Response to Cabinet Comments on the Herrington Lake Corrective Action Investigation, Source Assessment, and Risk Assessment Report

This document and the attached Addendum (Appendix A, *Corrective Action Investigation Source Assessment, and Risk Assessment [ISARA] Report- Coal Pile Addendum*) provide the responses to the January 31, 2020 Kentucky Energy and Environment Cabinet Department for Environment Protection (Cabinet) comments on the *Corrective Action ISARA Report* for the Kentucky Utilities Company (KU) EW Brown Station[1]. The Cabinet comments are shown in italics followed by the corresponding responses.

Cabinet Comment 1.

Executive Summary, Section 1.2 mentions a key project will provide enhanced physical/chemical treatment of wastewaters, including groundwater collected from the toe drain of the closed Main Ash Pond. At the time the ISARA was written the physical/chemical treatment system was not installed. Had the system been installed prior to drafting the ISARA the design and operating parameters as well as treatment efficiencies would have logically been presented in the ISARA. To fully inform the decision making associated with the Supplemental Remedial Alternatives Analysis (SRAA), please describe the treatment technology, the CCR constituents removed and the removal efficiencies, the waste streams treated, and the fate of CCR pollutants collected by the technology. Finally, state whether the employed technology is sufficient to meet the goals in the Agreed Order or if a follow-up technology is needed.

Response:

The three new WWTP systems, the treatment technology employed, the design performance standards, and the fate of the pollutants in the permitted discharge are described below. The water balances for the three WWTPs are shown in the May 24, 2019 update to the then pending KPDES permit renewal application. The three treatment systems were designed to ensure compliance with anticipated water quality-based limits and Effluent Limitation Guidelines that would apply to internal outfalls and the combined wastewater discharge from new Outfall 006 under the KPDES Permit.

New Outfall 006 discharges via a diffuser in the main portion of Herrington Lake. CORMIX modelling of the allowable discharge from Outfall 006 was included in the KPDES application, and the CORMIX plume prediction file is included in the October 1, 2019 Fact Sheet issued for the permit. That modelling illustrates the anticipated fate and transport dispersal of the effluent in Herrington Lake. The Effluent Limitation Guideline (ELG) compliance plan for the Flue Gas Desulfurization (FGD) system wastewater, when generated (the FGD was converted to a zero discharge system), is also described in the KPDES application and CAP2, which was submitted to KDEP under the Agreed Order on October 28, 2019.

The operation of these WWTPs for wastewater discharges from EW Brown Station will ensure the protection of water quality in Herrington Lake. Sludges from the treatment systems will be disposed in the special waste landfill. The KPDES permit limits for wastewater discharges were established by KDOW to ensure compliance with applicable water quality standards at 401 KAR 10:031. Mass loading of constituents through Outfall 006 will also be substantially reduced after dewatering of the Aux Pond is completed. As noted in the CAP2 submittal, KU's ELG compliance plan, as approved in the KPDES permit, will be revisited after EPA finalizes its ELG reconsideration rule, which is projected for 2020 or 2021. These systems will be sufficient to protect water quality in Herrington Lake with respect to process water discharges consistent with the Agreed Order.

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[1] Ramboll. 2019. Corrective Action Investigation Source Assessment, and Risk Assessment Report for Herrington Lake, EW Brown Station. Prepared For: Kentucky Utilities Company for Submittal to KDOW Agreed Order No. DOW - 17001. June 2019.

Specifics on the three new WWTPs are provided below.

Toe Drain and Coal Pile Runoff Treatment System (TDCPRTS)

The TDCPRTS is a chemical water treatment system that receives influent from the Toe Drain Abutment Collection System and stormwater runoff from the Coal Pile Retention Pond. Prior to the construction of the TDCPRTS, both influent streams were discharged into the Auxiliary Ash Pond (Aux Pond). The TDCPRTS was completed during the 4th quarter of 2019 at which time the toe drain and coal pile runoff flows were redirected. The treatment system consists of two parallel and redundant trains. Each train consists of three tanks which drain into a common effluent tank. Within the system, the influent is treated with polymer, caustic, and organosulfide. The effluent is then drained into the Landfill Leachate Pond to allow for solids to settle before being discharged to the Process Pond and out through KPDES Outfall 006. The removal efficiencies of the treatment system were not provided by the system supplier. The system was designed to ensure compliance with water quality-based limits in the facility's recent KPDES permit.

Process Water System (PWS)

The PWS is a physical-chemical water treatment system that receives wastewater from the FGD system when wastewater is generated that requires discharge. As noted in CAP2, KU has targeted its ELG compliance as zero liquid discharge of FGD wastewater, but has provided for the PWS treatment system for backup if necessary. Prior to the construction of the PWS treatment system, FGD wastewater was discharged into the Aux Pond. The PWS treatment system was completed during the 4th quarter of 2019. Any FGD wastewater is now directed to the PWS. The KPDES permit requires compliance with the final ELG for FGD wastewater by December 31, 2023. Because the ELG rule reconsideration has not been finalized by EPA, KU will modify plans as necessary based upon the final ELG reconsideration rule and coordinate on those compliance plans with KDEP.

The PWS treatment system consists of two reaction tanks, one clarifier, filter system, and an effluent tank. Within the system, the influent is treated with caustic, organosulfide, ferric chloride, and polymer. The treatment system removes suspended solids, adjusts pH, and removes metals by chemical reactions with organosulfide compounds. The effluent is then pumped from the effluent tank to the Process Pond and then discharged through KPDES Outfall 006. The removal efficiencies of the treatment system were not provided by the system supplier; however, performance standards for the system as guaranteed by the contractor are set forth in Attachment 1.

CCR Impoundment Dewatering Treatment System

The CCR impoundment dewatering treatment system is a physical-chemical water treatment system that receives influent from the Aux Pond. Free water and interstitial water removed from the Aux Pond is pumped into the dewatering treatment system. After treatment, the water is pumped to a storage basin from where it is pumped into the adjacent Landfill Leachate Pond. Water from the Landfill Leachate Pond is then pumped to the Process Pond and then discharged through KPDES Outfall 006. This treatment system will only be used for dewatering of the Aux Pond, which is expected to be completed by the end of 2020. The removal efficiencies of the treatment systems were not provided by the system supplier; however, the system as guaranteed by the contractor was designed to meet all KPDES effluent limits for the Aux Pond in the KPDES permit at the outlet of the system (prior to the leachate pond).

Cabinet Comment 2.

Executive Summary, 1.4.6 Adult Small Fish Whole-Body Tissue from the Ash Pond. The words written as a quote from Fish tissue results from the auxiliary fly ash pond EW Brown, Mercer County, Kentucky, prepared for E.ON U.S. Louisville, Kentucky, are not a quote and the error has a nuance not found in the Stantec quote. The quote should be corrected in the errata.

Response:

This comment is acknowledged. Although the selenium concentrations in fish tissues collected from the ash pond in the 2009 sampling effort were accurately presented elsewhere in Section 1.4.6 of the Corrective Action ISARA Report, the block quoted text erroneously referred to selenium in place of mercury. The Stantec 2009 report concluded that selenium concentrations in fish from the ash pond were higher than concentrations found in reference sites.

Cabinet Comment 3.

Executive Summary, Section 1.5, the last paragraph. Kentucky no longer has an egg/ovary water quality standard for selenium. Kentucky's proffered standard was not approved by the USEPA, and so it was removed from 401 KAR 10:031 in January 2020. DEP would recommend that the 19.3 µg/g egg/ ovary threshold not be used in future evaluations or documentation. No change is necessary in the ISARA as the change in regulation occurred post drafting the ISARA and as future actions proposed in the ISARA include ovary tissue sampling.

Response:

Comment acknowledged. Section 1.5 of the Corrective Action ISARA Report mentions that "the Kentucky standard was not approved by USEPA and that Kentucky was expected to repeal its egg/ovary criterion." For this reason, the USEPA egg/ovary criterion of 15.1 µg/g was also discussed in the Corrective Action ISARA Report text and shown on report Figures ES-4B and 2-3B, 2-3F1. Future evaluations or documentation will not reference the now-repealed Kentucky 19.3 µg/g egg/ ovary criterion.

Cabinet Comment 4.

Section 3.1.1 discusses and Figure 3-1J shows runoff collection for the coal pile along the northern edge of the stored coal. The ISARA asserts that drainage from the coal pile is collected in the coal pile runoff and settling pond. It is, however, unclear whether runoff shedding towards the south, for example, would be captured by this collection system. Additionally, it is unclear whether groundwater infiltration from this area is important to decision making in the SRAA. Ensure all potential runoff from the stored coal is adequately described and the basis of that description documented and presented to support the SRAA. Efforts such as, but not limited to, human reconnaissance of the area and drone or remote sensing photography of potential flow paths may be useful. Please provide a response in the errata.

Response:

An addendum to the Corrective Action ISARA Report is provided in an Appendix to these responses (Appendix A) to address the coal pile and the coal pile retention pond as potential sources of coal-related constituents to Herrington Lake. This Coal Pile Addendum provides additional background information for the coal pile and the coal pile retention pond, describing:

- The location of the coal pile and coal pile retention pond relative to Herrington Lake.
- The geological and hydrogeological setting, which explains the conceptual model for how water from beneath the pond would migrate to the lake.
- An assessment of potential mass loading for selenium and arsenic in any seepage to Herrington Lake.

- A comparison of the coal-related constituent concentrations in the coal pile retention pond water, as a surrogate for potential exposure point concentrations, to water quality criteria for the protection of human health and the environment, and an evaluation of constituent concentrations in the lake at sampling locations closest to the coal pile.

The Coal Pile Addendum provided in the Appendix A concludes that there is no indication that coal-related constituents are migrating to Herrington Lake due to possible seepage to groundwater from the coal pile or the coal pile retention pond at concentrations or loadings that would pose an unacceptable risk to the environment or human health.

Cabinet Comment 5.

The Executive Summary and Section 3.1.1 describes the Toe Drain water collection system, stating that the bottom of the pumping chamber is at an elevation of 730 feet above sea level which is typically below the summer pool elevation. Please discuss if the collection system experiences infiltration from the summer pool of the lake and if so, propose steps to ameliorate this interface with the lake. A response should be provided in the errata.

Response:

The toe drain sump design is depicted in Attachment 2. Based on design drawings from AMEC (BRO-C-01445 and 01146, Rev. E, March 2015), an area with approximate dimensions of 70 feet by 100 feet was excavated into competent bedrock at El. 734-735 feet MSL. A reinforced concrete hydraulic cutoff wall was constructed into bedrock across the valley to the east of the toe drain collection system as a barrier between the collection system and Curds Inlet. The length of the barrier is about 135 feet. The mixing chamber and pump station components of the system were socketed into the bedrock on the west side of the barrier wall and extend from the base of the excavation to about El. 756 feet MSL.

The toe drain system operating levels are as follows: pumps off at 734 feet MSL; pump #1 on at 736.5 feet; and pump #2 on at 738.5 feet MSL. Under normal pumping operations, the water level in the sump is lower than the typical summer pool level of Herrington Lake (i.e., 740 feet MSL). While the concrete barrier wall and sump construction are intended to prevent any significant infiltration of lake water into the sump under summer pool conditions, some seepage could potentially occur around the ends of the concrete structure or beneath the barrier through bedrock. However, a comparison of pump operations for the toe drain collection system during time periods when the lake level was at or above El. 740 feet MSL to pump operations when the lake level was below 735 feet MSL shows that pump operating hours at the lower lake levels were 90 to 100% of the operating levels when the lake was at the higher level. Coupled with the absence of discernable trends in selenium and arsenic concentrations of water collected in the toe drain during periods of higher and lower lake levels, this indicates that infiltration of lake water to the toe drain collection system when the lake level is high is at most only a minor contributor to the total flow through the system.

The potential for some minor infiltration into the sump during high lake elevations does not affect system operation or cause any concerns with respect to Herrington Lake. The sump water is pumped to a new treatment system, as described in Response to Comment 1, and discharged to Outfall 006. Accordingly, no action is deemed necessary to address any minor infiltration of lake water as the sump system is properly operating under all lake level conditions.

Cabinet Comment 6.

The 2018 second quarter selenium concentration in Table 3-3A is 21.7 µg/L. The KPDES permit renewal listed the value as 55.9 µg/L. After recalculating the average and conducting a t-test on the dataset, it *was determined that the correction does not alter the conclusion that mass loading has decreased post-IRMs. No specific response is needed.*

<u>Response:</u>

Comment noted.

Cabinet Comment 7.

Section 2.2.7, Human Health Risk-Based Concentration for Fish Ingestion, the RBC formula. The formula is incorrect. No change in the document is necessary as the values given in Table 4-3 are correct within rounding error. Provide a corrected formula in the errata.

<u>Response:</u>

While the Human Health Risk-Based Fish Ingestion calculations are correct, it is acknowledged that the equation provided in the Corrective Action ISARA Report Section 2.2.7 text contained a typographical error. The equation is reformatted herein to correct that typographical error. This response, and formulae provided here serves as the erratum for the Corrective Action ISARA Report for this comment. The equation is:

$$\text{RCC} = \frac{(\text{BW} * \text{AT} * \text{Target Risk})}{\text{INf} * \text{FI} * \text{EF} * \text{ED} * \text{CF} * (\text{cooking/trimming loss}) * (\text{CSF or } 1/\text{RFD})}$$

Where:

RCB = Chronic daily intake in milligrams per kilogram (mg/kg) calculated with the exposure terms described here (USEPA 1989)

BW = Body weight (kg), Adult body weight of 80 kg used here (USEPA 2018a)

AT = Averaging time of 25,550 days (365 days x 70 years) used here for cancer and 365 days x exposure duration used for noncancer (USEPA 2018a)

Target Risk = Cancer: 1 x10^{-6} used for the inorganic arsenic RBC noncancer: Hazard index of 1 used for all others (USEPA 1989)

INf = Ingestion rate of fish. Assumed to be 50 meals per year consistent with the 350 days per year exposure frequency used in the USEPA RSLs, and very close to the meal per week upper end of meals in the Kentucky advisory for mercury in fish. The 50 meals per year basis is equivalent to 32.2 g/day

FI = Fractional intake, which represents the fraction taken from this resource. Assumed to be 100% here or an FI of 1.0

EF = Exposure frequency and 350 days per year are used for fish consumption (USEPA 1989, 2018a)

ED = Exposure duration and 26 years was used for adults (USEPA 2018a)

CF = Conversion factor or 0.001 g–mg

Cooking Loss = No cooking loss was assumed here

CSF or 1/RfD = Cancer slope factor in (mg/kg-day)$^{-1}$ (CSF) or reference dose in mg/kg-day (RfD) for noncancer is a chemical specific value taken from USEPA RSL Table 1 (USEPA 2018a) .

Cabinet Comment 8.

Section 3.4.1.2. Monitoring Well (MW) 106 was omitted from the groundwater analysis of Section 3.4.1.2 due to other wells being located between MW-106 and the lake; however, due to karst and fracture flows it should not be assumed that flow from CCR disposal areas must migrate in a single direction past MWs-109, 110, 111. Please include MW-106 in the evaluation of pollutant loading due to groundwater in future analyses. No change is required to the ISARA.

<u>Response:</u>

Comment acknowledged. Consistent with common practice for conducting mass flux analysis, MW-106 was excluded because it is upgradient of the existing transect. Any future loading analyses will be conducted to include potential loading from the area around MW-106. No Change is required in the Corrective Action ISARA Report.

Cabinet Comment 9.

Section 3.4.2.2, final paragraph. It is stated that MW-116 is the furthest well south and closest to Hardin Inlet (HI) and that the lack of arsenic in the well "demonstrates" no apparent migration of CCR-related constituents via groundwater to the well. The lack of arsenic in an "indication", not a "demonstration". No response is required.

Response:

Comment noted.

Cabinet Comment 10.

Section 3.5, 2nd to the final bullet. It is stated that "Atmospheric deposition of CCR constituents in particulate emissions... is not a likely source of CCR-constituents to the lake." This assertion is made multiple times in the document, but it is not supported by any information in the document. While this reviewer similarly surmises that atmospheric deposition is an unlikely significant source of CCR-constituents to the lake, the document provides no support for the assertion. No response is required as the point is not relevant to the data collected and analyzed in support of the ISARA.

Response:

Comment noted.

Cabinet Comment 11.

Section 4.3.2, 3rd paragraph, 1st sentence. Table 4-6 lists the arsenic RSL value for residential soil as 1 mg/Kg. The value cited in section 4.3.2 is correct, that is, 0.68 mg/Kg. This is one example of multiple occurrences in the document where numbers listed in tables are slightly inaccurate. This reviewer conjectures that the problem is associated with rounding errors or possible default settings in Excel. Please check the "significant factors" setting in Excel to possibly avoid this issue. No response is required as the error does not change any conclusions or recommendations in the ISARA.

Response:

The reviewer is correct. The arsenic residential soil RSL value reported in Corrective Action ISARA Report, Table 4-6 should be 0.68 mg/kg, not 1 mg/Kg. The reviewer is also correct that the value was unintentionally rounded in the source Excel spreadsheet that was used to create Table 4-6 and the number used in the screening shown for sediments was 0.68 mg/kg. This rounding does not change any conclusions or recommendations in the ISARA Report.

Cabinet Comment 12.

Section 4.4, SA- Surface area of skin employed in the analysis is 2,373 cm^2. Kentucky typically uses 3300 cm^2 for 1-6 years and 7500 cm^2 adolescents. The 50th % for 3 to 6-year-olds is 0.74 m^2. The head, lower legs, feet, forearm, feet make up 35% of the body's surface area. So, 0.74m X 10,000 cm/meter X 0.35 =2590 cm^2 the 95th % is 0.95 X 0.35 X 10,000 = 3325 cm^2. These values are provided for context. On the other hand, it is difficult to imagine getting the head wet without getting the neck wet. Perhaps only considering the forearms, calves, and feet as wet in wadding is sufficient. If the head is not considered part of wadding, then the number cited is appropriate. No response is required as the various options in describing wadding behavior do not change any conclusions or recommendations in the ISARA.

Response:

Comment noted.

Cabinet Comment 13.

Section 4.4, Table 4-10, Concentration of arsenic in sediments. Duplicate samples were entered into the exposure point calculation as independent samples. Duplicates are not independent samples; thus, one of a duplicate pair should be employed in the calculation of statistical parameters such as means, etc. We recommend using the data from the primary sample in the data analysis. Remove the duplicates for the dataset and recalculate the exposure point concentrations used in the HHRA. Please make the corrections and state in errata the impact of these changes on the findings and recommendations of the ISARA.

Response:

The duplicates were used for third-party data validation, as planned and as reported in the Corrective Action ISARA Report. Duplicate results can be correctly excluded from risk assessment statistics as stated in the comment. But duplicates can also be correctly used in summary statistics. For example, USEPA 2015[2] ProUCL cited in the Corrective Action ISARA Report states that ProUCL does not pre-process field duplicates and that averages or maximums may be used. Kentucky Risk Assessment guidance refers to the calculation of UCLs using USEPA's 1992 Supplemental to Risk Assessment Guidance, which identifies the use of duplicates for quality control purposes (as stated in the comment), but USEPA 1992 does not specifically state to exclude use of duplicates otherwise. Kentucky guidance states to "*Use all samples of the property and site(s)*". For the Corrective Action ISARA Report, duplicate samples were therefore included in tables, figures, appendices, and risk assessment statistical calculations as individual samples for the sake of transparency and completeness.

In response to this comment, the arsenic sediment exposure point concentrations 95th percentile upper confidence limit (UCL) values were recalculated for Middle Curds Inlet (MCI) excluding 2 duplicate samples and for Upper Curds Inlet (UCI) excluding 3 duplicate samples, as shown in Table 1 below. The exclusion of these values resulted in the following limited changes in the UCL values:

- The UCL value used in the Corrective Action ISARA Report for MCI was 223 mg/kg and would be 220 mg/kg if the 2 duplicates are excluded from the UCL calculation, approximately a 2% reduction in concentration.
- The UCL value used in the Corrective Action ISARA Report for UCI was 161 mg/kg and would be 176 mg/kg if the 3 duplicates are excluded from the UCL calculation, a 9 percent increase in concentration.

Removal of duplicate values has no effect on the human health risk assessment conclusions. These changes do not alter risk estimates for these two areas, which still each have hazard indices less than one and cancer risk estimates of $1x10^{-5}$. Table 1 summarizes these changes.

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[2] USEPA 2015 ProUCL Version 5.1 2015 Technical Guide Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. Available at: https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_tech-guide.pdf

Table 1: Comparison of Statistics Using or Excluding Duplicate Samples

	Number of Samples	Mean Concentration (mg/kg)	Maximum Concentration (mg/kg)	UCL Value Used in HHRA (mg/kg)
Middle Curds Inlet UCLs used in HHRA	14	150	415	223
Middle Curds Inlet UCLs Without Duplicates	**12**	**139**	415	**220**
Upper Curds Inlet UCLs used in HHRA	19	110	391	161
Upper Curds Inlet UCLs Without Duplicates	**16**	**119**	391	**176**

Note: Rows shaded gray with bold text exclude the 2 duplicate samples for Middle Curds Inlet and 3 duplicate samples for Upper Curds Inlet. The maximum values do not change. The difference Middle Curds Inlet UCL are less than 2%. The difference in Upper Curds Inlet values are less than 10%.

Cabinet Comment 14.

The Executive Summary and Section 4.6.1 state that an excess lifetime cancer risk less than the upper end of USEPA's target risk range of $1x10^{-4}$ *generally requires further characterization, although it may not necessarily require remedial action or other risk reduction measures. While the statement on its face is correct, by statute, KRS 224.1-530(1), Kentucky is to use the screening levels contained in EPA's Regional Screening Level (RSL) Table, Risk-Based Concentration Table User's Guide, USEPA, Region 3, June 8, 2011, which are based on a one in one million excess risk (*$1x10^{-6}$*) for carcinogenic constituents and a hazard index of 1 for non-carcinogens. Cancer risk levels greater than* $1x10^{-6}$ *and hazard index greater than 1.0, which conform with the assumptions set out in the Risk-Based Concentration Table User's Guide, require a response. No change is needed in the document as the SRAA and Report will propose responses informed by the HHRA and ERA.*

Response:

The comment is acknowledged. The Supplemental Remedial Alternative Analysis (SRAA) Report will reference the screening steps conducted using the USEPA's RSL table based on a $1x10^{-6}$ cancer risk target. The SRAA Report will identify that arsenic concentrations in the sediments from Curds Inlet exceeded the residential RSL. The SRAA Report will also summarize the findings of the Human Health Risk Assessment from the Corrective Action ISARA Report which identified a maximum risk estimate of $1x10^{-5}$ based on conservative health protective exposure assumptions regarding exposures to sediments during recreational activities. The implications of these risk assessment results will be considered in the SRAA Report.

