BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
	)	
STANDARDS FOR THE DISPOSAL OF	)	**R20-19**
COAL COMBUSTION RESIDUALS	)	**(Rulemaking – Land)**
IN SURFACE IMPOUNDMENTS:	)	
PROPOSED NEW 35 ILL. ADM. CODE 845	)	

NOTICE OF FILING

To: ALL PARTIES ON THE ATTACHED SERVICE LIST

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Pollution Control Board **Dynegy's Prefiled Testimony**, copies of which are herewith served upon you.

Respectfully submitted,

/s/ Ryan C. Granholm
Ryan C. Granholm

Dated: August 27, 2020

SCHIFF HARDIN LLP
Joshua R. More
Stephen J. Bonebrake
Ryan C. Granholm
233 South Wacker Drive,
Suite 7100
Chicago, Illinois 60606
(312) 258-5633
rgranholm@schiffhardin.com

Michael L. Raiff
GIBSON, DUNN & CRUTCHER LLP
2001 Ross Avenue, Suite 2100
Dallas, TX 75201-6912
(214) 698-3350
mraiff@gibsondunn.com

Attorneys for Dynegy

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
	)	
STANDARDS FOR THE DISPOSAL OF	)	**R20-19**
COAL COMBUSTION RESIDUALS	)	**(Rulemaking – Land)**
IN SURFACE IMPOUNDMENTS:	)	
PROPOSED NEW 35 ILL. ADM. CODE 845	)	

Dynegy's Prefiled Testimony

1. Prefiled Testimony of Cynthia Vodopivec, Vice President, Environmental Health and Safety, Dynegy Midwest Generation, LLC & IPH, LLC

2. Prefiled Testimony of Lisa Bradley, Ph.D., DABT, Principal Toxicologist, Haley & Aldrich, Inc.

3. Prefiled Testimony of Melinda Hahn, Ph.D, Senior Managing Consultant, Ramboll

4. Prefiled Testimony of David Hagen, Principal Consultant, Haley & Alrich, Inc.

5. Prefiled Testimony of Andrew Bittner, P.E., Principal, Gradient

6. Prefiled Testimony of Mark Rokoff, P.E., Senior Vice President, AECOM

7. Prefiled Testimony of Rudolph Bonaparte, Ph.D, P.E., NAE, Senior Principal, Geosyntec Consultants, Inc.

Respectfully submitted,

/s/ *Ryan C. Granholm*

Joshua R. More
Stephen J. Bonebrake
Ryan C. Granholm
Schiff Hardin LLP
233 South Wacker Drive
Suite 7100
Chicago, Illinois 60606
(312) 258-5500
rgranholm@schiffhardin.com

Michael L. Raiff
GIBSON, DUNN & CRUTCHER LLP
2001 Ross Avenue, Suite 2100
Dallas, TX 75201-6912
(214) 698-3350
mraiff@gibsondunn.com

Attorneys for Dynegy

Testimony 1:

Cynthia Vodopivec

Prefiled Testimony of Cynthia Vodopivec

I. Introduction.

My name is Cynthia Vodopivec and I am presenting testimony in this matter on behalf of Dynegy Midwest Generation, LLC; Electric Energy Inc.; Illinois Power Generating Company; Illinois Power Resources Generating, LLC; and Kincaid Generation, LLC (collectively, "Dynegy"). I am Vice President, Environmental Health and Safety at Dynegy Midwest Generation, LLC and IPH, LLC (the indirect corporate parent of Illinois Power Generating Company and Illinois Power Resources Generating, LLC). As part of my duties, I oversee permitting and regulatory development and compliance for air, water, and waste issues at Dynegy's Illinois generating stations.

