Route	Potential Receptors: Current/Future Commercial/ Industrial Worker	Current/Future On-Site Construction Worker	Current/Future On-Site Trespasser	Current/Future Off-Site Resident Adult/Child	Current/Future Off-Site Recreational User (a)	Benthic Invertebrates and Fish	Aquatic Birds and Mammals	Terrestrial Birds and Mammals
Outdoor Air	Inhalation (b)	●	●	●	○	○	○	○	○
Surface Water (Offsite)	Drinking Water Use	○	○	○	○	○	○	○	○
	Incidental Ingestion	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○
Sediment (Offsite)	Plant/Incidental Ingestion	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○
Fish Tissue	Ingestion	○	○	○	○	○	○	○	○
Groundwater	Incidental Ingestion	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○
Groundwater	Drinking Water Use	○	○	○	○	○	○	○	○
CCR Material	Direct Contact (b)	●	●	●	○	○	○	○	○

(a) Includes Current/Future Off-Site Recreational Wader, Recreational Swimmer, Recreational Boater, and Recreational Fisher.

(b) Pathways are potentially complete during placement of CCR material as crown fill, and will be incomplete once construction is completed.

● Pathway potentially complete.

○ Pathway evaluated and found incomplete/insignificant.

AES CCR: AES Coal Combustion Residuals.

⟶ Potential complete migration pathway.

- - ▶ Incomplete/insignificant migration pathway.

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