Cabinet Comment 15.

5.4.1.1, 1st paragraph. While mean boron concentrations are below average background according to the source cited, it should be noted that boron is highest in Curds Inlet (CI) and trends down with distance from CI. This appears true for water, pore water, sediment, vegetation, and fish tissue (adult larger fish fillet is equivocal) in Phase I. Such a trend deserved comment or a bullet point. No response is required as the various options do not change the conclusions or recommendations of the ISARA.

Response:

Comment noted.

Cabinet Comment 16.

5.4.1.1, bullet points. Two bullet points are repeated. Editorial, no response needed.

Response:

Comment noted.

Cabinet Comment 17.

Section 5.4.5.1 Fish. No authority is cited to indicate whether the noted deformity levels are typical or unusual. Multiple studies are available to inform an estimate of expected deformity levels. In future studies please make a statement regarding the expected numbers of deformities and provide citations to the studies employed in developing that estimate.

Response:

The 2018 YOY study included three sampling locations within Curds Inlet nearest the Kentucky Pollution Discharge Elimination System (KPDES) Outfall BRN001, one sampling location in HQ Inlet (just outside of Curds Inlet), and three sampling locations away from the influence of EW Brown Station: Hardin Inlet (approximately 0.75 miles upgradient from Curds Inlet), a cove east of Dix Dam (Rocky Run Embayment, approximately 0.5 miles to the east and upgradient from Curds Inlet), and Lower Herrington Lake location 6 (LHL6, more than 2 miles upgradient from Curds Inlet near Sunset Marina). These latter three locations are considered outside the influence of any significant impacts from EW Brown Station, and thus were considered applicable for an understanding of deformity rates that are typical of Herrington Lake unrelated to the EW Brown Station, particularly location LHL6. Section 5 of the Corrective Action ISARA Report provides comparison of YOY deformities in Curds Inlet to other locations in Herrington Lake that were considered outside of the influence of EW Brown Station.

It is agreed that information regarding typical or "background" YOY deformity rates provides important context for evaluating the results of the YOY bluegill deformity assessment presented in the Corrective Action ISARA Report. One study of larval bluegill reported deformity rates at one reference location in West Virginia for two different years of 0% (based on a sample size of 72 larval fish) and 1.27% (based on a sample size of 1,340 fish) (West Virginia Department of Environmental Protection[3] 2010). Baseline deformity rates for other species have been reported at ranges from 2% to 17% (Janz et al. 2010[4]). Skeletal and other abnormalities in fish populations have been observed in the range of 7-20% for young fish in marine hatcheries due to a variety of factors ranging from nutrition to water currents (Berillis 2015[5]).

Cabinet Comment 18.

5.4.5.3, 3rd paragraph. "Generally, methylmercury is much more toxic than inorganic mercury, but methylmercury typically comprises less than 3%, and often much less than 1%, of total mercury in soil (Davis et al. 1997; USEPA 1997b)." This sentence addresses mercury in soil, but the topic is mercury in the aquatic environment where methylmercury is more prevalent than in soil. No response is required as the assertion does not change any conclusions or recommendations of the ISARA.

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[3] Selenium-induced Developmental Effects Among Fishes in Select West Virginia Waters. January. http://dep.wv.gov/WWE/watershed/wqmonitoring/Documents/Selenium/Se%20Larvae%202010%20final.pdf.

[4] Janz, D., D Deforest, M. Brooks, P. Chapman, G. Gilron, D. Hoff, W. Hopkins, D. McIntyre, C. Mebane, V. Palace, J Skorupa, and Wayland. 2010. In: Ecological Assessment of Selenium in the Aquatic Environment. Eds: P. Chapman et al. SETAC Press.

[5] Berillis, P. 2015. Factors that can lead to the development of skeletal deformities in fishes: a review. Journal of Fisheries Sciences. 9(3):17-23.

Response:

The comment is acknowledged but it is noted that Davis et al., 1997 and USEPA 1997b address both soils and sediments.

Cabinet Comment 19.

Table 5-11. A number of the values in the table cannot be found in the cited authorities. For example, the food ingestion rate for the mallard duck cannot be reproduced using the cited weight. How was the range for the Great Blue Heron determined? It was not based on the 10 to 15 km cited in USEPA 1993. The top foraging range provides a closer value of 2,290 acres. Similarly, the body weights for the raccoon, mink, river otter, and muskrat are close but not consistent with the cited source. The reviewer checked the calculations using values consistent with the citations and did not find the differences substantial enough to change conclusions made in the document and is, therefore, not requesting that the table be corrected. It is encouraged that in future documents all such parameters be checked, and all formulae provided.

Response:

The values provided in Table 5-11 reference USEPA 1993 Volumes 1 and 2, which cited in the reference section of the Corrective Action ISARA Report. Future reporting will more clearly provide the basis of values, as follows:

- Footnote b of Table 5-11 refers to the allometric equation in Chapter 3 of USEPA 1993 and mentions that an 80% rate is used to convert from dry weight to wet weight. Future reporting, as appropriate, will also state that the food ingestion rate for the mallard was calculated using the non-passerine formula 3-5 from USEPA 1993, where:
  Food Ingestion (grams per day) = $0.301(\text{Body Weight})^{0.751}$
- For the blue heron range, please refer to Corrective Action ISARA Table 5-11 footnote g which states that for species like the blue heron where home range is given in kilometers instead of hectares, a conversion is made. In addition, linear kilometers of shoreline are converted to the diameter of a circle:
  Footnote g from Table 5-11 states: "T*he home range is from USEPA (1993) except for wood duck and gray bat. The home range of mallard was used as a surrogate for wood duck. For gray bat, different sources were reviewed which stated that gray bats home range could vary from 1 km to 81 km (KYBWG 1999; USFWS 2009; Harriman 2003). As a conservative measure, Ramboll assumed 1 km of shoreline and converted it to acres, as previously described. For those species where home range is given in kilometers instead of hectares, Ramboll assumed this correlated to the diameter of a circle (assuming that the species was not restricted to one direction) and converted it to acres using the area of a circle formula (area = π * radius*^{2}*).*"

The following notes were not provided on Table 5-11 for the great blue heron and will be used in the future reporting, as appropriate:

- There was a significant difference between the two types of territory (mean of 11 acres for feeding territory vs 19,031 acres using both feeding and foraging territory [after converting and using radius formula]). As a conservative measure, the Corrective Action ISARA Report used only the smaller feeding territory.

For body weights, the following clarity is provided for the river otter, the raccoon, and the mink in these responses and for future risk assessment reporting, if any, to provide the clarity in the footnote tables:

- River Otter (from Table 2.2.5 of USEPA 1993b[6]): Given the regional similarities between the southeastern United States and the state of Kentucky, mean adult river otters weights were used from studies located in Alabama and Georgia. Other regional studies, including a study conducted in Idaho study, were not included. The resultant average adult otter weight of 7.4 kg is an average of 8.13 kg and 6.73 kg.
- Raccoon (from Table 2.2.3 of USEPA 1993b): The mean adult racoon weights from all the studies were used. Weights from juveniles or neonates were not included. That filtering resulted in 7 values with an average adult racoon weight of 5.78 kg.
- Mink (from Table 2.2.4 of USEPA 1993b): The mean adult mink weights from the studies were used. Weights from juveniles or neonates were not included. Two studies from the 95% confidence interval were used 8 adult weights resulted in an average adult mink weight of 1.23 kg.

Cabinet Comment 20.

Section 6, ERA Summary and Conclusions. DEP agrees that future monitoring focused on Curds Inlet would be beneficial. DEP recommends including the collection of adult bluegills (especially females) prior to spawning in the spring and analyzing whole-body samples. Additionally, DEP recommends adding a middle Herrington Lake sampling site for comparison to see if Curds Inlet results decrease over time to levels similar to those farther upstream. Finally, a couple of composite largemouth bass samples from both sites could also be useful for comparison to previous Phase I and Phase II (Curds Inlet) results. Please provide affirmation in the errata.

Response:

Comment noted. As part of the SRAA Report, confirmatory in-lake monitoring will be proposed that includes DEP's recommendations for consideration by the Cabinet during review of that report.

Cabinet Comment 21.

Note that the ISARA on the EW Brown Station website file:///U:/Asst%20Director/EW%20Brown/EW%20Brown%20Corrective%20Action%20ISARA%20Report%20ed.pdf is not the same version as provided to the DEP for review. No response needed.

Response:

Comment is acknowledged. A functioning link that provides the June 2019 version of the report is provided below.
https://lge-ku.com/sites/default/files/2019-06/0%20EW_Brown_Corrective_Action_ISARA_Report_Text_Tables_Figures_June_2019b_1.pdf

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[6] As cited in the Corrective Action ISARA Report - USEPA. 1993b. Wildlife Exposure Factors Handbook. Volumes I and II. U.S. Environmental Protection Agency, Office of Research and Development. Washington, DC. EPA/600/R-93/187.

Response to Cabinet Comments on the Herrington Lake Corrective Action Investigation, Source Assessment, and Risk Assessment Report

Attachment 1.

Auxiliary PWS System Performance Guarantee Limits

ATTACHMENT 1

Auxiliary PWS System Performance Guarantee Limits

Effluent Constituent	**Guaranteed Value**
Arsenic (As)	< 0.00598 mg/L
Cadmium (Cd)	< 0.005 mg/L
Chromium (Cr)	< 0.1 mg/L
Copper (Cu)	< 0.0357 mg/L
Iron (Fe)	< 1.0 mg/L
Lead (Pb)	< 0.1 mg/L
Mercury (Hg)	< 0.000159 mg/L
Nickel (Ni)	< 0.05 mg/L
Total Suspended Solids	< 4 mg/L or Non-Detect
pH	6.0 – 9.0

Response to Cabinet Comments on the Herrington Lake Corrective Action Investigation, Source Assessment, and Risk Assessment Report

Attachment 2. Toe Drain Collection System Schematic

BRO-C-01446

TOE DRAIN COLLECTION SYSTEM – PROFILE A

1"=5' HORIZ. 1"=2.5' VERT.

0 1.25 2.5 5 SCALE IN FEET

0 2.5 5 10 SCALE IN FEET

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REVISIONS

Rev.	Drawn Date:	Drawn By:	Revision Made
A	11/25/14	JVM	CLIENT
B	12/19/14	BJB	CLIENT
C	1/19/15	BJB	IFC
D	2/13/15	JVM	CLIENT
E	3/05/15	BJB	IFC

Title
E.W. BROWN GENERATING STATION
EW BROWN MAIN POND TOE DRAIN
COLLECTION SYSTEM – PHASE 1B
PROFILE A

Location and Unit:
E.W. BROWN GENERATING STATION

Scale: 1"=5'H, 1=2.5V
Drawn:
Date:
Checked:
Approved:

JOB NO. JOB NO. JOB NO. JOB NO.

Kentucky Utilities Company

Drawing No: BRO-C-01446
Rev. E

DMS Version 2.0

Response to Cabinet Comments on the Herrington Lake Corrective Action Investigation, Source Assessment, and Risk Assessment Report

Appendix A. Coal Pile Addendum

Prepared for:
Kentucky Utilities Company for Submittal to Kentucky Division of Water

Prepared By:
Ramboll US Corporation

Date:
March 2020

Agreed Order No.:
DOW - 17001

Project Number:
1690006320

CORRECTIVE ACTION INVESTIGATION, SOURCE ASSESSMENT, AND RISK ASSESSMENT REPORT – COAL PILE ADDENDUM

E.W. BROWN STATION, HERRINGTON LAKE, MERCER COUNTY, KENTUCKY

CORRECTIVE ACTION INVESTIGATION, SOURCE ASSESSMENT, AND RISK ASSESSMENT REPORT – COAL PILE ADDENDUM
E.W. BROWN STATION, HERRINGTON LAKE, MERCER COUNTY, KENTUCKY

Revision	**1**
Checked by	**MT Sorensen**
Approved by	**JM Nielsen**
Description	
Ref	16900006320

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DOCUMENT DEVELOPMENT AND APPROVAL

Title and Approval Sheet

Action By	Signature	Date
Prepared by: Thomas Gauthier, Ramboll	Thomas D. Gauthier	February 28, 2020
Prepared by: Jon Johnson, Ramboll		February 28, 2020
Prepared by: Alex Smith, Ramboll	alex	March 1, 2020
Prepared/Reviewed/Approved by: Mary Sorensen, Ramboll	MJSorensen	March 3, 2020
Approved by: Mark Nielsen, Ramboll	J Mark	March 3, 2020

CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

%	percent
µg/L	micrograms per liter
Cabinet	Kentucky Energy and Environment Cabinet
CCR	coal combustion residuals
ESV	Ecological screening value
ft	Feet
GPD	Gallon per day
pH	Potential of Hydrogen
HQ Inlet	HQ Inlet
In	Inch (in equations)
ISARA	Investigation, Source Assessment, and Risk Assessment
KDOW	Kentucky Division of Water
KPDES	Kentucky Pollutant Discharge Elimination System
L/day	Liters per day
LHL	lower Herrington lake
MCL	maximum contaminant level
mg	milligrams
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
R4	USEPA Region 4
USEPA	United States Environmental Protection Agency

1. INTRODUCTION AND BACKGROUND

Kentucky Utilities Company (KU) submitted a *Corrective Action Investigation, Source Assessment, and Risk Assessment Report* (hereafter Corrective Action ISARA Report) for Herrington Lake to the Kentucky Energy and Environment Cabinet (Cabinet) in June 2019 (Ramboll 2019). The Corrective Action ISARA Report was developed in accordance with the approved *Corrective Action Plan* (CAP), including the *Phase I Technical Memorandum and Phase II Plan*, the *Quality Assurance Project Plan*, and the *Standard Operating Procedures*; all approved by the Cabinet (Ramboll 2017a,b,c,d,e,f, 2018a,b,c,d).

By letter dated January 31, 2020, the Cabinet provided comments on the Corrective Action ISARA report. This addendum to the Corrective Action ISARA Report (hereafter referred to as the Coal Pile Addendum) was prepared in response to Comment #4, which requested additional evaluation regarding potential impacts to Herrington Lake from runoff or groundwater infiltration associated with the coal pile and coal pile retention pond.

1.1 Coal Pile and Coal Pile Retention Pond Background Information

As depicted on Figure 1-1, the coal pile and its retention pond are located approximately 600 feet northwest of Dix Dam spillway, approximately 700 feet northwest of main Herrington Lake (upstream of Dix Dam), and approximately 800 feet northeast of Curds Inlet.

Coal has been stored and used at the E.W. Brown Station since initial operation of Unit 1 in 1957 (110 megawatts [MW]), Unit 2 in 1963 (180 MW), and Unit 3 in 1971 (460 MW). From the 1970s to 2019, up to approximately 300,000 tons of coal were stored for a 30 to 60-day supply for generation of electricity during the operation of the three units. Units 1 and 2 were retired in 2019 and the pile now holds an estimated 150,000 to 200,000 tons (8 to 10-acre footprint), which represents a 30 to 60-day inventory for Unit 3. The coal pile retention pond, located on the north side of the coal pile and measuring approximately 0.75 acres, retains stormwater runoff and coal fines from the pile. Figures 1-2A through 1-2D provide current views of the coal pile and the coal pile retention pond from the four cardinal directions, for reference. The map provided in Figure 1-2E displays the sampling locations in Herrington Lake (specifically within Curds Inlet) adjacent to the coal pile and coal pile retention pond.

A drainage swale wraps around the perimeter of the pile and directs the stormwater runoff from all sides of the pile into the retention pond (Figures 1-2A to 1-2D). A recent inspection by KU personnel confirmed that the drainage swale effectively captures runoff from the coal pile. See Figures 1-2F, 1-2G, and 1-2H for images of the drainage swale. The stormwater collected in the retention pond is pumped to the facility's permitted wastewater treatment system.

The coal pile retention pond also receives flows associated with treatment of lake water for use in the boiler, coal-crushing and handling operations, sump drainage from retired cooling towers, and combustion turbine compressor cleaning operations. Approximate maximum flows from these processes, assuming that all generating units are operating, are described in the 2019 KPDES permit application update water balance diagrams as follows (KU 2019):

- Flows from water treatment operations (backwash of the Trimite and fixed media filters, reject water from the reverse osmosis systems, water from regeneration of the demineralizers): 141,300 gallons per day (GPD)
- Coal crusher house dust collector (wet scrubber): 27,800 GPD
- Drainage from cooling tower sumps: 1,200 GPD
- Combustion turbine compressor cleaning: 200 GPD

Runoff from the coal pile handling and storage area was estimated at 20,700 GPD (KPDES 2019). Flow rates for water pumped from the coal pile retention pond vary depending on the amount of precipitation and may range from approximately 200,000 to 300,000 gallons of water per day, when pumping occurs.

Until November of 2019, water from the coal pile retention pond was pumped to the Auxiliary Pond where it was discharged to Curds Inlet via Kentucky Pollution Discharge Elimination System (KPDES) Outfall BRN001. *S*tarting in November 2019, water from the coal pile retention pond is pumped to a treatment system, then to a leachate pond, and from the leachate pond, water flows for settling/mixing/neutralization in the new Process Pond prior to ultimate discharge via KPDES permitted submerged diffuser Outfall BRN006 (KPDES 2019). The treatment system is further described in response to Cabinet Comment Number 1. Overall, the vast majority of runoff from the coal pile area is captured and eventually discharged to a permitted KPDES outfall. The impact of these flows on Herrington Lake was fully considered as part of the evaluation of KPDES permitted discharges in the Corrective Action ISARA Report.

The earliest known schematics for the coal pile and retention pond (also referred to as the retention basin) are from 2006 (see Figures 1-3A and 1-3B of this addendum, which provide the KU schematics). Notes on these drawings state that the retention pond expansion area is lined with 2 feet of clay. According to KU, the original pond has a clay layer of unknown thickness. In 2011, the coal pile retention pond was expanded, and a small part of the coal pile support-pad was modified adjacent to the expanded portion of the pond (Figure 1-3C). The design plan for the coal pile support pad specifies compacted fill with a 5% graded slope toward the retention pond (see Figure 1-3C, which provides MACTEC, Louisville Gas and Electric /KU design and as-built drawings).

Sediments are dredged from the retention pond bottom once or twice a year to maintain the required storage capacity. Prior to construction of the landfill over the former main ash pond, the dredged sediment was placed in one of the on-site ash impoundments. Now the dredged sediment is assessed and if comprised primarily of coal, it is returned to the pile. If not, it is disposed in the on-site landfill.

1.2 Lines of Evidence to Evaluate Potential Influence of Seepage from the Coal Pile and Coal Pile Retention Pond on Herrington Lake

This Coal Pile Addendum provides an evaluation of the potential for migration of coal-related constituents from the coal pile and coal pile retention pond and any associated impacts to Herrington Lake. Potential contaminants in seepage from a coal pile can be expected to differ from constituents in leachate from CCR Units because the combustion process and associated air emission control systems affect the chemical composition and leachability of CCR. Effluent limitation guidelines for metals have not been promulgated by the United States Environmental Protection Agency (USEPA) for raw coal as has been the case for CCR-related waste streams. In its 2009 detailed study of steam electric plants to support its ELG rule, USEPA found that "The type and amount of contaminants generated in coal pile runoff depends upon the coal characteristics and the residence time of water within the coal pile. The rainfall generating the coal pile runoff can dissolve inorganic salts or cause chemical reactions in the coal piles, which will be carried away in the runoff. Coal pile runoff is typically acidic due to the oxidation of iron sulfide, which produces sulfuric acid, and ferric hydroxide or ferric sulfate. Coal pile runoff may contain high concentrations of copper, iron, aluminum, nickel, and other constituents present in coal." [EPA 2009]. To account for these differences, monitoring of constituents in the coal pile retention pond at E.W. Brown over a three-month period (during the summer of 2017) was used to characterize the constituents of concern associated with runoff and potential seepage from the coal pile.

The following lines of evidence are discussed in each of the sections of this Coal Pile Addendum, as follows:

- Section 2 considers the geological and hydrological conditions that determine groundwater flow characteristics and migration pathways in the area of the coal pile and the coal pile retention pond.
- Section 3 provides estimated maximum mass loadings of selenium and arsenic from the coal pile and the coal pile retention pond in seepage to groundwater that could potentially migrate to Herrington Lake using a conservative approach and compares those estimated loadings to other known sources to show the relative potential contributions from the coal pile and retention pond.
- Section 4 compares measured concentrations for coal-related constituents detected in the water from the coal pile retention pond to Kentucky surface water quality standards and USEPA screening levels for the protection of human health. Section 4 also considers the measured concentrations for coal-related constituents detected in Herrington Lake during the Phase I (2017) and Phase II (2018) investigations, which reflect the most relevant concentrations for assessing potential impacts of groundwater migration from the coal pile area to Herrington Lake.
- Section 5 summarizes the conclusions.

2. GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS NEAR THE COAL PILE

The geology around the coal pile and the coal pile retention pond is formed in such a way that migration of groundwater from the coal pile and coal pile retention pond would be more likely to flow in a lateral pathway toward Herrington Lake than a downward path to the lake which could result in groundwater upwelling below the lake surface. This shallow migration pathway would result in visible seeps along the shoreline of either Curds Inlet or of the Dix Dam spillway.

The coal pile sits on top of the Curdsville/Logana Member of the Lexington Limestone which is approximately 30 to 40 feet thick at the location near the coal pile. The Curdsville/Logana is a sandy coarse-grained limestone. It is interbedded with shale and has discontinuous bentonite layers. The geologic map for the area near the coal pile is illustrated on Figure 2-1 (AMEC 2013). Beneath the Lexington Limestone is the Tyrone Formation. The Tyrone Formation outcrops at Curds Inlet south of the coal pile and at Herrington Lake southeast of the coal pile and along the slope northeast of the coal pile towards the emergency spillway. The Tyrone Formation is approximately 60 to 100 feet thick at this location and extends to a depth just above or just below the lake waterline depending on pool elevation. The Tyrone Formation is primarily a microcrystalline limestone which contains intermittent bentonite layers. The interface between the Curdsville/Logana Member and the Tyrone Formation occurs at about 850 feet above sea level. Beneath the Tyrone Formation and generally below lake-level is the Oregon Formation, which is approximately 20 to 25 feet thick. Below the Oregon Formation is the Camp Nelson Limestone, which outcrops in the lower end of the Dix Dam spillway and on the downstream side of the Dix dam.