Dynegy supports the broad outlines of the Illinois Environmental Protection Agency's ("IEPA" or the "Agency") proposed regulations for CCR surface impoundments, to be codified at 35 Ill. Adm. Code Part 845 ("Part 845"). Specifically, Dynegy supports that, like the U.S. Environmental Protection Agency's ("U.S. EPA") regulations concerning the Disposal of Coal Combustion Residuals From Electric Utilities ("CCR Rule"),[1] the Agency's Part 845 proposal allows for site-specific determinations for corrective action and closure of CCR surface impoundments. A site-specific approach—such as that provided under the CCR Rule at 40 C.F.R. § 257.96 and proposed by the Agency at Section 845.660 and 845.710—allows for both regulated entities and IEPA to take advantage of their substantial existing knowledge and prior study of CCR surface impoundments within the state to craft the closure and/or corrective action plan best suited for the unique characteristics of each site.

---

[1] Initially adopted at 80 Fed. Reg. 21,302 (Apr. 17, 2015), codified at 40 C.F.R. §§ 257.50 – 257.107 & App'x I – IV.

My testimony addresses the following topics: (1) a summary of Dynegy's operations in Illinois; (2) background on the factual and regulatory context to which Part 845 will apply; (3) the status of the West Ash Pond at Dynegy's Joppa Steam Generating Plant; and (4) the ways in which IEPA's proposed Part 845 exceeds the requirements of the federal CCR Rule, imposing costly or impracticable requirements, often without associated environmental benefits.

In addition to my testimony, Dynegy is also presenting testimony from a number of outside experts, which provide general and specific comments on IEPA's Part 845 proposal and suggest a number of revisions:

Lisa Bradley – Dr. Bradley is a toxicologist and risk assessor at Haley & Aldrich whose testimony covers topics including CCR's regulation as a non-hazardous, non-toxic waste; the conservative and overly-protective nature of both the federal CCR Rule and Part 845; and some ways in which IEPA's Part 845 proposal goes beyond the CCR Rule.

Melinda Hahn – Dr. Hahn is a consultant with Ramboll focusing on site investigation and remediation. Dr. Hahn's testimony focuses on the scope of the impacts associated with impoundments in Illinois and their lack of risk to potable water sources.

David Hagen – Mr. Hagen is a hydrogeologist at Haley & Aldrich, whose testimony covers topics including using groundwater modeling to show how different closure methods may be used to achieve the proposed groundwater protection standards; how closure-in-place can be as protective as closure by removal; and how caps and monitored natural attenuation have been successful at mitigating groundwater contamination from CCR surface impoundments in Illinois.

Andrew Bittner – Mr. Bittner is a professional engineer at Gradient, whose testimony covers topics supporting the Section 845.710 alternatives analysis and the relative protectiveness of closure-in-place vs. closure-by-removal.

Mark Rokoff – Mr. Rokoff is a professional engineer and National Practice Lead for Coal Ash Management at AECOM, whose testimony covers topics including the prevalence of closure-in-place for CCR surface impoundments across the country; a comparison of the closure alternatives analyses under the CCR Rule and Part 845; and the permit application timeline under Part 845.

Rudy Bonaparte – Dr. Bonaparte is a professional civil engineer and Professor of the Practice in the School of Civil and Environmental Engineering at the Georgia Institute of Technology, whose testimony covers topics including the appropriate minimum design requirements for closing-in-place using a final cover system and consolidating CCR units during closure.

Dynegy appreciates the Board's consideration of the expert testimony submitted on its behalf, as well as the testimony presented below.

II. Summary of Dynegy's Operations in Illinois.

Dynegy is an important part of Illinois' economy, particularly in Downstate Illinois, where it is a key component of the state's electrical and natural gas infrastructure, and a major employer and taxpayer. Dynegy owns a total of five operating coal-fired and three operating gas-fired generating plants in Illinois. Dynegy's retail electric and natural gas brands serve about 650,000 retail customers, in over 300 communities, throughout the state.

Currently, Dynegy directly employs approximately 650 people in Illinois, supports thousands of indirect jobs, and has an annual Illinois payroll of about $39 million. Dynegy pays approximately $23 million per year in state and local sales/use taxes and $17 million in local property taxes. Dynegy's annual economic impact to the State of Illinois is over $2 billion in direct and indirect benefits, reaching about 80 of Illinois' 102 counties.