Groundwater movement in the general area has been studied extensively (including dye-trace studies performed in 2011 and 2012) (AMEC 2013). Based on the findings from these studies, groundwater near the coal pile likely flows primarily in the limestone bedrock of the Lexington and Tyrone Formations through a shallow system of fractures and solution channels. Groundwater generally follows topographic gradient.

The presence of bentonite layers within the Lexington Limestone and within the Tyrone Formation is an important feature in the subsurface since these layers can form a barrier to vertical groundwater flow, and over time may result in lateral solution channels, and the formation of springs (AMEC 2013). Therefore, migration of groundwater away from the coal pile and coal pile retention pond would be expected to flow in a lateral pathway toward Herrington Lake, ultimately becoming visible through springs and seeps rather than a downward path to the lake which could result in groundwater upwelling below the lake surface. Because the geological conditions favor lateral flow emerging as springs and seeps as the water migrates toward the lake, the prevalence of springs and seeps in the vicinity of the coal pile and coal pile retention pond is one line of evidence regarding the extent of flow from the area of the coal pile and coal pile retention pond toward Herrington Lake.

Therefore, this section discusses seeps and springs nearest to the coal pile and coal pile retention pond (i.e., Curds Inlet, Herrington Lake near the coal pile, and the Dix Dam spillway) that have been observed and documented.

2.1 Curds Inlet Observations

Figure 2-2A points out a potential seep into Curds Inlet that is visible on the November 24, 2015 images as orange-stained shoreline located near the northwest shore of upper Curds Inlet. The location of the orange staining is also estimated on Figure 2-2B. The orange staining does not exhibit visible waterflow, despite a recent (November 19th, 2015) rainfall event of greater than one inch (source: US Climate Data). Figure 2-2A also indicates the estimated location of the stained shoreline relative to the Phase I and Phase II Curds Inlet sampling transects. Considering the proximity of the staining to the transects, the Phase I and II sampling results account for any groundwater entering upper Curds Inlet at that location.

Figure 2-2C includes images of Curds Inlet from November 2015 at 721 feet asl (below winter-pool) and from January 2017 at 729 feet asl (winter-pool). No visible evidence of springs or other potential groundwater migration to Curds Inlet from the coal pile is visible in these 2015 and 2017 images of Curds Inlet northeastern bank location nearest to and in line with the coal pile.

No seeps were observed during the field sampling conducted in 2018 and 2018 to implement the CAP. The Phase I field sampling occurred from October to December 2017 and Phase II field investigations occurred in June and July 2018. No visible signs of orange staining or perennial flow were observed in any of the wet weather drainage channels that lead to nearby Curds Inlet. The divers that placed sediment pore water devices and collected sediment samples did not report any conditions suggestive of groundwater upwelling, and the field measurements did not show specific areas with temperature differences suggesting an upwelling condition. The groundwater and pore water sampling results do not indicate that groundwater is a source of constituents upwelling from Curds Inlet, as described in Section 3.5 of the Corrective Action ISARA Report.

2.2 Lower Herrington Lake Observations Outside of Curds Inlet

Areas of Lower Herrington Lake outside of Curds Inlet but also near the coal pile were sampled as part of the Phase I and Phase II Herrington Lake investigations in 2017 and 2018 including sampling transect location LHL2 (Lower Herrington Lake 2). LHL2 is located southeast of the coal pile near Dix Dam and BRN005. BRN005 is the lake-water intake source for E.W. Brown Station (see Figures 1-2B and 1-2C). Water concentrations are monitored quarterly for KPDES Permitted Outfall BRN005 and were reported on the Form C submittal for the 2019 KPDES permit renewal application (KPDES 2014). During the Phase I and II field investigations, which occurred during both summer-pool and winter-pool lake levels, no visible indications of staining were observed along the shoreline adjacent to, and included in, the LHL2 sampling region. Any effects from potential groundwater migration from the coal pile or coal pile retention pond are also accounted for in the results of the LHL2 multi-media sampling, including, adult multi-species whole-body and filleted fish, aquatic macro-invertebrates, aquatic vegetation, sediment, and surface water. The LHL2 surface water samples were collected at multiple depths and in multiple seasons. Extensive surface water profiling was also conducted at LHL2, in 10-ft increments, including temperature, dissolved oxygen (DO), pH, oxidation reduction potential (ORP), and conductivity.

2.3 Dix Dam Emergency Spillway Observations

At the Dix Dam emergency spillway, any groundwater migration endpoint to the spillway should be readily apparent through seeps or springs along the sheer rock face of the spillway and there were no areas of groundwater upwelling in the spillway observed during the Phase I and Phase II sampling efforts. Attached as Figure 2-3 is a digital image of the exposed rock strata in the western wall of the emergency spillway (Ivanowski 2020). The elevation of the excavated rock spillway channel close to the dam where the digital image was taken is approximately 740 feet asl. At the downstream section directly northeast of the coal pile, where Dix Dam Road crosses the spillway, the elevation of the spillway channel base is approximately 730 feet asl. The rock strata are exposed for the entire length of the spillway down to the Dix River to a base elevation that is 524 feet asl. There are also no known significant areas of orange staining within the section of the Dix Dam spillway that was inspected that would suggest that groundwater containing elevated levels of iron is migrating from the coal pile or the coal pile retention pond to the spillway as a spring or seep. The various exposed strata are described above.

2.4 Summary of Geologic-based Observations

In summary, any seepage to groundwater from beneath the coal pile would be expected to flow laterally, following the topography, in shallow fractures and solution features in a stair step pattern toward Herrington Lake with seeps emerging at more impervious shale and bentonite layers. Observations of the near vertical exposed strata on the north, east, and south sides below the coal pile do not show evidence of any significant seeps migrating from the coal pile or retention pond to Herrington Lake.

3. POTENTIAL LOADING OF SELENIUM AND ARSENIC FROM THE COAL PILE TO HERRINGTON LAKE

The Corrective Action ISARA Report presented estimates of mass loading of certain contaminants to Herrington Lake from various sources both on and off the E.W. Brown Plant Site. Because the runoff from the coal pile is directed from the retention pond to the permitted outfalls, that flow was included as part of the evaluation of contaminant loading in the Corrective Action ISARA Report. This section presents the calculation of the maximum potential loading of selenium and arsenic from seepage from the coal pile to groundwater migrating to Herrington Lake.

Unlike Section 3 of the ISARA report that focuses on the Coal Combustion Residual (CCR)-related mass loading sources, this addendum focuses on the onsite unburned piled coal and the water in the coal pile retention pond. Coal and CCRs differ physically and chemically. Compared to an equal mass of coal, the coal ash can have significantly higher surface area to weight ratio and can also have higher concentrations of heavy metals. Coal consists mostly of carbon but also contains hydrogen, oxygen, nitrogen, sulfur, and other naturally occurring metals. Most of the carbon is burned off during the combustion process, concentrating the heavy metals in the ash. Most of the mineral matter in coal undergoes thermal transformation during the combustion process, resulting in the primary components of coal ash: fly ash, bottom ash, and boiler slag (USEPA 2020, Cox et al. 1979).

As discussed below, the estimated maximum potential loading from the coal pile to groundwater is negligible compared to other sources that were evaluated in the Corrective Action ISARA Report.

There are no groundwater data available for areas around, or under, the coal pile. For estimates presented in this Coal Pile Addendum, the coal pile retention pond water chemistry served as a proxy for any influence of potential seepage from the coal pile or its pond on groundwater conditions. Table 2-1 provides a summary of the water samples from the coal pile retention pond, showing field parameters (pH, temperature, specific conductance, ORP) and chemical parameters, such as total and dissolved selenium and total and dissolved arsenic.

Water samples were collected from the coal pile retention pond from June to August 2017. The water from the coal pile retention pond represents a range of pond conditions with a pH range of 3.33 to 7.06 and ORP range of -77.3 to 353.8 millivolts (Table 2-1). These differences probably reflect a number of factors, including water residence time in the retention pond prior to sampling and duration between rain events. Acknowledging that the precise groundwater geochemical conditions beneath the coal pile may differ from that of the retention pond, potentially affecting concentrations beneath the coal pile, the underlying limestone formation suggests that groundwater pH is unlikely to be in the lower end of the recorded range for the pond (i.e., the groundwater is unlikely to be acidic because calcium carbonate from limestone acts as a natural buffer). The presence of coal fines in the retention pond dredged sediment suggests that concentrations of coal-related constituents in the pond water should approach equilibrium conditions similar to water seeping through the coal pile, particularly as residence times increase.

The influence of potential seepage from the coal pile is estimated by calculating a mass flux through the pile assuming all rain falling on the coal pile seeps through the coal pile at concentrations of coal related constituents equal to maximum concentrations detected in the coal pile retention pond. This is a conservative assumption. The United States Environmental Protection Agency (USEPA) has estimated that on average 73% of rainfall results in sheet runoff from a coal pile (USEPA 1979). At E.W. Brown, such runoff would be captured in the coal pile retention pond and pumped to the treatment system prior to discharge under the KPDES discharge permit.

At an average annual rainfall of 43 inches (AMEC 2013), the maximum potential seepage rate assuming all rainfall drains through the 10-acre coal pile is approximately 121,000 liters per day (L/day) as indicated in equation (3-1).

(Equation 3-1)[1] $$10\, acres\ x\ \frac{43{,}560\, ft^2}{acre}\ x\ \frac{43\, in}{yr}\ x\ \frac{ft}{12\, in}\ x\ \frac{28.32\, L}{ft^3}\ x\ \frac{yr}{365\, day} = \frac{121{,}000\, L}{day}$$

This estimate represents a maximum potential seepage rate because it does not account for evaporation and includes the runoff that flows to the coal pile retention pond and pumped to the treatment system prior to discharge under the KPDES discharge permit. Using this maximum potential seepage rate, the mass flux for selenium and arsenic is calculated below.

3.1 Estimated Maximum Potential Selenium Mass Flux from the Coal Pile to Herrington Lake

The maximum concentration of selenium detected in the coal pile retention pond samples is 0.00588 milligrams per liter (mg/L), based on the maximum detected concentration of total selenium as observed July 5, 2017 (Table 2-1). At this concentration, the upper bound estimate for the mass flux of selenium from the coal pile is:

(Equation 3-2) 121,000 L/day x 0.00588 mg/L= 711 mg/day

= 0.7 grams per day of selenium

The average concentration of selenium in the coal pile retention pond (0.0022 mg/L) with the seepage rate of 121,000 L/day yields:

(Equation 3-3) 121,000 L/day x 0.0022 mg/L = 266 mg/day

≤ ***0.3 grams per day of selenium***

The estimated loading of selenium from the coal pile would range from approximately 0.3 grams per day to 0.7 grams per day, conservatively assuming that all rain falling on the coal pile infiltrates through coal pile to groundwater at concentrations seen in the coal pile retention pond and there is no dilution or attenuation of the seepage as it migrates with groundwater from the base of the coal pile to Herrington Lake. The mass contribution from the coal pile to Herrington Lake is illustrated on Figure 3-1, which is similar to the figure presented in Section 3 of the Corrective Action ISARA Report.

3.2 Estimated Maximum Potential Arsenic Mass Flux from the Coal Pile to Herrington Lake

A similar approach is applied for arsenic. The contribution of arsenic to the lake from the coal pile also assuming all rain falling on the coal pile infiltrates through coal pile, and assuming maximum concentrations of arsenic detected in the coal pile retention pond accurately represent concentrations in the seepage from the coal pile.

The arsenic source-estimate is based on the maximum seepage rate of 121,000 L/day and maximum detected arsenic concentration recorded in the retention pond (0.00723 mg/L):

(Equation 3-4) 121,000 L/day x 0.00723 mg/L = 874 mg/day

≤ ***0.9 grams per day of arsenic***

The arsenic source-estimate based on the seepage rate of 121,000 L/day and average detected arsenic concentration recorded in the retention pond (0.00222 mg/L)

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[1] ft^2 (square feet), ft^3 (cubic feet), yr (year), L (liter), in (inch)

(Equation 3-5) *121,000 L/day x 0.00222 mg/L = 268 mg/day*

≤ ***0.3 grams per day of arsenic***

The estimated loading of arsenic from the coal pile would range from approximately 0.3 grams per day to 0.9 grams per day, conservatively assuming that all rain falling on the coal pile infiltrates through coal pile to groundwater at concentrations seen in the coal pile retention pond and there is no dilution or attenuation of the seepage as it migrates with groundwater from the base of the coal pile to Herrington Lake. The mass contribution from the coal pile to Herrington Lake is illustrated on Figure 3-2, which is similar to the figure presented in Section 3 of the Corrective Action ISARA Report.

4. COAL PILE RETENTION POND CHEMISTRY

An additional line of evidence to assess whether coal-related constituents from the coal pile and the coal pile retention pond are a source of coal-related constituents to Herrington Lake at concentrations that pose unacceptable risks to human health and the environment is to consider the detected concentrations of coal-related constituents in the coal pile retention pond from a 2017 sampling program as compared to risk-based standards and screening levels, as discussed below.

Environmental Evaluation: the risk-based evaluation for potential environmental exposures is provided in Table 4-1. Potential ecological exposures were considered by comparing the analytical results for each sampling event for the coal pile retention pond and the average of the monitoring data for the entire summer monitoring period to the following:

- Kentucky Surface Water Quality Standards for Warm Water Aquatic Habitat (Source: 401 KAR 10:031, KDOW 2020); and
- USEPA Region 4 chronic aquatic life water quality screening levels for the coal-related metals for which no Kentucky Surface Water Quality Standards have been established (USEPA 2018).

Human-Health Evaluation: the risk-based evaluation for potential human health exposures is provided in Table 4-2. Potential human health exposures were considered by comparing the average of analytical results for the coal pile retention pond by month and the average for the entire summer monitoring period to the following:

- Kentucky Surface Water Quality Standards for Domestic Water Supply Use for protection of human health (Source: 401 KAR 10:031, 2020);
- USEPA Maximum Contaminant Levels (MCL) (2018a); and
- Where Kentucky Surface Water Quality Standards for Domestic Water Supply Use or MCLs are not available, the USEPA Regional Screening Levels for tap water (2018b).

Each of the chemicals listed on Tables 4-1 and 4-2 is discussed below.

4.1 Total and Dissolved Selenium

- The detected total and dissolved selenium concentrations were less than the Kentucky aquatic life water surface water quality standard except a single detection of 0.00588 mg/L, which only slightly exceeded the Kentucky aquatic life water surface water quality standard of 0.005 mg/L. The summer average for total and dissolved selenium from the coal pile retention pond (0.0022 mg/L and 0.0011 mg/L, respectively) were less than the 0.005 mg/L Kentucky aquatic life water surface water quality standard. Note that fish tissue data takes precedent over surface water quality standards where, as here, fish tissue selenium data are available. All adult fish sampled in Curds Inlet had whole body fish tissue selenium concentrations below the Kentucky whole-body fish-tissue standard (KDOW 2020).
- For human-health, the average total and dissolved selenium concentrations in the 2017 coal pile retention pond were below the Kentucky human health surface water quality standard (0.05 mg/L).
- A direct comparison of the coal pile retention pond monitoring data to the Kentucky aquatic life surface quality water standard for selenium indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.

- The lake non-contact cooling water intake for E.W. Brown Station is the KPDES Permitted Outfall BRN005, located near the mouth of Curds Inlet, as displayed on Figures 1-2B and 1-2C of this Addendum. The water quality monitoring data for BRN005 submitted to the Cabinet as part of the KPDES permit renewal application indicates that total selenium was not detected from 13 sampling events between January 2016 and January 2019 (KU 2019).
- As discussed in Section 3 of the Corrective Action ISARA, the selenium detected in sediment pore water in Curds Inlet is due to the partition of selenium from sediment to sediment pore water and is not considered indicative of a groundwater upwelling source.
- Selenium concentrations in Herrington Lake surface water sampling locations nearest to the coal pile are below the Kentucky aquatic life surface water quality standard of 0.005 mg/L, confirming any potential migration of selenium from the coal pile through groundwater has not adversely affected the lake. The strong decreasing trend in surface water concentrations of selenium in Curds Inlet reported in the Corrective Action ISARA Report as the distance from Outfall BRN001 increases indicates that the ash pond discharge from Outfall BRN001 was the primary source of selenium loading to Curds Inlet and the concentrations of selenium detected in the water column.

4.2 Total and Dissolved Arsenic

- None of the detected total or dissolved arsenic concentrations from the 2017 coal pile retention pond monitoring exceed the Kentucky aquatic life surface water quality standard (0.15 mg/L).
- For human-health, the average total and dissolved arsenic concentrations in the 2017 coal pile retention pond were below the Kentucky human health surface water quality standard (0.01 mg/L).
- Arsenic concentrations in Herrington Lake surface water sampling locations nearest to the coal pile are below applicable water quality standards, confirming any potential migration of selenium from the coal pile through groundwater has not adversely affected the lake. None of the total or dissolved arsenic concentrations from surface water from Herrington Lake from the Phase I (2017) and Phase II (2018) investigations exceed the Kentucky aquatic life surface water quality standard of 0.15 mg/L or the Kentucky human health surface water quality standard of 0.01 mg/L, including locations within Curds Inlet and at sampling location LHL2 near Curds Inlet.
- The water quality monitoring data for lake intake water at BRN005 indicates that the maximum detected total arsenic from 13 sampling events between January 2016 and January 2019 was 0.0015 mg/L, approximately two orders of magnitude lower than the Kentucky aquatic life surface water quality standard of 0.15 mg/L (KU 2019).
- As discussed in the Corrective Action ISARA Report, the source of arsenic detected in sediment pore water from locations in Curds Inlet is due to the partition of arsenic from sediment and is not considered indicative of a groundwater upwelling source.
- A direct comparison of the coal pile retention pond monitoring data to surface water quality standards for arsenic indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.

4.3 Total and Dissolved Mercury

- Total and dissolved mercury were not detected in the coal pile retention pond at concentrations exceeding Kentucky aquatic life or human health surface water quality standards.
- A direct comparison of the coal pile retention pond monitoring data to Kentucky surface water quality standards for mercury indicates that any seepage from the coal pile or coal pile retention

pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.

- The water quality monitoring data for lake intake water at BRN005 indicates that mercury was not detected in 12 of 13 sampling events between January 2016 and January 2019 (KU 2019). The single detection of total mercury of 10 ng/L is below the Kentucky aquatic life surface water quality standard of 770 ng/L (KU 2019).
- Mercury concentrations in Herrington Lake surface water and sediment pore water at sampling locations nearest to the coal pile are below Kentucky aquatic life and human health surface quality water standards, confirming any potential migration of mercury from the coal pile through groundwater has not adversely affected the lake.

4.4 Boron

- Boron was not detected in the coal pile retention pond at concentrations exceeding either the USEPA aquatic life screening level (7.2 mg/L) or the USEPA human health regional screening level (4 mg/L).
- A direct comparison of the coal pile retention pond monitoring data to water quality standards for boron indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.
- Boron concentrations in Herrington Lake surface water and sediment pore water from sampling locations nearest to the coal pile are below USEPA aquatic life and human health regional screening levels, confirming any potential migration of selenium from the coal pile through groundwater has not adversely affected the lake.
- The average boron concentration in lake intake water at BRN005 as reported in the 2014 KPDES permit application for 3 samples is 0.42 mg/L. This average concentration is less than the aquatic life and human health screening levels.

4.5 Magnesium

- Magnesium was not detected in the coal pile retention pond at concentrations exceeding the USEPA aquatic life screening level (82 mg/L). There are no Kentucky surface water quality standards for magnesium and there are no USEPA human health water regional screening levels tap water for magnesium.
- A direct comparison of the coal pile retention pond monitoring data to the USEPA ecological screening level for magnesium indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.
- Magnesium concentrations in Herrington Lake surface water and sediment pore water sampling locations nearest to the coal pile are below USEPA aquatic life surface water quality screening level, confirming any potential migration of magnesium from the coal pile through groundwater has not adversely affected the lake.
- The average magnesium concentration in lake intake water at BRN005 as reported in the 2014 KPDES permit application for 3 samples is 10 mg/L. This average magnesium concentrations is substantially less than the USEPA aquatic life surface water quality screening level of 82 mg/L.

4.6 Lead

- Lead was not detected in the coal pile retention pond at concentrations exceeding Kentucky aquatic life or human health surface water quality standards.
- A direct comparison of the coal pile retention pond monitoring data to Kentucky surface water quality standards for lead indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.
- The water quality monitoring data for lake intake water at BRN005 indicates that lead was not detected in 12 of 13 sampling events between January 2016 and January 2019. The single detection of 0.00096 mg/L was well below the Kentucky aquatic life surface water quality standard of 0.0.0056 mg/L (KU 2019).
- Lead concentrations in Herrington Lake surface water and sediment pore water sampling locations nearest to the coal pile are below applicable Kentucky water quality standards confirming any potential migration of selenium from the coal pile through groundwater has not adversely affected the lake.

4.7 Molybdenum

- Molybdenum was not detected in the coal pile retention pond at concentrations exceeding USEPA aquatic life screening levels or human health tap water regional screening levels. There are no molybdenum aquatic life or human health surface water quality standards developed for Kentucky.
- The average molybdenum for the coal pile retention pond summer monitoring period (0.006 mg/L) is well below the USEPA aquatic life water quality screening level (0.8 mg/L) and the USEPA human health regional screening level for tap water (0.1 mg/L).
- A direct comparison of the coal pile retention pond monitoring data to water quality screening levels for molybdenum indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.
- The average molybdenum concentration in lake intake water at BRN005 as reported in the 2014 KPDES permit application for 3 samples is 0.002 mg/L. This average concentration is well below than the USEPA aquatic life and human health screening levels.

4.8 Cadmium

- The detected cadmium concentrations in the coal pile retention pond exceeded the hardness dependent Kentucky chronic aquatic life surface water quality standard for Herrington Lake (0.00037 mg/L) for the 10 sampling events but did not exceed the Herrington Lake Kentucky acute aquatic life surface water quality standard for the average of the summer.
- Cadmium was not detected at average concentrations from the coal pile retention pond that exceeded Kentucky human health surface water quality standards.
- A direct comparison of the coal pile retention pond monitoring data to the Kentucky surface water quality standards indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.

- Cadmium concentrations in Herrington Lake surface water sampling locations are below the hardness-based chronic Kentucky aquatic life chronic surface water quality standard for the lake (0.00037 mg/L). The cadmium concentrations in surface water from Herrington Lake are also less than the Kentucky human health surface water quality standard.
- Only one cadmium concentration in pore water exceeded the hardness-based Kentucky aquatic life chronic water quality standard for the lake (0.00037 mg/L) and no concentrations in pore water exceeded the Kentucky acute aquatic life water quality standard for the lake (0.0034 mg/L). Therefore, any potential migration of cadmium from the coal pile through groundwater has not adversely affected the lake.
- Cadmium was not detected from 13 sampling events between January 2016 and January 2019 in lake intake water at BRN005 (KU 2019).

4.9 Cobalt

- There are no cobalt aquatic life or human health surface water quality standards developed for Kentucky.
- Cobalt was detected in the coal pile retention pond water at concentrations exceeding the USEPA chronic aquatic life water quality screening level (0.019 mg/L) but less than the USEPA acute aquatic life water quality screening level (0.12 mg/L), except for one location where the detection (0.14 mg/L) slightly exceeded the acute screening level. The summer average concentration for cobalt (0.063 mg/L) was less than the USEPA acute aquatic life water quality screening level (0.12 mg/L).
- Average monthly and the summer average cobalt detections exceeded the USEPA's human health regional screening level for tap water but the USEPA regional screening level for tap water is a provisional value that is not as robust or significant as a Kentucky or USEPA regulatory water quality standard.
- A direct comparison of the coal pile retention pond monitoring data to the USEPA ecological and human health screening levels indicates that any seepage from the coal pile or coal pile retention pond would not likely have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.
- The average cobalt concentration in lake intake water at BRN005 as reported in the 2014 KPDES permit application for 3 samples is 0.0007 mg/L. This average concentration is less than the USEPA aquatic life water quality screening level (0.019 mg/L) and human health regional screening level for tap water (0.006 mg/L).

4.10 Lithium

- There are no lithium aquatic life or human health surface water quality standards developed for Kentucky.
- The average concentration for the June to August monitoring period (0.032 mg/L) does not exceed the USEPA aquatic life surface water quality screening level (0.44 mg/L) or the USEPA human health regional screening level (0.04 mg/L).
- A direct comparison of the coal pile retention pond monitoring data to water quality screening levels for lithium indicates that any seepage from the coal pile or coal pile retention pond would not have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.

4.11 Zinc

- Zinc was detected in the coal pile retention pond at concentrations exceeding the hardness-based Kentucky aquatic life surface water quality standard for Herrington Lake (0.174 mg/L) in the 10 coal pile retention pond samples. The summer average of the 10 sampling events had a concentration (0.472 mg/L) that also exceeded the Kentucky aquatic life surface water quality standard for Herrington Lake (0.174 mg/L).
- The zinc detected in the coal pile retention pond was not detected at average concentrations exceeding the Kentucky human health surface water quality standard (7.4 mg/L).
- A direct comparison of the coal pile retention pond monitoring data to the Kentucky aquatic life and human health surface water quality standards indicates that any seepage from the coal pile or coal pile retention pond would not likely have an adverse impact on human health or the environment in the lake, particularly in light of the dilution of any such seepage as it migrates and mixes with groundwater and runoff prior to entering the lake.
- The maximum zinc concentration from the Phase I and II Herrington Lake stratified surface water samples (0.0098 mg/L) is substantially less than the Kentucky hardness-based aquatic life water quality standard calculated for Herrington Lake (0.174 mg/L), and the Kentucky human health surface water quality standard for Herrington Lake (7.4 mg/L).
- Zinc was not detected in monitoring in lake intake water at BRN005 for 8 of 13 monitoring events from January 2016 to January 2019 (KU 2019). The maximum zinc concentration detected from January 2016 to January 2019 is 0.0129 mg/L (KU 2019), which is less than the Kentucky hardness-based aquatic life water quality standard for Herrington Lake (0.174 mg/L) and less than the human health surface water quality standard for the lake (7.4 mg/L).
- Zinc concentrations in Herrington Lake surface water and sediment pore water sampling locations nearest to the coal pile are below hardness-based Kentucky aquatic life surface water quality standards and Kentucky human health surface water quality standards. Therefore, any potential migration of zinc from the coal pile through groundwater has not adversely affected the lake.

4.12 Iron

- The average iron concentration in the coal pile retention pond exceeds the USEPA human health regional screening level (14 mg/L) for drinking water. However, in Herrington Lake, where people recreate and contact the surface water, the Phase I and II stratified surface water iron concentration (0.466 mg/L) is well below the USEPA regional screening level for iron in drinking water (14 mg/L).
- For human-health, the Kentucky surface water quality standard for iron is a secondary water quality standard based on iron in domestic water supply systems as it pertains to laundry and porcelain stains. The Kentucky iron surface water quality standard appears to be more of a nuisance concern than a potential health hazard and is not based on adverse human health effects (Kentucky Natural Resources and Environmental Protection Cabinet http://www.state.ky.us/nrepc/water/wcpfe.htm).
- The detected concentrations of iron in the coal pile retention pond exceed the Kentucky aquatic life surface water quality standard of 1.0 mg/L. However, the concentrations of iron in Herrington Lake surface water are below the Kentucky aquatic life surface water quality standard (1.0 mg/L), as shown in Figures 4-1A of this Addendum (including locations in close proximity to the orange staining observed in Curds Inlet in 2015). The maximum iron concentration in surface water from the Phase I and II surface water sampling events was 0.466 mg/L, below the Kentucky aquatic life surface water quality standard (1 mg/L). The Kentucky aquatic surface water quality standard

also states that "*the chronic criterion for iron shall not exceed three and five tenths (3.5) mg/L if aquatic life has not been shown to be adversely affected*."

- The average iron concentration in lake intake water at BRN005 as reported in the 2014 KPDES permit application for 3 samples is 0.063 mg/L. This average concentration is substantially less than the aquatic life and human health water quality standards.
- Iron was detected in the Herrington Lake sediment pore water at concentrations lower than seen in the coal pile retention pond. The iron concentrations detected in pore water are compared to the Kentucky aquatic life surface water quality standards (1.0 mg/L and 3.5 mg/L) on Figure 4-1A, but it is noted that there are no Kentucky aquatic life water quality standards or USEPA aquatic life screening levels specific to pore water.
- In order to evaluate if the concentrations of iron in sediment pore water are likely due to partitioning from sediment or indicate a potential groundwater upwelling influence, the concentrations of iron in sediment pore water are plotted against concentrations of iron in sediment at Curds Inlet locations where both sediment and pore water were collected (Figure 4-1B of this addendum). The results of this evaluation indicate that the sediment is the likely source of iron seen in pore water. Specifically:
    - In Figure 4-1B, sampling locations are color-coded to represent "A", "B" and "C" sediment locations where, the "A" thalweg samples are associated with more reducing sediments and the "C" samples have been characterized as more oxidizing sediments.
    - As indicated in the Figure 4-1B, the highest pore water concentrations are associated with more reducing "A" and "B" sediments, and only low pore water concentrations are associated with the more oxidizing "C" sediments. This is similar to the relationship observed for arsenic (see Figure 3-9A in the ISARA Report).
    - Because the solubility of both iron and arsenic is increased under more reducing conditions, higher pore water concentrations are expected to be associated with the more reducing "A" sediments. This relationship is demonstrated in the plot of pore water arsenic vs pore water iron concentrations detected in Curds Inlet (as indicated in the new Figure 4-1B of this addendum). The highest concentrations are associated with "A" samples and there is a good correlation ($r^2 = 0.64$) between pore water concentrations.
    - Collectively, this relationship and correlation indicated in Figure 4-1B indicates that the sediment is the likely source of iron seen in pore water from those more reducing sediments where elevated iron in sediment pore water was measured.

5. CONCLUSIONS

To supplement the information provided in the Corrective Action ISARA Report, this Coal Pile Addendum provides an evaluation of potential impacts to Herrington Lake from groundwater migrating from beneath the coal pile and the coal pile retention pond, based on the following:

- The location of the coal pile and coal pile retention pond relative to Herrington Lake.
- The geological and hydrogeological setting, which explains how water from beneath the pond would migrate to the lake.
- An assessment of potential mass loading for selenium and arsenic which conservatively assumes that all rain falling on the coal pile seeps through the pile to groundwater at the maximum detected concentrations in the coal pile retention pond and migrates to the lake.
- A direct comparison of the coal-related constituent concentrations in the coal pile retention pond water, as a surrogate for potential exposure point concentrations, to water quality criteria for the protection of human health and the environment, and an evaluation of constituent concentrations in the lake at sampling locations closest to the coal pile.

This evaluation finds that there is no indication that any coal-related constituents are migrating to Herrington Lake due to possible seepage to groundwater from the coal pile or the coal pile retention pond at concentrations that would pose an unacceptable risk to the environment or human health.

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Appendix A: Corrective Action Investigation, Source Assessment, and Risk Assessment [ISARA] Report - Coal Pile Addendum

Tables and Figures

Appendix A: Corrective Action Investigation, Source Assessment, and Risk Assessment [ISARA] Report - Coal Pile Addendum

Tables

Table 2-1 Coal Pile Retention Pond Water Analytical Data for Estimated Source Loading to Curds Inlet
Coal Pile Addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

Analyte	**Units**	6/13/2017		6/20/2017		6/27/2017		7/5/2017		7/12/2017		7/20/2017		7/26/2017		8/1/2017		8/9/2017		8/17/2017	
Field Parameters																					
pH	S.U.	7.06		6.91		3.33		4.30		6.35		6.00		4.65		6.97		5.13		6.67	
Temperature	ºC	27.03		20.78		26.11		24.81		21.27		23.43		28.07		20.31		24.05		21.00	
Specific Conductance (SC)	µS/cm	1248		983		1193		1660		954		1508		1044		1013		826		813	
ORP	mv	-77.3		-1.3		353.8		456.1		-1.4		40.9		130.2		-21.3		-17.8		-41.8	
Laboratory Parameters																					
Total Dissolved Solids	mg/L	1130		710		713		1050		612		1060		828		576		544		473	
Total Suspended Solids	mg/L	182		34.0		196		94.0		60.0		144		71.0		38.0		33.1		51.0	
Arsenic, Total	mg/L	0.00202		0.000819	J	0.00107		0.00723		0.00197		0.00261		0.00204		0.00203		0.000879	J	0.00116	
Arsenic, Dissolved	mg/L	0.000320	J	0.000286	J	0.000645	J	0.00115		0.000407	J	0.000613	J	0.000502	J	0.000469	J	0.000434	J	0.000307	J
Selenium, Total	mg/L	0.00299		0.000938	J	0.00221		0.00588		0.00113	J	0.00326		0.00244		0.00163	J	0.00118	J	0.000805	J
Selenium, Dissolved	mg/L	0.000875	J	0.000771	J	0.00191	J	0.00229		0.000954	J	0.000946	J	0.00108	J	0.000839	J	0.00140	J	0.000341	J
Hardness, as CaCO3	mg/L	436		403		393		470		367		592		442		436		306		286	
pH	S.U.	7.06		6.91		3.33		4.30		6.35		6.00		4.65		6.97		5.13		6.67	

Notes:

ºC	Degrees Celsius
mg/L	milligrams per Liter
mv	millivolts
NA	Not available or not established
S.U.	Standard Unit
µS/cm	microsiemens per centimeter

(a) This comparsion is made to illustrate that the concentrations of CCR-related constituents is generally low. Similarly, people do not drink water from the coal pile retention pond. Compairson to MCLs is for comparative purposes only.

(b) As disucssed in Section 4 of the Corrective Action Investigation, Source Assessment, Risk Assessment Report, the value shown for boron, molybdenum, and cobalt is the Regional Screening Level (RSL) for Tap Water. Cobalt and lithium values are based on a provisional reference doses

J The identification of the analyte is acceptable; the reported value is an estimate.

Table 4-1 Coal Pile Retention Pond Water Analytical Data for Coal-Related Constituents Compared to Kentucky Surface Water Standards and USEPA Surface Water Screening Levels for Aquatic Wildlfe
Coal Pile Addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

Analyte (units mg/L unless noted)	Kentucky WQS	USEPA Screening Levels	6/13/2017		6/20/2017		6/27/2017		7/5/2017		7/12/2017		7/20/2017		7/26/2017		8/1/2017		8/9/2017		8/17/2017		June to August Average
Selenium, Total	0.005 (c)	NA	0.00299		0.000938	J	0.00221		0.00588		0.00113	J	0.00326		0.00244		0.00163	J	0.00118	J	0.000805	J	0.0022
Selenium, Dissolved	0.005 (c)	NA	0.000875	J	0.000771	J	0.00191	J	0.00229		0.000954	J	0.000946	J	0.00108	J	0.000839	J	0.00140	J	0.000341	J	0.0011
Arsenic, Total	0.15 (c)	NA	0.00202		0.000819	J	0.00107		0.00723		0.00197		0.00261		0.00204		0.00203		0.000879	J	0.00116		0.0022
Arsenic, Dissolved	0.15 (c)	NA	0.000320	J	0.000286	J	0.000645	J	0.00115		0.000407	J	0.000613	J	0.000502	J	0.000469	J	0.000434	J	0.000307	J	0.0005
Mercury, Total (ng/L)	770 (c)	NA	3.96		1.58		3.40		5.39		5.15		1.89		5.14		2.51		1.88		1.18		3.21
Mercury, Dissolved (ng/L)	770 (c)	NA	1.29		0.933		<0.500		0.945		0.565		<0.500		1.20		0.519		0.281	J	<0.500	<	0.779
Boron	NA	7.2 (c)	0.635		0.428		0.369		0.408		0.433		0.456		0.311		0.359		0.316		0.318		0.40
Magnesium	NA	82 (c)	32.1		26.1		30.5		33.6		23.1		41.8		27.9		25.4		18.4		18.7		27.8
Lead (b)	0.0056 (c)	NA	0.000555	J	<0.00100		0.000457	J	0.000927	J	0.000477	J	0.000299	J	0.00164		0.000782	J	0.000308	J	<0.00100		0.00072
Molybdenum	NA	0.8 (c)	0.0132		0.00329	J	0.00103	J	0.00152	J	0.00681		0.0132		0.00537		0.00979		0.00139	J	0.00478	J	0.0060
Cadmium (b)	0.00037 (c), 0.034 (a)	NA	0.00173		0.00124		0.00375		0.00838		0.00097	J	0.00206		0.00161		0.000785	J	0.00229		0.000638	J	0.0023
Cobalt	NA	0.019 (c), 0.120 (a)	0.072		0.0493		0.111		0.14		0.0289		0.077		0.0561		0.0222		0.0483		0.027		0.063
Lithium	NA	0.44 (c), 0.91 (a)	0.0428		0.0264		0.0528		0.0596		0.0192		0.0403		0.0260		0.0126	J	0.0280		0.0169		0.032
Zinc (b)	0.174 (c), 0.174 (a)	NA	0.569		0.307		0.821		0.956		0.177		0.583		0.415		0.122		0.294		0.166		0.472
Iron	1 (c)	NA	97.3		27.3		137		135		17.1		73.4		31.2		13.1		19.8		19.6		57.1

Notes:

WQS	Kentucky Chronic Aquatic Life Water Quality Standards (WQS) are identified where available (2020). When not available, USEPA Chronic Aquatic Life Screening Levels are shown.
USEPA Screening Levels	United States Environmental Protection Agency Chronic Aquatic Life Screening Levels. USEPA Screening Levels are only shown for constituents lacking Kentucky WQS.
J	The identification of the analyte is acceptable; the reported value is an estimate.
<	Constituent not detected, value is below the reporting limit
	Blue highlighted cells show data that exceeds chronic Kentucky WQS.
	Gray highlighted cells show data that exceed USEPA chronic aquatic life surface water screening levels .
(a)	acute screening levels.
(b)	Hardness based formulae per KY guidance (See Table 5-2 of the Corrective Action ISARA Report).
(c)	chronic screening levels.
mg/L	milligrams per liter.
ng/L	nanograms per liter.
NA	Not available or not applicable (USEPA screening levels are not shown if Kentucky WQS are available).

Table 4-2 Coal Pile Retention Pond Water Analytical Data for Coal-Related Constituents Compared to Kentucky Water Quality Standards and USEPA Screening Levels for Human Health
Coal Pile Addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

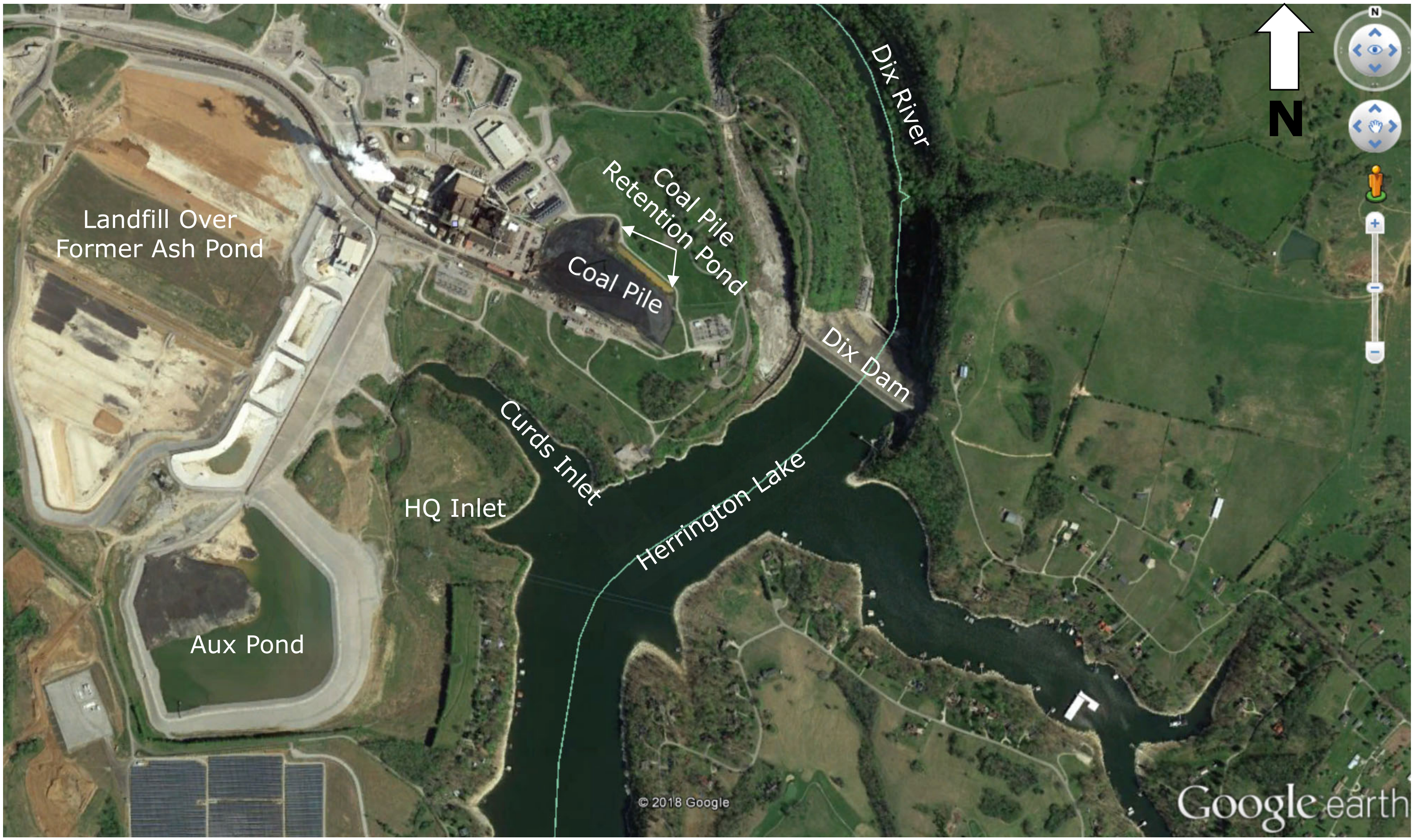
				Lab ID Sample ID Sample Collection Date	June 2017 Average	July 2017 Average	August 2017 Average	Summer (June to August) Average
Analyte	Units	Kentucky WQS	USEPA MCL (a)	USEPA RSL (b)				
Selenium, Total	mg/L	0.17	0.05	NA	0.0020	0.0034	0.0012	0.002
Selenium, Dissolved	mg/L	0.17	0.05	NA	0.0012	0.0014	0.00086	0.001
Arsenic, Total	mg/L	0.01	0.01	NA	0.0013	0.0039	0.0014	0.002
Arsenic, Dissolved	mg/L	0.01	0.01	NA	0.00042	0.00072	0.00040	0.001
Mercury, Total	ng/L	200	200	NA	3.0	4.1	1.9	2.99
Mercury, Dissolved	ng/L	200	200	NA	0.91	0.7	0.43	0.67
Boron	mg/L	NA	NA	4 (b)	0.48	0.43	0.33	0.41
Magnesium	mg/L	NA	NA	NA	29.6	32.8	20.8	27.7
Cadmium	mg/L	0.005	0.005	NA	0.0022	0.0038	0.0012	0.002
Cobalt	mg/L	NA	NA	0.006 (b)	0.077	0.082	0.0325	0.06
Lithium	mg/L	NA	NA	0.04 (b)	0.04	0.040	0.019	0.032
Lead	mg/L	0.015	0.015	NA	0.00067	0.0006	0.00070	0.001
Molybdenum	mg/L	NA	NA	0.1 (b)	0.0058	0.0072	0.0053	0.01
Zinc	mg/L	7.4	NA	NA	0.57	0.57	0.194	0.44
Iron	mg/L	0.3 (c)	NA	14 (b)	87.2	75.2	17.5	60.0

Notes:

NA	Not available or not established, or not applicable because Kentucky standards are available.
MCL	USEPA Maximum Contaminant Level for drinking water unless otherwise noted; https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations (accessed December 2019)
mg/L	milligrams per Liter
WQS	Kentucky Water Quality Standards for human health drinking water (401KY 10:31).
RSL	Risk based screening levels for human health, such as the Regional Screening Level (RSL) for consumption of residential drinking water.
(a)	This comparison is made to illustrate that the concentrations of coal-related constituents is generally low. Similarly, people do not drink water from the coal pile retention pond. Comparison to MCLs is for comparative purposes only.
(b)	As discussed in Section 4 of the Corrective Action Investigation, Source Assessment, Risk Assessment Report, the value shown for molybdenum, cobalt, and lithium is the Regional Screening Level (RSL) for Tap Water. Cobalt and lithium values are based on a provisional reference doses.
(c)	The Kentucky criteria for iron is a secondary water quality standard intended to protect against rusty color; sediment; metallic taste; reddish or orange staining when water is used as residential drinking water. It is not based on adverse human health effects. The RSL of 14 mg/L is based on human health for residential tap water use.
🟦	Exceeds the Kentucky WQS for iron but does not exceed the USEPA RSL for iron (see footnote c above); exceeds the USEPA Regional Screening Levels (RSL) for cobalt (see footnote b above).

Appendix A: Corrective Action Investigation, Source Assessment, and Risk Assessment [ISARA] Report- Coal Pile Addendum

Figures



Notes:

- The distance west from the coal pile to the Curds Inlet is greater than 800 feet.
- The distance east from the coal pile to Herrington Lake is greater than 700 feet.
- The coal pile covers approximately 8 to 10 acres.
- The coal pile retention pond (including the 2011 extension of the pond) covers approximately ¾ acres.

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

DATE: 10/29/2019

E.W. BROWN STATION SITE LAYOUT
INCLUDING THE COAL PILE AND COAL PILE RETENTION POND

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-1

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

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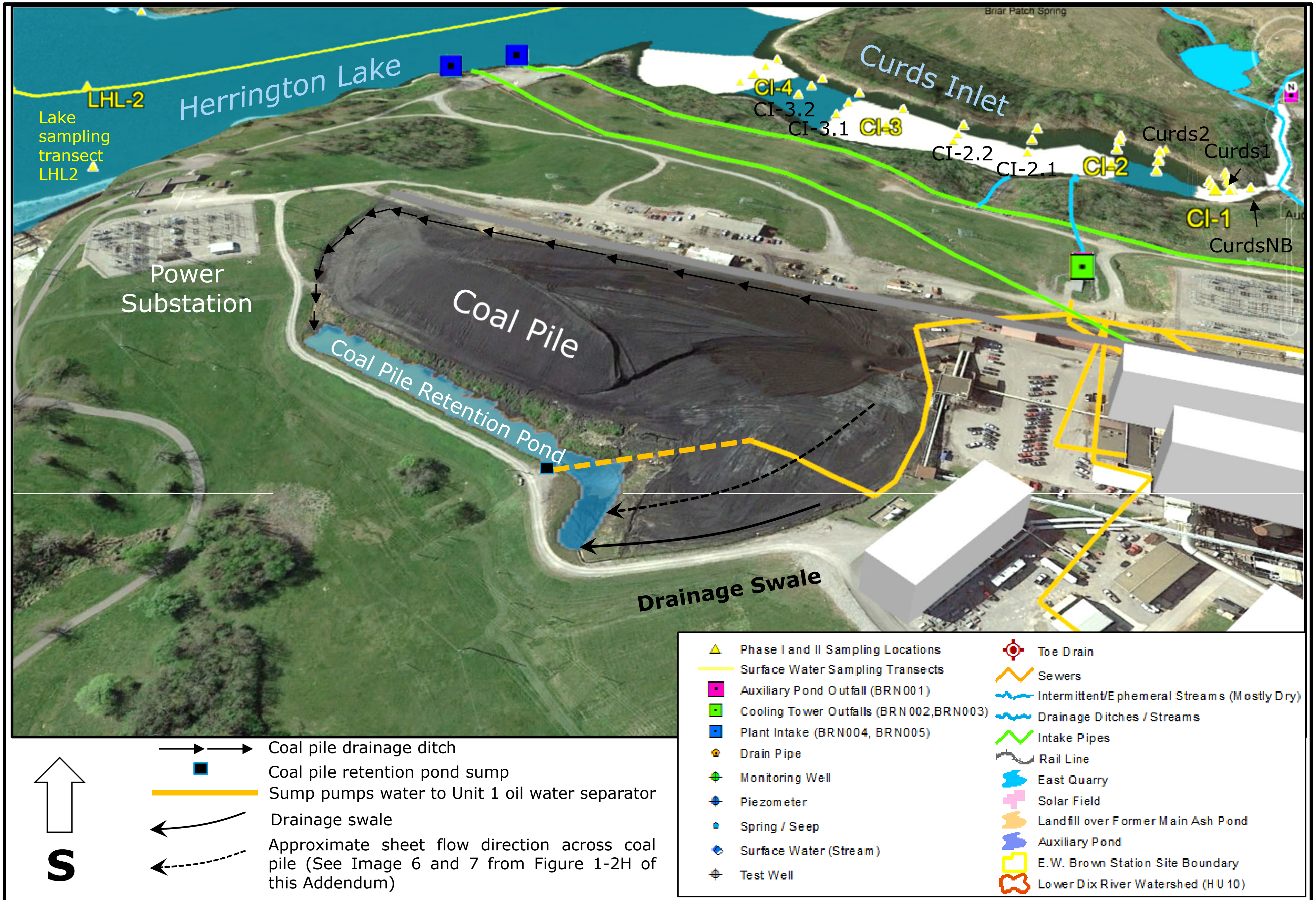
DATE: 10/29/2019

COAL PILE AND COAL PILE RETENTION POND, NORTH VIEW

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-2A



This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

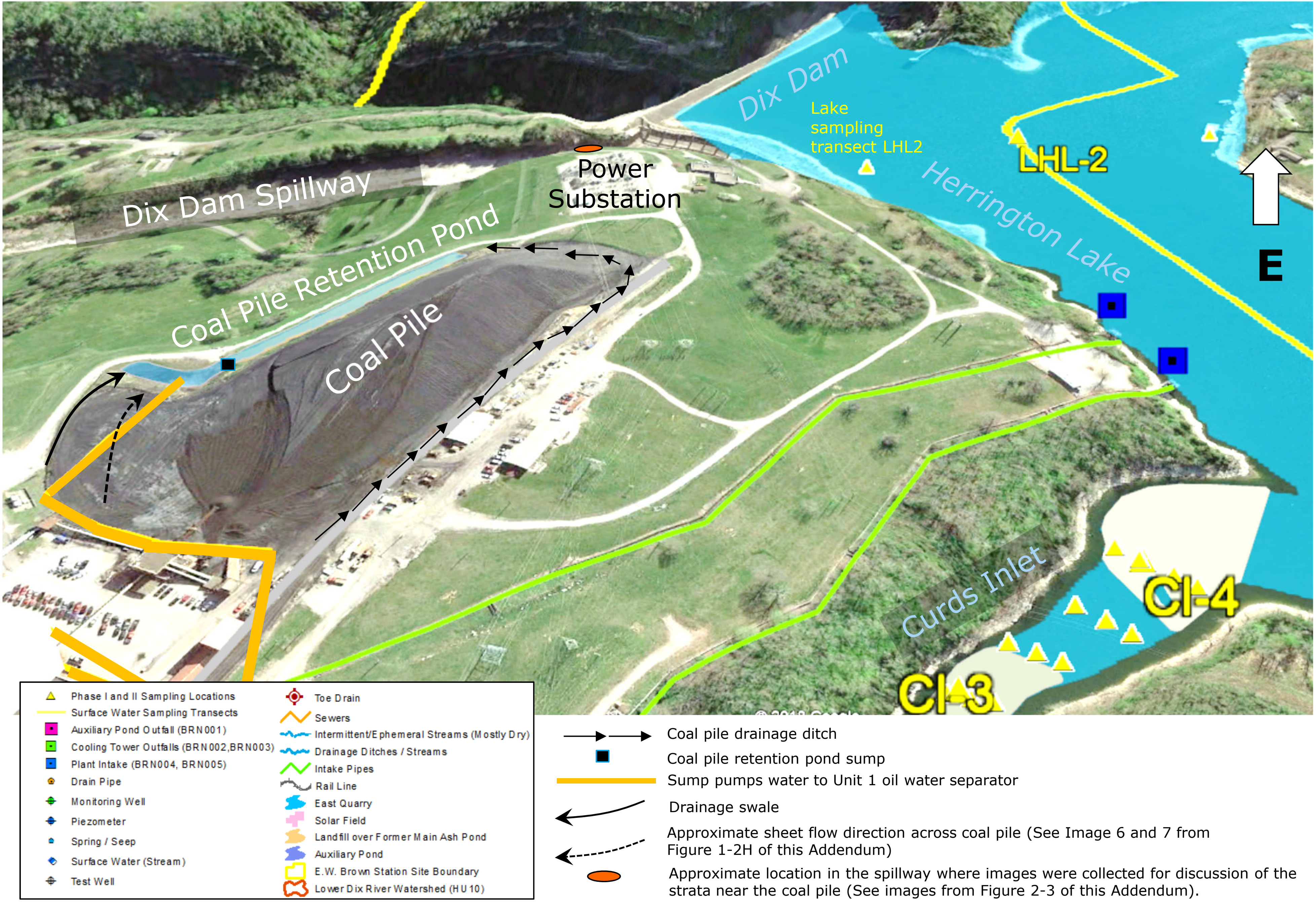
DATE: 10/29/2019

COAL PILE AND COAL PILE RETENTION POND, SOUTH VIEW

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-2B



This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

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DRAFTED BY: CDB

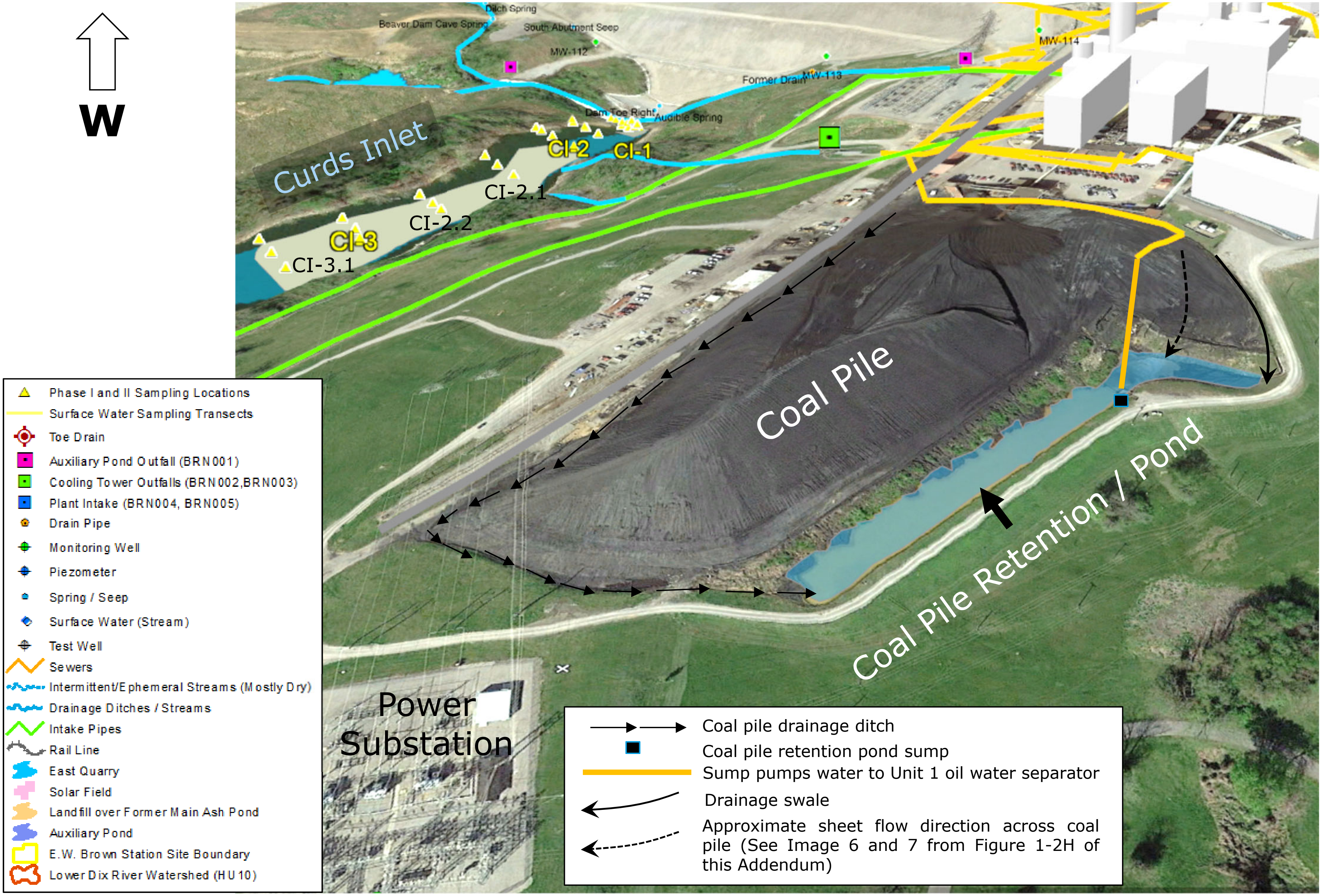
DATE: 10/29/2019

COAL PILE AND COAL PILE RETENTION POND, EAST VIEW

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-2C



This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

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DRAFTED BY: CDB

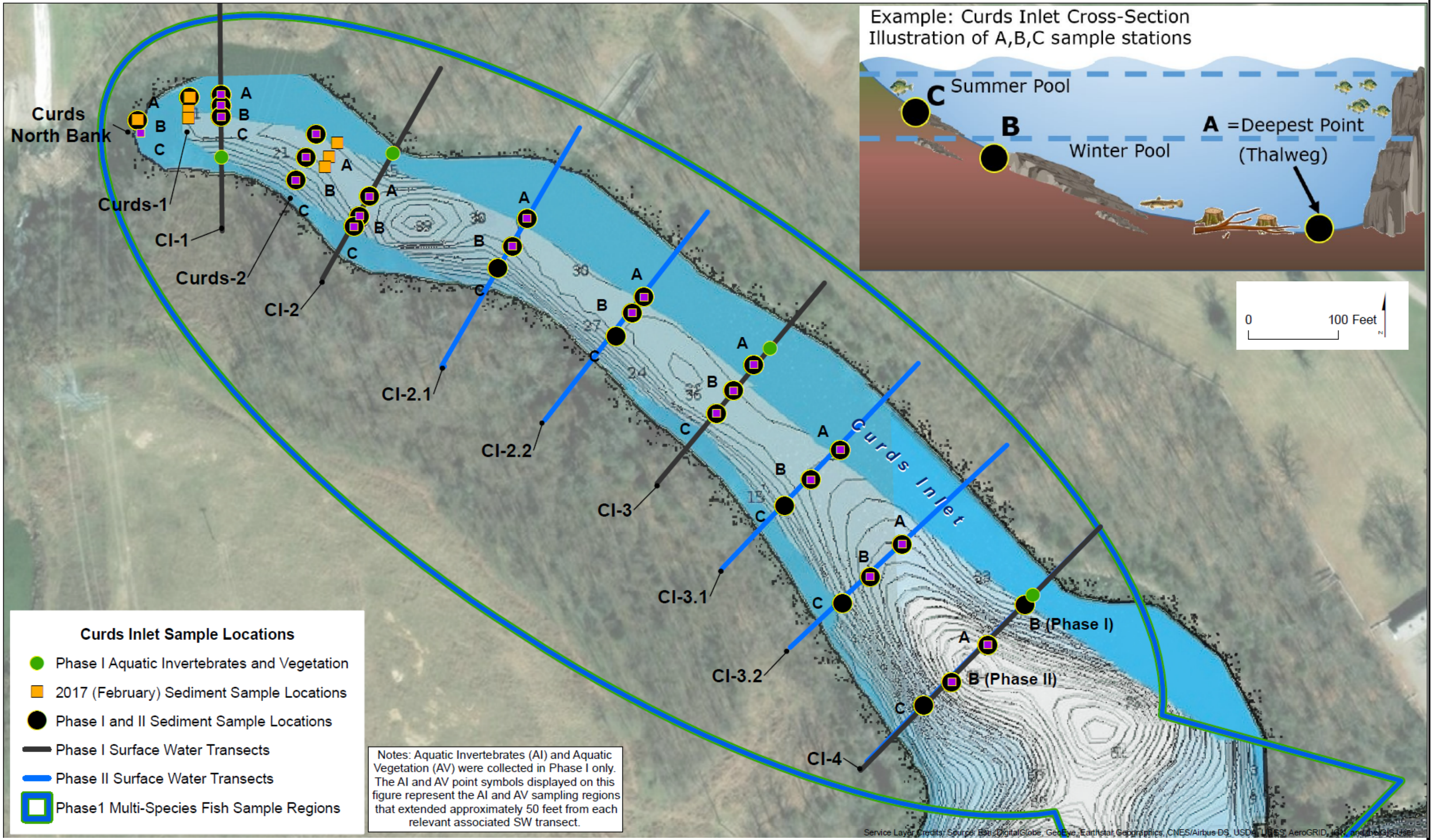
DATE: 10/29/2019

COAL PILE AND COAL PILE RETENTION POND, WEST VIEW

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-2D



Notes: Aquatic Invertebrates (AI) and Aquatic Vegetation (AV) were collected in Phase I only. The AI and AV point symbols displayed on this figure represent the AI and AV sampling regions that extended approximately 50 feet from each relevant associated SW transect.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

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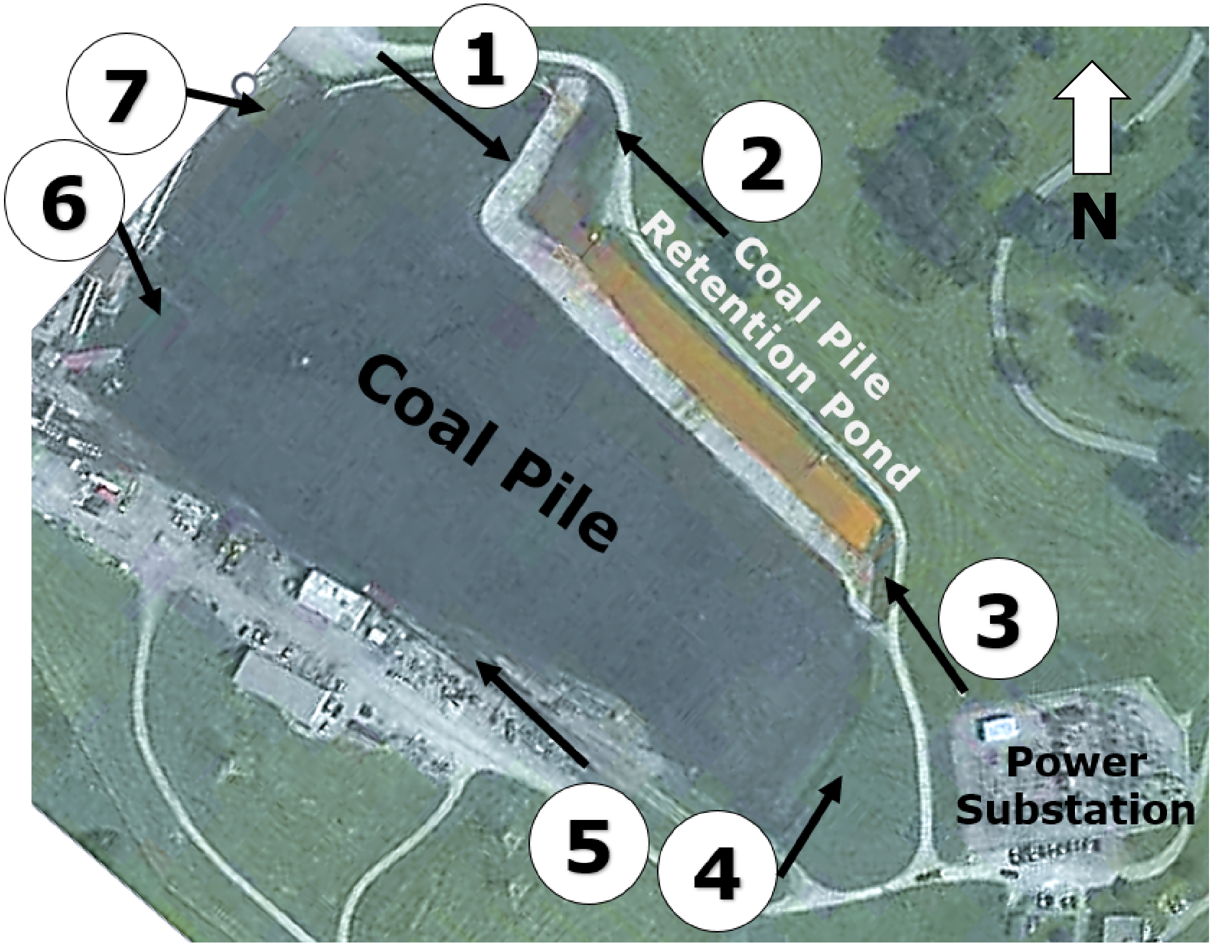
DATE: 10/29/2019

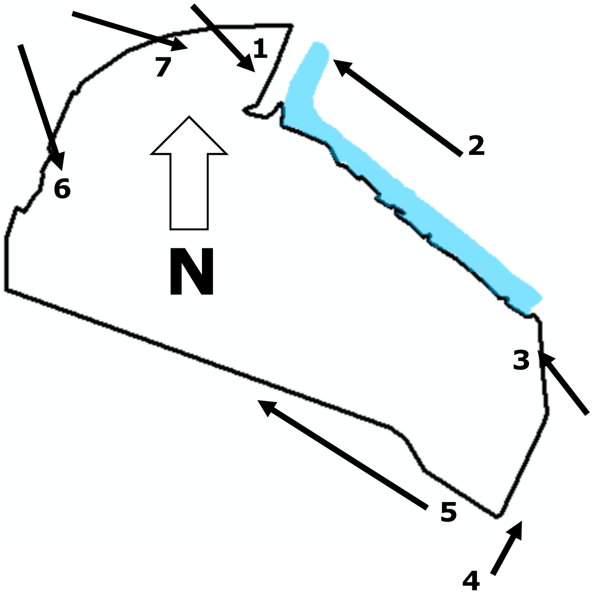
CURDS INLET SAMPLING LOCATIONS NEAR THE COAL PILE (2017-2018)

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-2E





This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

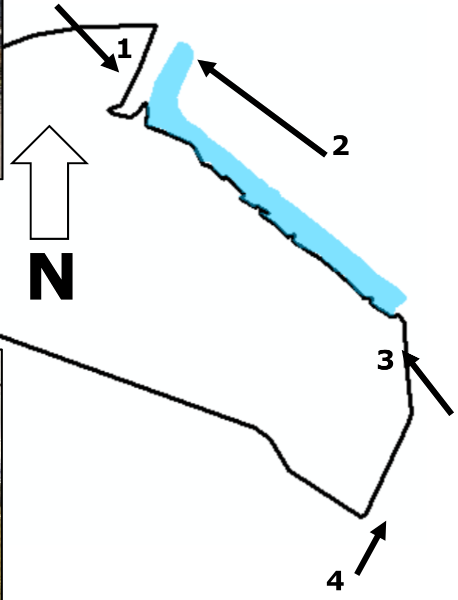
DATE: 10/29/2019

AERIAL VIEW OF THE E.W. BROWN STATION COAL PILE SWALE IMAGERY LOCATIONS

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-2F



This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

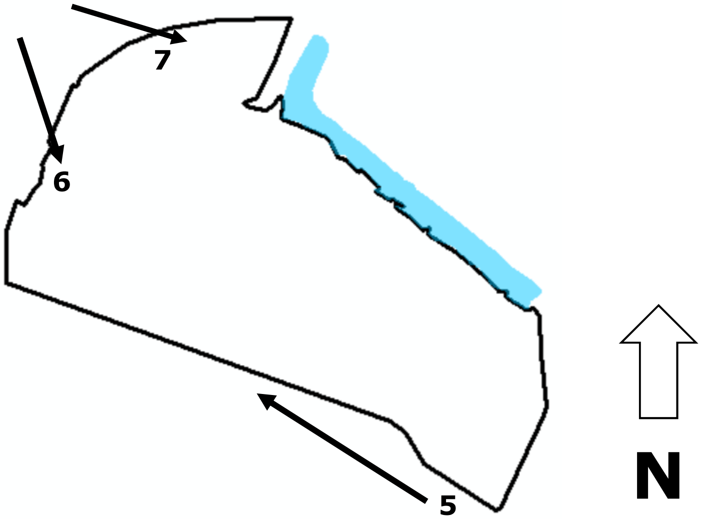
DATE: 10/29/2019

DIGITAL IMAGERY OF THE E.W. BROWN STATION COAL PILE SWALE
(LOCATIONS 1-4)

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

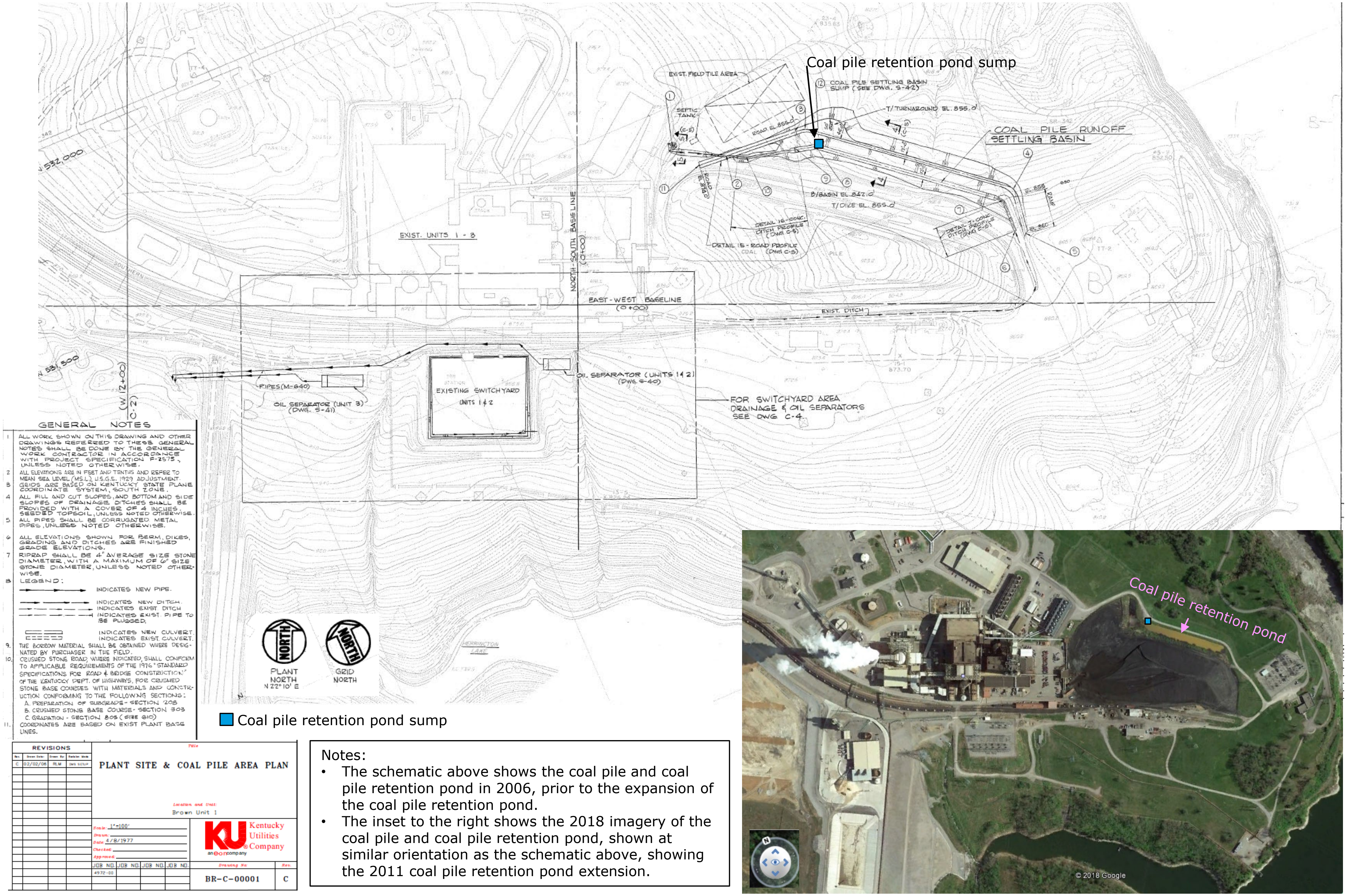
FIGURE

1-2G



This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL	**DIGITAL IMAGERY OF THE E.W. BROWN STATION COAL PILE SWALE (LOCATIONS 5-7)** Coal Pile Addendum to the Corrective Action ISARA Report E.W. Brown Station, Herrington Lake, Mercer County, Kentucky	FIGURE 1-2H
DRAFTED BY: CDB DATE: 10/29/2019		



GENERAL NOTES

1. ALL WORK SHOWN ON THIS DRAWING AND OTHER DRAWINGS REFERRED TO THESE GENERAL NOTES SHALL BE DONE BY THE GENERAL WORK CONTRACTOR IN ACCORDANCE WITH PROJECT SPECIFICATION F-2575, UNLESS NOTED OTHERWISE.
2. ALL ELEVATIONS ARE IN FEET AND TENTHS AND REFER TO MEAN SEA LEVEL (M.S.L.), U.S.G.S. 1929 ADJUSTMENT.
3. GRIDS ARE BASED ON KENTUCKY STATE PLANE COORDINATE SYSTEM, SOUTH ZONE.
4. ALL FILL AND CUT SLOPES, AND BOTTOM AND SIDE SLOPES OF DRAINAGE DITCHES SHALL BE PROVIDED WITH A COVER OF 4 INCHES SEEDED TOPSOIL, UNLESS NOTED OTHERWISE.
5. ALL PIPES SHALL BE CORRUGATED METAL PIPES, UNLESS NOTED OTHERWISE.
6. ALL ELEVATIONS SHOWN FOR BERM, DIKES, GRADING AND DITCHES ARE FINISHED GRADE ELEVATIONS.
7. RIPRAP SHALL BE 4" AVERAGE SIZE STONE DIAMETER, WITH A MAXIMUM OF 6" SIZE STONE DIAMETER, UNLESS NOTED OTHERWISE.
8. LEGEND:
   - INDICATES NEW PIPE.
   - INDICATES NEW DITCH.
   - INDICATES EXIST. DITCH
   - INDICATES EXIST. PIPE TO BE PLUGGED.
   - INDICATES NEW CULVERT.
   - INDICATES EXIST. CULVERT.
9. THE BORROW MATERIAL SHALL BE OBTAINED WHERE DESIGNATED BY PURCHASER IN THE FIELD.
10. CRUSHED STONE ROAD, WHERE INDICATED, SHALL CONFORM TO APPLICABLE REQUIREMENTS OF THE 1976 "STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION" OF THE KENTUCKY DEPT. OF HIGHWAYS, FOR CRUSHED STONE BASE COURSES WITH MATERIALS AND CONSTRUCTION CONFORMING TO THE FOLLOWING SECTIONS:
    A. PREPARATION OF SUBGRADE - SECTION 208
    B. CRUSHED STONE BASE COURSE - SECTION 303
    C. GRADATION - SECTION 805 (SIZE 610)
11. COORDINATES ARE BASED ON EXIST PLANT BASE LINES.

REVISIONS

Rev.	Drawn Date:	Drawn By:	Revision Mode
C	02/02/06	RLM	DMS SETUP

Title

PLANT SITE & COAL PILE AREA PLAN

Location and Unit:
Brown Unit 1

Scale: 1"=100'
Drawn:
Date: 4/8/1977
Checked:
Approved:

Kentucky Utilities Company
an eon company

JOB NO.	JOB NO.	JOB NO.	JOB NO.	Drawing No.	Rev.
4972-00				BR-C-00001	C

🟦 Coal pile retention pond sump

Notes:
- The schematic above shows the coal pile and coal pile retention pond in 2006, prior to the expansion of the coal pile retention pond.
- The inset to the right shows the 2018 imagery of the coal pile and coal pile retention pond, shown at similar orientation as the schematic above, showing the 2011 coal pile retention pond extension.

This figure is an addendum to the Corrective Action Investigation, /source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

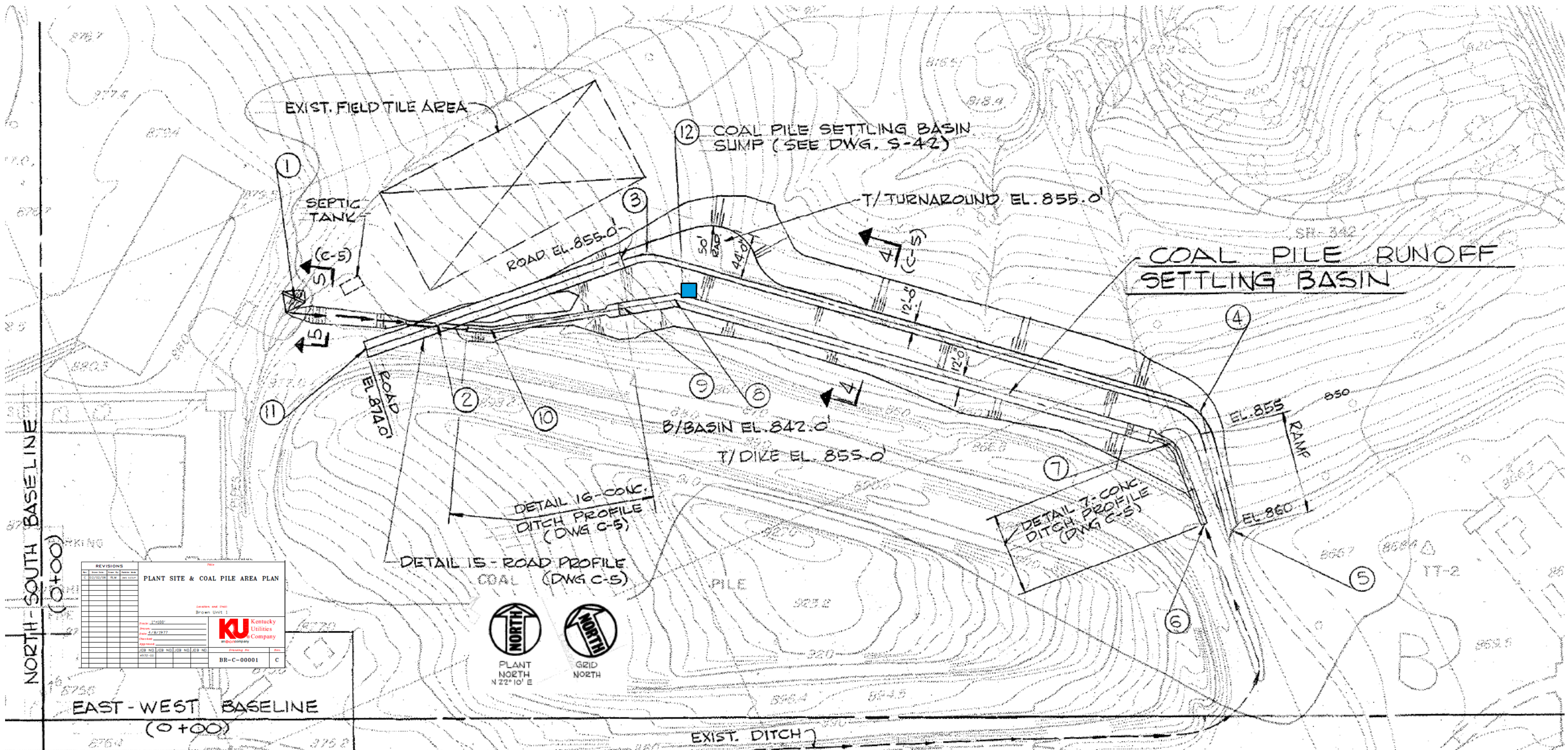
DATE: 10/29/2019

COAL PILE AND COAL PILE RETENTION POND DESIGN SCHEMATIC, 2006

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-3A



GENERAL NOTES

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2. ALL ELEVATIONS ARE IN FEET AND TENTHS AND REFER TO MEAN SEA LEVEL (M.S.L.), U.S.G.S. 1929 ADJUSTMENT.
3. GRIDS ARE BASED ON KENTUCKY STATE PLANE COORDINATE SYSTEM, SOUTH ZONE.
4. ALL FILL AND CUT SLOPES, AND BOTTOM AND SIDE SLOPES OF DRAINAGE DITCHES SHALL BE PROVIDED WITH A COVER OF 4 INCHES. SEEDED TOPSOIL, UNLESS NOTED OTHERWISE.
5. ALL PIPES SHALL BE CORRUGATED METAL PIPES, UNLESS NOTED OTHERWISE.
6. ALL ELEVATIONS SHOWN FOR BERM, DIKES, GRADING AND DITCHES ARE FINISHED GRADE ELEVATIONS.
7. RIPRAP SHALL BE 4" AVERAGE SIZE STONE DIAMETER, WITH A MAXIMUM OF 6" SIZE STONE DIAMETER, UNLESS NOTED OTHERWISE.

GENERAL NOTES

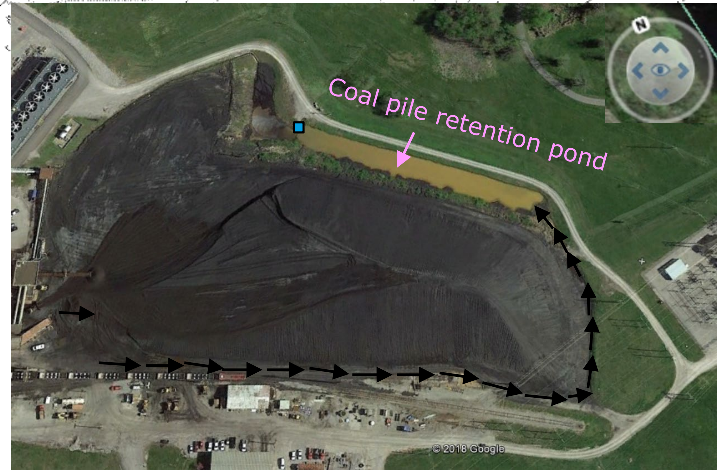
8. LEGEND:

——▶——▶——▶	INDICATES NEW PIPE.
—▶ —▶ —▶	INDICATES NEW DITCH.
–→– – –→– – →	INDICATES EXIST. DITCH
–→– – –→– – ⊣	INDICATES EXIST. PIPE TO BE PLUGGED.
▭▭	INDICATES NEW CULVERT.
⊏⊐⊏⊐	INDICATES EXIST. CULVERT.

9. THE BORROW MATERIAL SHALL BE OBTAINED WHERE DESIGNATED BY PURCHASER IN THE FIELD.
10. CRUSHED STONE ROAD, WHERE INDICATED, SHALL CONFORM TO APPLICABLE REQUIREMENTS OF THE 1976 "STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION" OF THE KENTUCKY DEPT. OF HIGHWAYS, FOR CRUSHED STONE BASE COURSES WITH MATERIALS AND CONSTRUCTION CONFORMING TO THE FOLLOWING SECTIONS:
    A. PREPARATION OF SUBGRADE - SECTION 208
    B. CRUSHED STONE BASE COURSE - SECTION 303
    C. GRADATION - SECTION 805 (SIZE 610)
11. COORDINATES ARE BASED ON EXIST PLANT BASE LINES.

Notes:
- The schematic above shows a close view of the drawing provided on previous figure focused on the coal pile and coal pile retention pond in 2006, prior to the expansion of the coal pile retention pond.

—▶—▶	Coal pile drainage ditch
🟦	Coal pile retention pond sump
▬ ▬ ▬	Sump flow to the sewer system, which flows to the oil water separator



This figure is an addendum to the Corrective Action Investigation, /source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

DATE: 10/29/2019

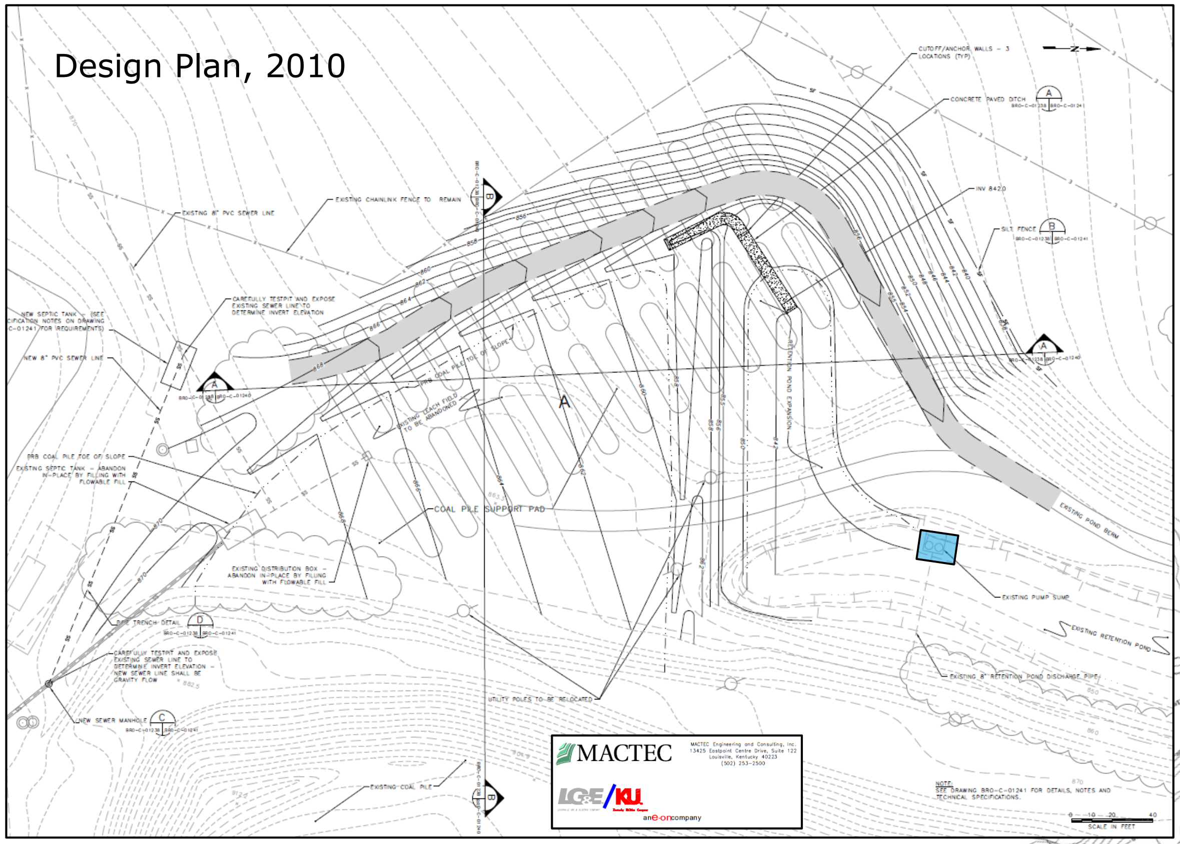
ZOOM VIEW OF THE COAL PILE AND COAL PILE RETENTION POND SCHEMATIC, 2006

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

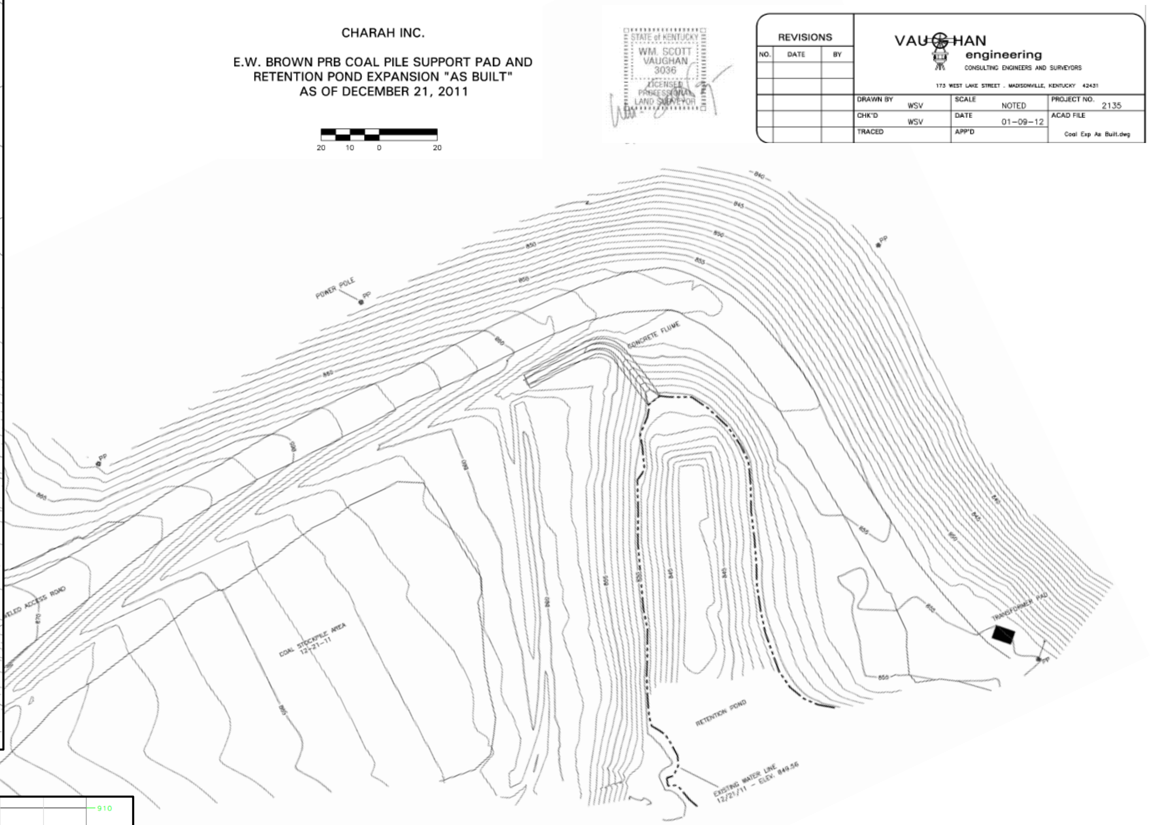
FIGURE

1-3B

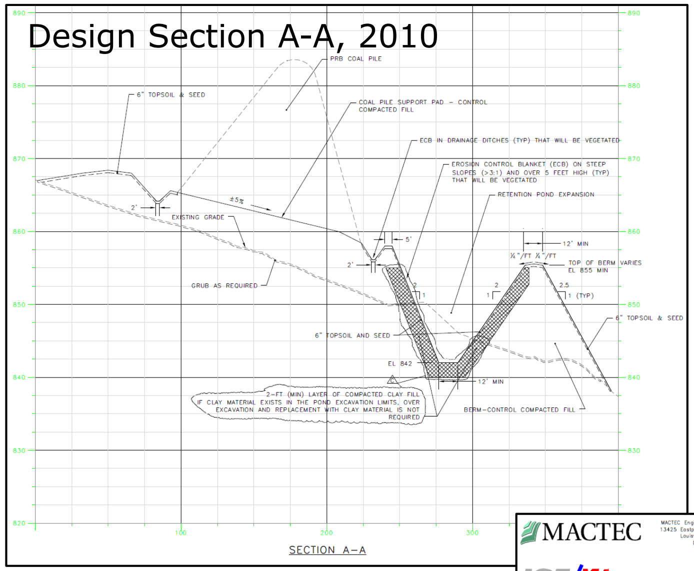
Design Plan, 2010



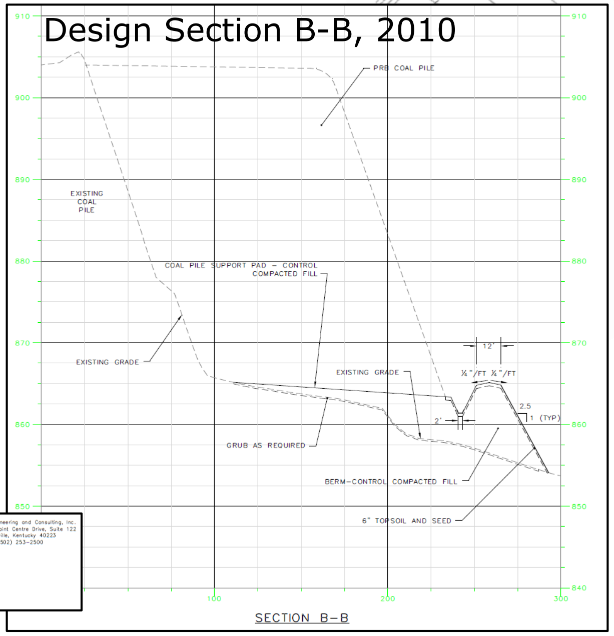
As Built Coal Pile Retention Pond Expansion 2011



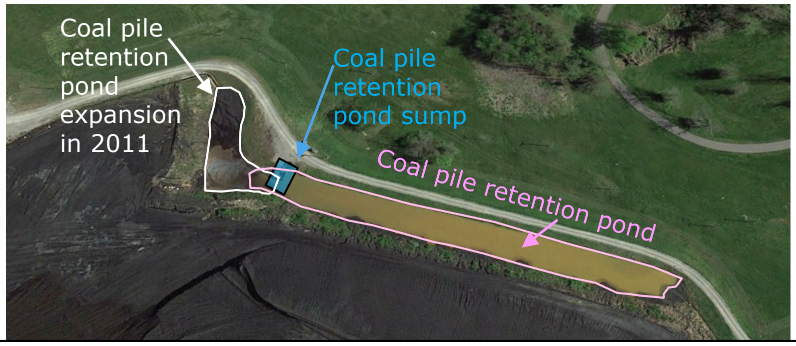
Design Section A-A, 2010



Design Section B-B, 2010



🟦 Coal pile retention pond sump



Notes:

- The coal pile retention pond (including the 2011 extension of the pond) covers approximately ¾ acres.
- The retention pond depth is approximately 5 to 6 feet at the deepest points.
- The retention pond is dredged once or twice per year. Dredged materials are disposed in the landfill or returned to the coal pile.
- The retention pond is lined with clay, depth unknown for the pond originally built and 2 foot minimum layer for the 2011 expansion area, as shown in the design plans.

This figure is an addendum to the Corrective Action Investigation, /source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

DATE: 10/29/2019

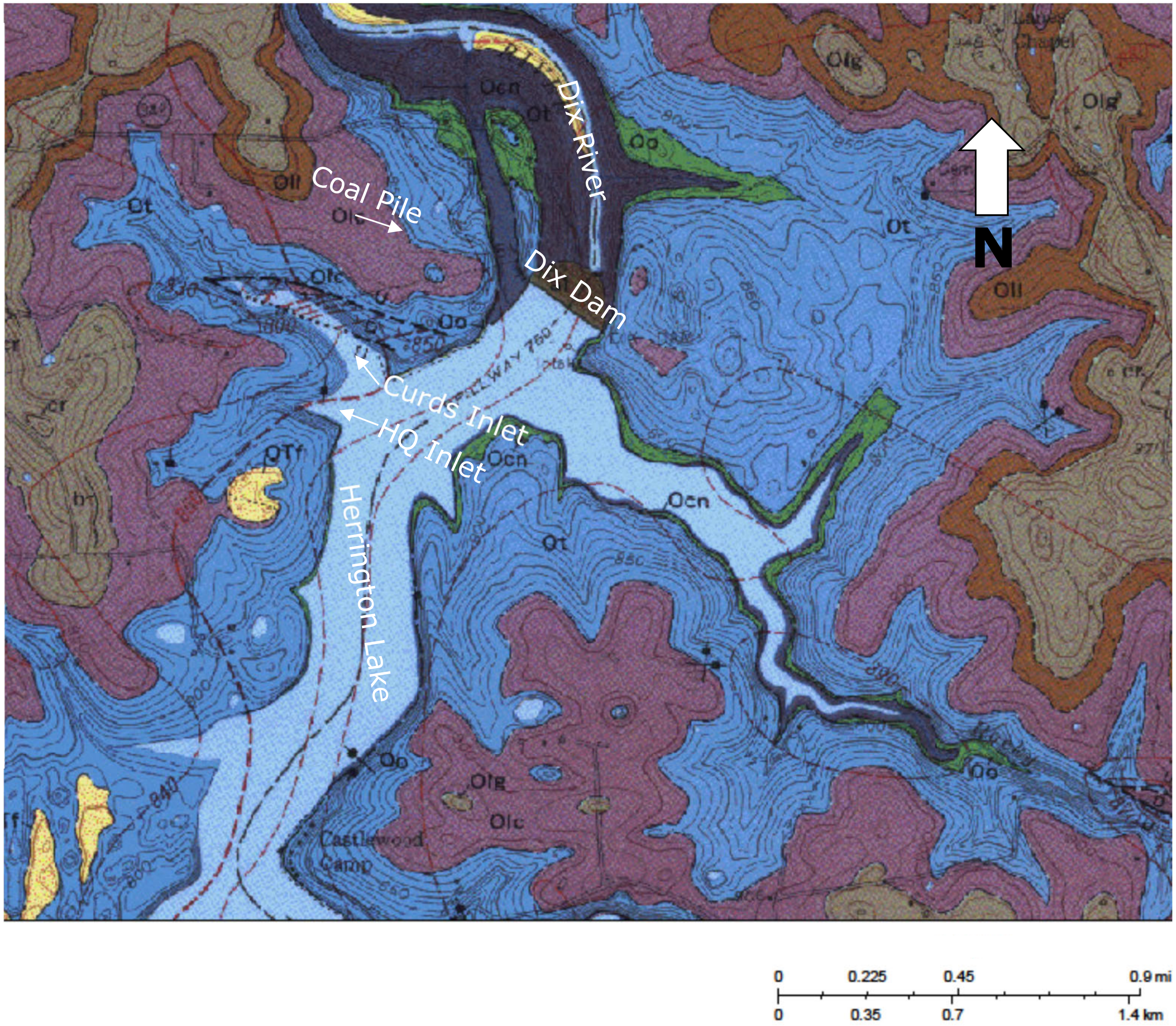
COAL PILE RETENTION POND EXPANSION DESIGN AND AS-BUILT DRAWINGS, 2010-2011

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

1-3C

Qal	**Alluvium** (Quaternary - Quaternary)
QTf	**High-level fluvial deposits** (Tertiary - Quaternary)
Ocf	**Clays Ferry Formation** (Middle Ordovician - Upper Ordovician)
Olu	**Upper part of Lexington Limestone** (Lower Ordovician - Middle Ordovician)
Olt1	**Tanglewood Limestone Member (1)** (Lower Ordovician - Middle Ordovician)
Ollr	**Lower part of Lexington Limestone** (Lower Ordovician - Middle Ordovician)
Oto	**Tyrone Limestone and Oregon Formation** (Lower Ordovician - Middle Ordovician)
Ocn	**Camp Nelson Limestone** (Lower Ordovician - Middle Ordovician)



Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
KyFromAbove
Kentucky Geological Survey

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

DRAFTED BY: CDB

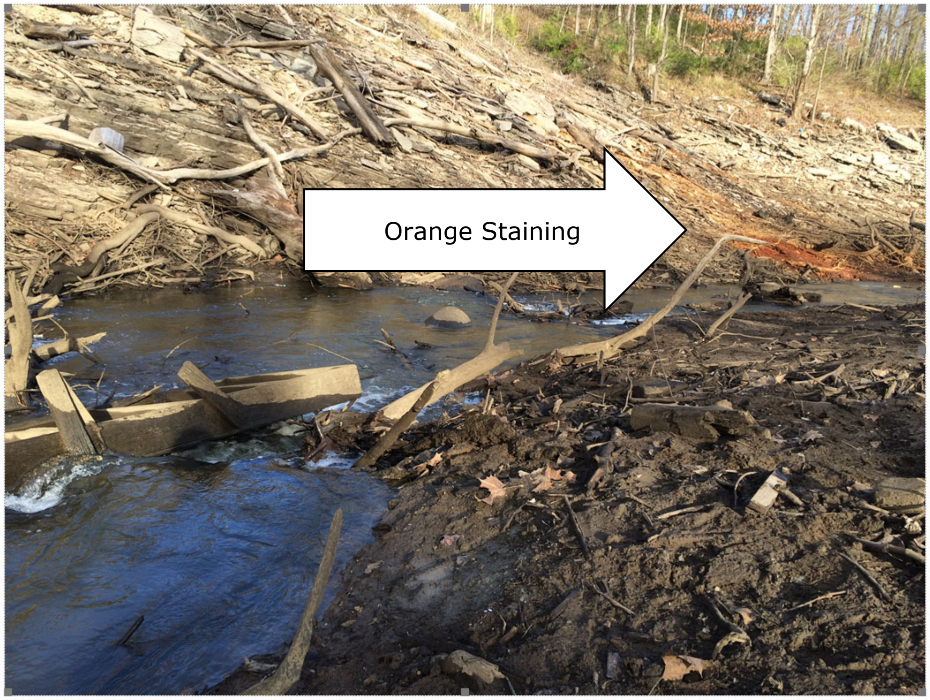
DATE: 10/29/2019

GEOLOGIC MAP FOR E.W. BROWN STATION

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

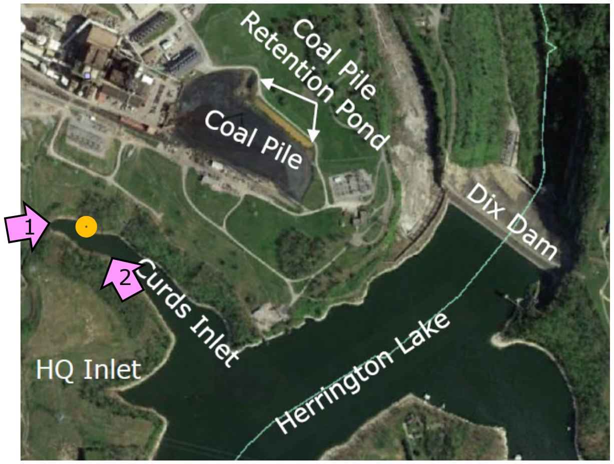
FIGURE

2-1



1. November 24, 2015, Lake elevation 721 feet, with photograph taken from the interior of Curds Inlet oriented toward the lake, with orange staining observed on the northern bank of Curds Inlet.

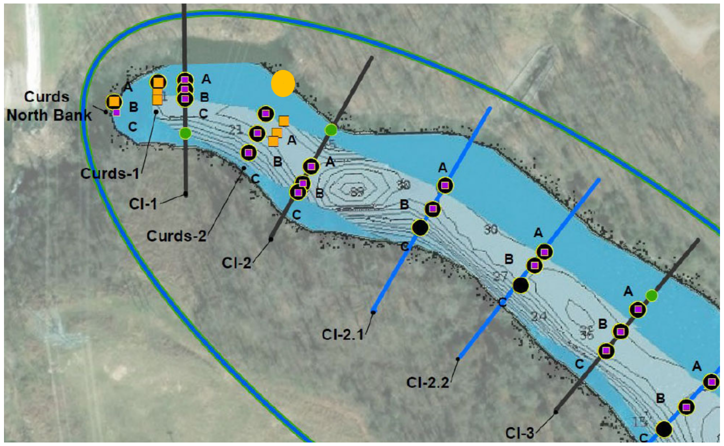
2. November 24, 2015, Lake elevation 721 feet, with photograph taken in Curds Inlet oriented toward the interior of Curds Inlet, with slight orange staining observed on the northern bank of Curds Inlet.



Excerpt from Figure 1-1 of this addendum

● Estimated area where orange staining was observed. Orange staining can indicate the presence of iron from oxidation at a point of groundwater discharge to the ambient environment.

➡ Arrow direction represents the approximate location where the November 24 photographs were taken



Excerpt from Figure 1-2E of this addendum

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

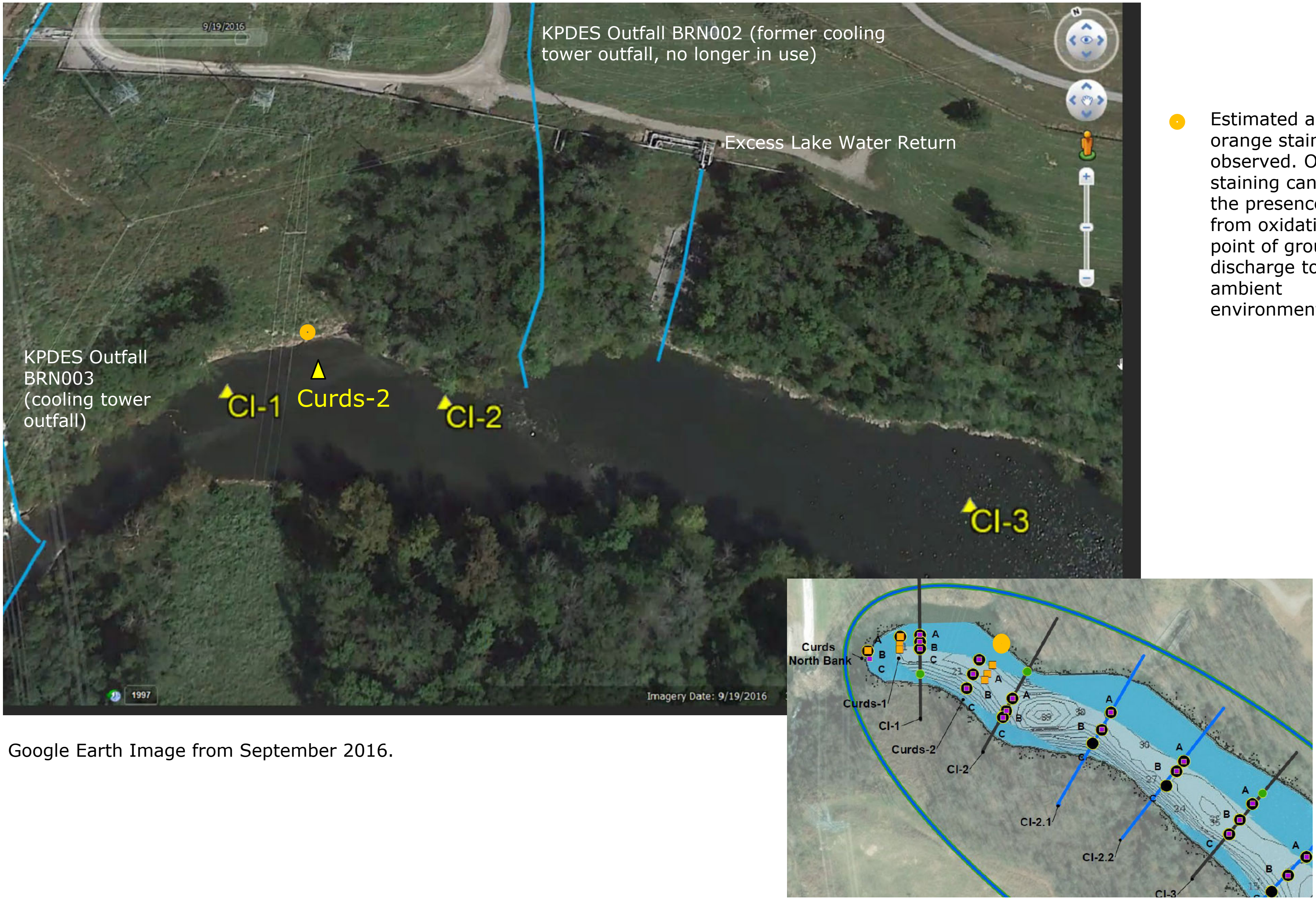
DATE: 10/29/2019

CURDS INLET SHORELINE NEAR THE COAL PILE WITH ORANGE STAINING (2015 LOW WATER IMAGES)

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

2-2A



● Estimated area where orange staining was observed. Orange staining can indicate the presence of iron from oxidation at a point of groundwater discharge to the ambient environment.

Google Earth Image from September 2016.

Excerpt from Figure 1-2E of this addendum

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

CURDS INLET SHORELINE NEAR THE COAL PILE WITH ORANGE STAINING (2016 IMAGERY)

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

2-2B

DRAFTED BY: CDB

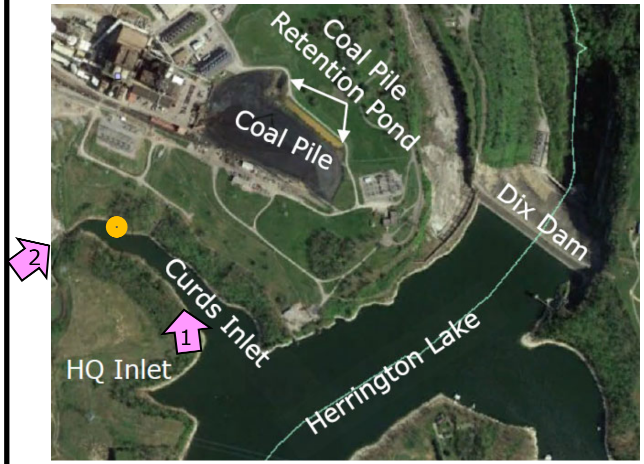
DATE: 10/29/2019

1. November 24, 2015, Lake elevation 721 feet, with photograph taken from the interior of Curds Inlet oriented toward the Plant, with orange staining observed on the northern bank of Curds Inlet.

● Estimated area where orange staining was observed. Orange staining can indicate the presence of iron from oxidation at a point of groundwater discharge to the ambient environment.

➡ Approximate location where November 24 photographs were taken

2. January 19, 2017, Lake elevation 729 feet with no visible evidence of springs or potential groundwater migration to Curds Inlet in an area of Curds Inlet near the coal pile.



Excerpt from Figure 1-1 of this addendum

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

DRAFTED BY: CDB

DATE: 10/29/2019

CURDS INLET SHORELINE NEAR THE COAL PILE WITH NO POTENTIAL GROUNDWATER PATHWAYS VISIBLE (2015 AND 2017 LOW WATER IMAGES)

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

2-2C

Notes:

1. These photos were taken of the west wall of the emergency spillway of Dix Dam (February 21, 2020).
2. The dashed lines show approximate geologic contacts between units.
3. The bentonite (green) layers are approximate, and are based on field observations and documented elevations.
4. The images were taken oriented toward the western wall of the emergency spillway (the power station can be seen at the top of the strata).
5. The location of the power station and the image collection location are provided in Figure 1-2A.
6. Source: Ivanowski 2020

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

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DRAFTED BY: CDB

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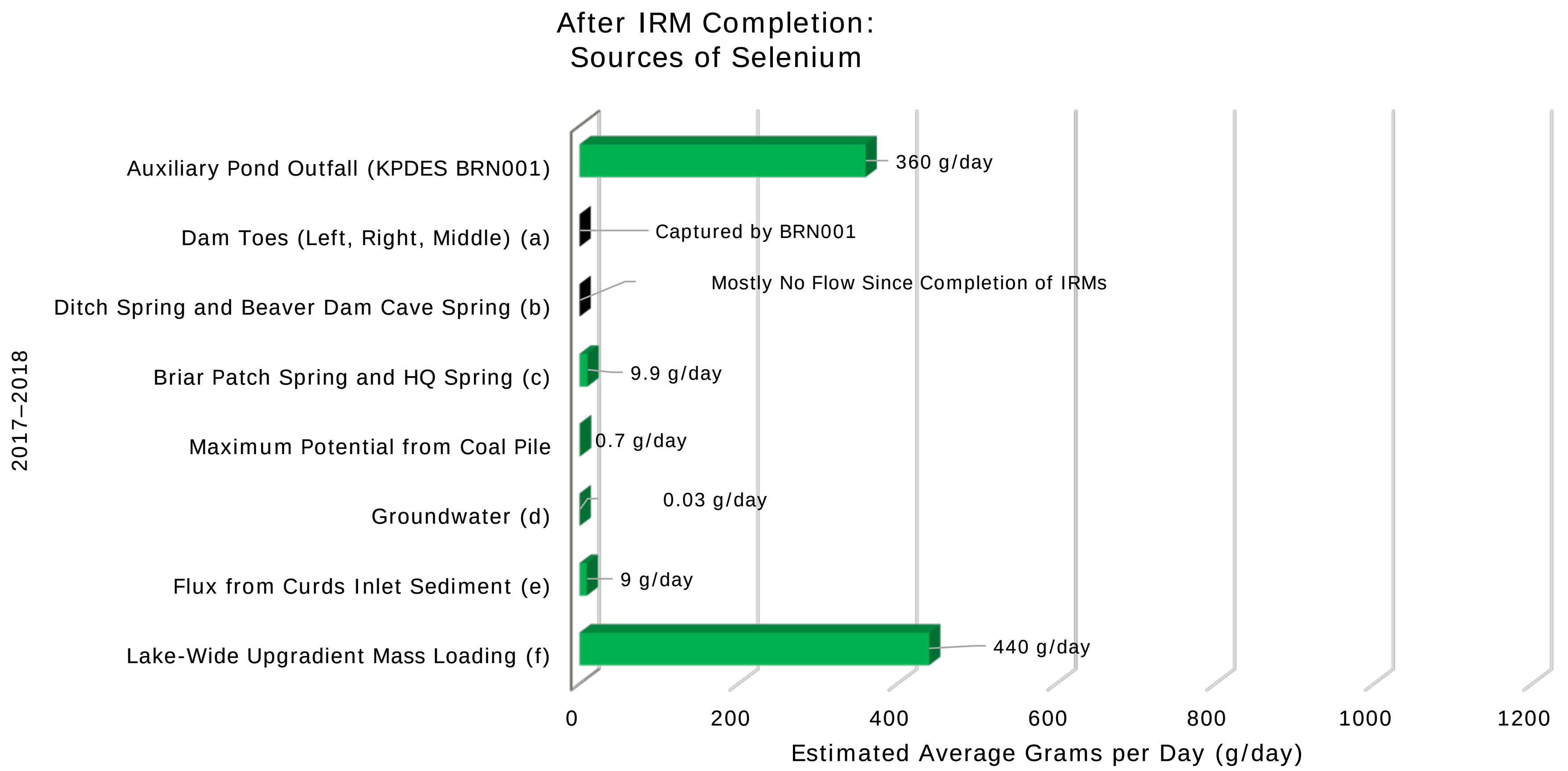
DIGITAL IMAGES OF EXPOSED ROCK STRATA IN THE WESTERN WALL OF THE EMERGENCY SPILLWAY

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

2-3



The Auxiliary Pond Outfall KPDES BRN001 is the primary outfall to Curds Inlet. The selenium mass loading ranged from 95–750 g/day, with a weighted average of 360 g/day.

a. Dam Toe Springs (Left, Right, and Middle) are now captured by the Toe Drain collection system; therefore, there is no longer direct flow from these springs to Curds Inlet.
b. There is minimal or no flow from Ditch Spring and Beaver Dam Cave Spring after completion of the IRMs.
c. Mass loading from Briar Patch Spring and HQ Spring post-IRMs yielded selenium estimates that ranged from 1.6–63.4 g/day, with a weighted average of 9.9 g/day.
d. Mass loading of selenium from groundwater wells closest to the lake range from 0.03-0.03 g/day, with a weighted average of 0.03 g/day (values are the same because selenium was not detected during 2017 or 2018, therefore the estimates reflect ½ the detection limit).
e. The mass loading estimates shown on this graphic are based on estimates using data from Phase I and Phase II investigations (2017 and 2018, after completion of the IRM). The selenium flux was estimated from 9–18 g/day, with a weighted average of 9 g/day.
f. The lake-wide upgradient mass loading shown on this graphic are based on estimates from Phase I and Phase II investigation data (2017 and 2018, after completion of the IRMs). The IRMs did not affect lake-wide upgradient conditions, therefore the same estimates are shown on both the pre-and post IRM figures. The selenium mass load estimates range 340–540 g/day, with a weighted average of 440 g/day.

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: AJS

DATE: 02/20/2020

Acronyms:
g – grams
IRM – Interim Remedial Measures
KPDES – Kentucky Pollution Discharge Elimination System

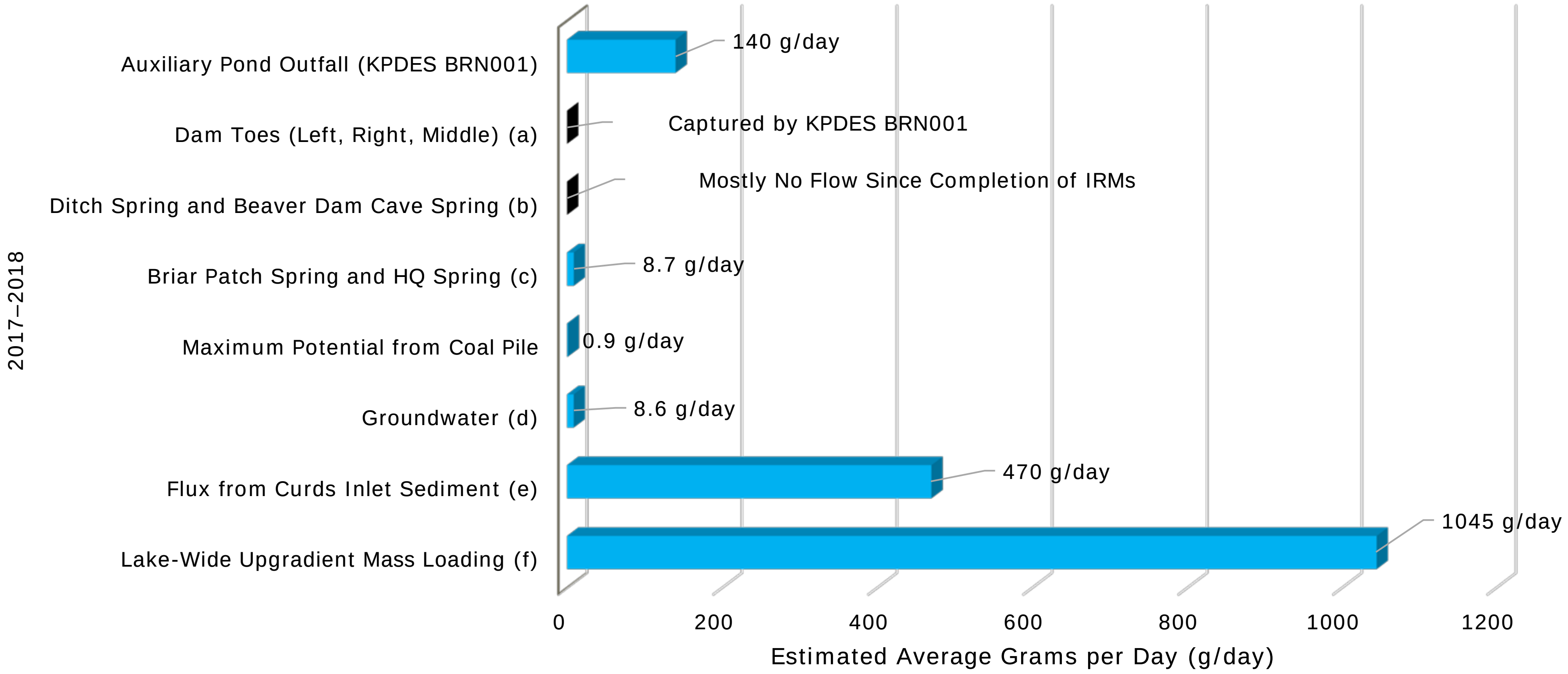
ESTIMATED SELENIUM MASS LOADING INTO HERRINGTON LAKE INCLUDING THE COAL PILE

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

3-1

After IRM Completion: Sources of Arsenic



The Auxiliary Pond Outfall KPDES BRN001 is the primary outfall to Curds Inlet. The arsenic mass loading ranged from 48-210 g/day, with a weighted average of 140 g/day.

a. Dam Toe Springs (Left, Right, and Middle) are now captured by the Toe Drain collection system; therefore, there is no longer direct flow from these springs to Curds Inlet.
b. There is minimal or no flow from Ditch Spring and Beaver Dam Cave Spring after completion of the IRMs.
c. Mass loading from Briar Patch Spring and HQ Spring post-IRMs yielded arsenic estimates that ranged from 1.2-36 g/day, with a weighted average of 4.1 g/day.
d. Mass loading of arsenic from groundwater wells closest to the lake range from 3.2-19.1 g/day, with a weighted average of 8.6 g/day.
e. The mass loading estimates shown on this graphic are based on estimates using Phase I and Phase II investigation data (2017 and 2018, after completion of the IRM). The arsenic flux was estimated from 180-760 g/day, with a weighted average of 470 g/day.
f. The lake-wide upgradient mass loading shown on this graphic are based on estimates from Phase I and Phase II investigation data (2017 and 2018, after completion of the IRMs). The arsenic mass load estimates range from 790-1,300 g/day, with weighted average of 1,045 g/day.

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: AJS

DATE: 02/20/2020

Acronyms:
g – grams
IRM – Interim Remedial Measures
KPDES – Kentucky Pollution Discharge Elimination System

ESTIMATED ARSENIC MASS LOADING INTO HERRINGTON LAKE INCLUDING THE COAL PILE

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

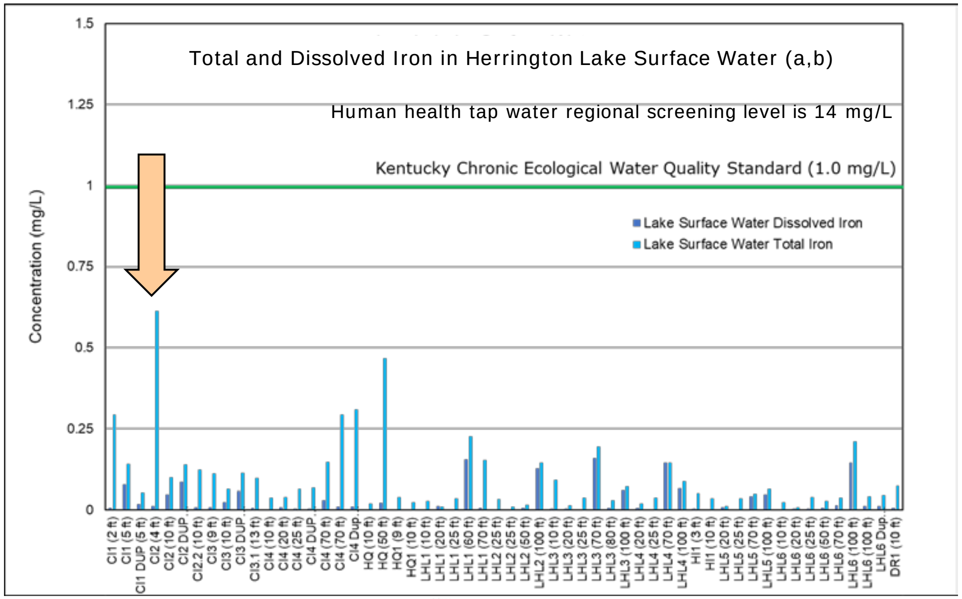
FIGURE

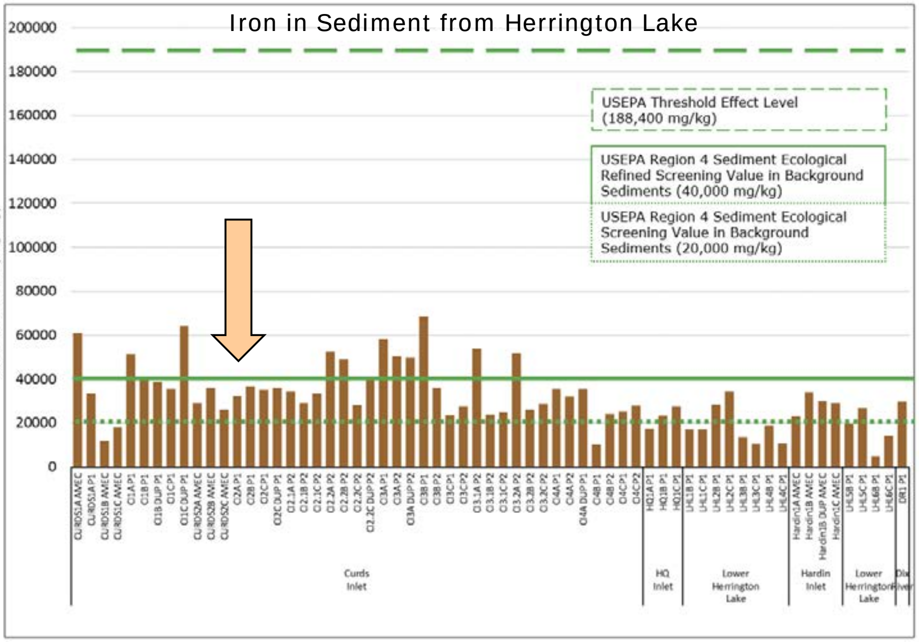
3-2

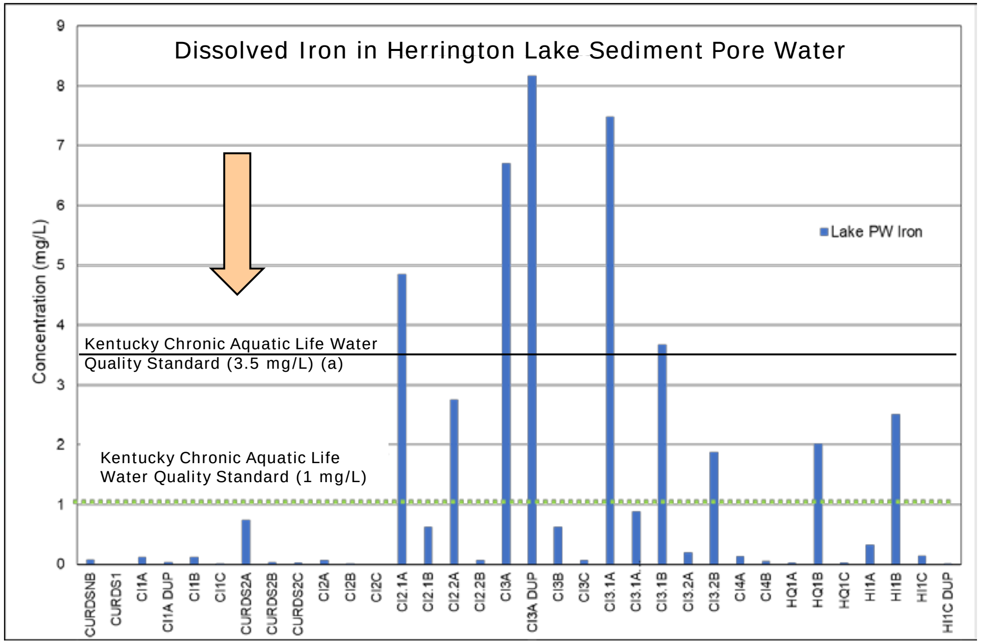
The arrow shows the area where orange staining is visible in the November 24, 2015 photographs provided on Figures 2-2A, 2-2B, and 2-2C.

For surface water: The orange staining was seen at a location between CI-1 and CI-2.

For sediment and sediment pore water, the nearest sampling location was Curds-2A.







Dissolved (D), Total (T), United States Environmental Protection Agency (USEPA), milligrams per liter (mg/L), milligrams per kilogram (mg/kg), Porewater (PW)

(a) Per 401 KAR 10:031. Surface water standards. Section 6. Pollutants. “The chronic criterion for iron shall not exceed three and five tenths (3.5) mg/L (thirty-five hundred µg/L) if aquatic life has not been shown to be adversely affected.”

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

RAMBOLL

DRAFTED BY: CDB

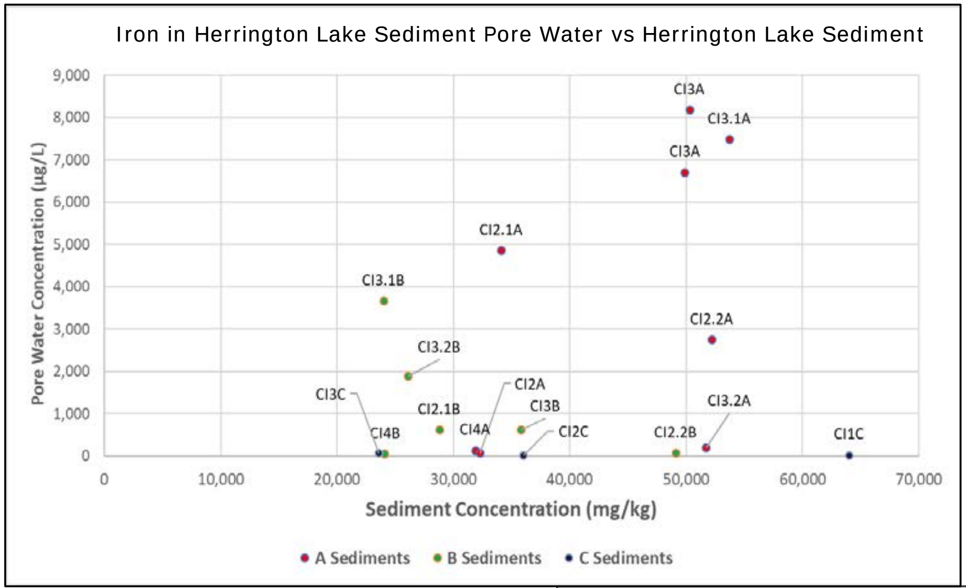
DATE: 10/29/2019

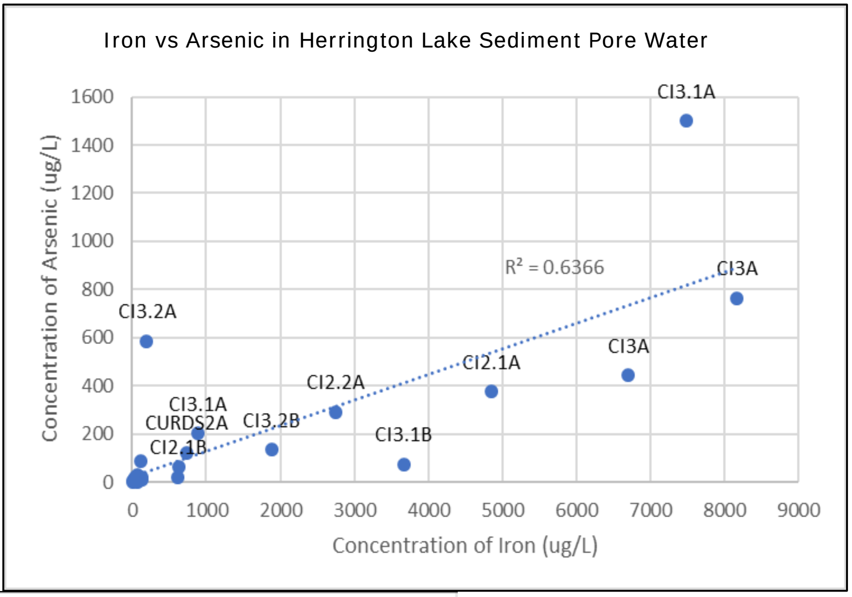
IRON IN THE COAL PILE RETENTION POND AND HERRINGTON LAKE SURFACE WATER, SEDIMENT PORE WATER, AND SEDIMENT

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

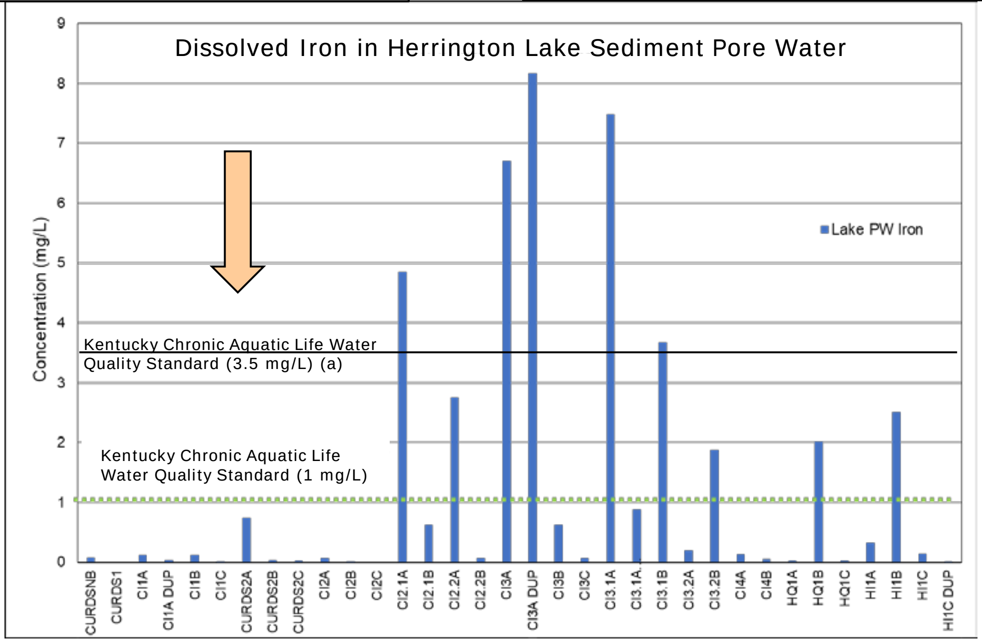
4-1A





⬇ The arrow shows the area where orange staining is visible in the November 24, 2015 images provided on Figures 2-2A, 2-2B, and 2-2C.

For sediment and sediment pore water, the nearest sampling location was Curds-2A.



Micrograms per liter (µg/L), milligrams per kilogram (mg/kg), Porewater (PW)

(a) Per 401 KAR 10:031. Surface water standards. Section 6. Pollutants. “The chronic criterion for iron shall not exceed three and five tenths (3.5) mg/L (thirty-five hundred µg/L) if aquatic life has not been shown to be adversely affected.”

This figure is an addendum to the Corrective Action Investigation, Source Assessment, Risk Assessment (ISARA) Report, Ramboll June 2019

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DRAFTED BY: CDB

DATE: 10/29/2019

IRON IN HERRINGTON LAKE SEDIMENTS VS SEDIMENT PORE WATER AND IRON IN SEDIMENT PORE WATER VS ARSENIC IN SEDIMENT PORE WATER

Coal Pile Addendum to the Corrective Action ISARA Report
E.W. Brown Station, Herrington Lake, Mercer County, Kentucky

FIGURE

4-1B