Dynegy looks forward to continued operations serving the citizens and business of Illinois. As a part of that future, Dynegy is advocating for a continued transition towards a lower carbon electricity market in Illinois. Dynegy is supporting the Coal to Solar and Energy Storage Act (HB 5663/SB 3848) ("Coal to Solar Act"), which aims to develop 300 MW of utility scale solar projects and 150 MW of new energy storage facilities at existing power generating assets in Illinois.[2] If fully implemented, the Coal to Solar Act could more than double both the state's solar generating and energy storage capacity.[3]

---

[2] https://renewillinoispower.com/fact-sheet/.

[3] Solar Energies Industry Association, "Illinois Solar", https://www.seia.org/state-solar-policy/illinois-solar (last accessed August 27, 2020) (describing Illinois' installed solar capacity

III. History of Dynegy's CCR Management in Illinois.

To assist the Board in its review of IEPA's Part 845 proposal, I will first provide a summary of the factual and regulatory context in which Part 845 will apply.

a. Dynegy's CCR Handling in Illinois

Dynegy owns 30 CCR surface impoundments potentially subject to Part 845 (as identified on Table 1, IEPA's Pre-Filed Answers at 181 (Aug. 3, 2020) ("IEPA's Table 1")). The majority of Dynegy's CCR surface impoundments are no longer receiving CCR.

All of Dynegy's operating coal-fired generating plants in Illinois manage both fly and bottom ash for beneficial reuse. CCR generated at Dynegy's facilities can and has been used in a variety of applications and products, including industrial abrasives, cement, and roofing shingles. While beneficial use of newly-generated CCR continues, there is currently no viable market for ponded CCR from Dynegy's historical operations. Market demand for CCR is dependent on its chemical characteristics. Even where CCR is of suitable chemistry for beneficial use, the market for reuse of ponded CCR is limited by the costs of excavating, dewatering, loading, and transporting CCR to industrial consumers.

b. Approved Closures of CCR Surface Impoundments

Dynegy has already closed or received approval to close eleven of the purported CCR surface impoundments identified on IEPA's Table 1, at five different plants in Illinois, well ahead of the schedules required by either Part 845 or the CCR Rule:

---

as of Q1 2020 at 275.77 MW); https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_02_a (last accessed Aug. 27, 2020) (describing Illinois' energy storage capacity as of June 2020 as 132.7 MW).

Baldwin Fly Ash Pond[4]

- Closure Approved — August 16, 2016
- Estimated Completion Date — September 2020

Coffeen Ash Pond 2

- Closure Approved — January 30, 2018
- Estimated Completion Date — September 2020

Duck Creek Ash Pond 1

- Closure Approved — November 23, 2016
- Estimated Completion Date — October 2020

Duck Creek Ash Pond 2

- Closure Approved — November 23, 2016
- Estimated Completion Date — October 2020

Havana South Ash Pond

- Closure Approved — June 27, 1996
- Post-Closure Care Completed — May 22, 2009

Hennepin East Ash Pond, Units 2 & 4

- Closure Approved — March 5, 2020
- Estimated Completion Date — September 2020

Hennepin West Ash Pond, Units 1 & 3

- Closure Approved — June 19, 2018
- Closure Completed — August 2020

Joppa West Ash Pond

- Closure Completed — 1970s

[4] As identified on IEPA's Table 1, the Baldwin Fly Ash Pond consists of the Old East Fly Ash Pond, the East Fly Ash Pond, and the West Fly Ash Pond.

For the five closure applications that have been approved in recent years, the approval process has involved extensive dialog with the Agency, including pre-application discussions, meetings, comments from IEPA, and responses to those comments. For those closures, the average time from application submission to final approval was over ten months.

c. CCR Rule Compliance

As noted by Dynegy's experts, particularly Dr. Lisa Bradley and Mark Rokoff, Dynegy's CCR surface impoundments are already subject to a comprehensive regulatory scheme—the federal CCR Rule. Since 2015, Dynegy has developed an extensive monitoring, assessment, and planning program to comply with that rule. This program involves a number of elements to ensure the safe operation and closure of CCR surface impoundments, including (but not limited to) the following:

- First, the CCR Rule required Dynegy to complete assessments of the locations, structural stability, safety factor, and hazard potential of each unit. Assessments of the structural stability, safety factor, and hazard potential must be conducted periodically. CCR surface impoundments must also be inspected weekly.
- Second, the CCR Rule required Dynegy to develop and install a groundwater monitoring network at each of its operating coal-fired facilities in Illinois, through which it now generates semi-annual (at least) groundwater monitoring reports.
- Third, if triggered by groundwater monitoring data, the CCR Rule will require corrective action plans to be developed and implemented.
- Finally, Dynegy has developed draft closure plans for each of the units subject to the CCR Rule.

Dynegy recommends that Part 845 account for the factual and regulatory context—described above—upon which the proposed new rules will be imposed. Specifically, the Board should recognize that many CCR surface impoundments in Illinois are already in the process of, or have already achieved, IEPA-approved closure. Further, under the CCR Rule, all CCR surface impoundments in Illinois are already subject to requirements for groundwater monitoring, assessment of corrective measures, and closure. As explained further in Part V of my testimony and in the testimony provided by Dynegy's experts, Dynegy urges the Board to adhere as closely as possible to the CCR Rule, to avoid creating unnecessary or impracticable requirements and ensure that Part 845 is not only protective of human health and the environment, but also technically feasible and economically reasonable.

IV. The Joppa West Ash Pond is Not a "CCR Surface Impoundment."

Before turning to the specific requirements of IEPA's Part 845 proposal, I will provide one comment regarding the scope of the proposed rule. As explained in greater detail below, in P.A. 101-0171, the Illinois Legislature adopted the exact same definition of "CCR surface impoundment" as used in the federal CCR Rule, clearly intending the scope of the Illinois CCR program to be identical to that of the federal rule. However, applying this definition, IEPA has identified the West Ash Pond at Dynegy's Joppa Steam Generating Plant as being subject to Part 845, despite that unit not being subject to the CCR Rule. IEPA's interpretation is contrary to the statutory language and should be rejected.

As amended by P.A. 101-0171, the Illinois Environmental Protection Act ("Act"), uses the exact same definition of "CCR surface impoundment" as is found in the CCR Rule: "a natural topographic depression, man-made excavation, or diked area, which *is designed to hold an accumulation of CCR and liquids*, and the unit treats, stores, or disposes of CCR." 415 ILCS 5/3.143 (emphasis added); 40 C.F.R. § 257.53 (emphasis added). Crucially, the Illinois

Legislature, like the U.S. EPA, chose to use present tense language—a regulated unit is one that "*is* designed to hold an accumulation of CCR and liquids. . . ." (emphasis added). Therefore, units that were not designed to hold CCR and liquids at the time the definitions were adopted are not regulated.

U.S. EPA explained in the preamble to the CCR Rule that while it chose to regulate "inactive" surface impoundments (those that contain *both* CCR *and* water, but no longer receive CCR), it chose not to regulate "closed" surface impoundments because they are "capped or otherwise maintained" and *no longer contain water*, although they may continue to contain CCR. 80 Fed. Reg. at 21,343. In other words, it chose not to regulate units that were no longer designed to hold an accumulation of liquids. The CCR Rule, U.S. EPA explained, was designed to address units that pose the highest level of risk: "units that contain a large amount of CCR managed with water, under a hydraulic head that promotes the rapid leaching of contaminants." *Id.* at 21,357. Accordingly, U.S. EPA decided not to "impose any requirements on any CCR surface impoundments that have in fact 'closed' before the rule's effective date [October 19, 2015]—i.e., those that no longer contain water and can no longer impound liquid." *Id.* at 21,343. The concept of hydraulic head as the greatest source of risk of contaminant leaching is discussed further in the pre-filed testimony of Dynegy's experts Dr. Lisa Bradley and David Hagen.

Dynegy encourages the Board to adhere to the plain language of the Act, which, in light of the explanation provided in the CCR Rule, establishes that units that were "capped or otherwise maintained" as of the effective date of P.A. 101-0171—*i.e.* those that did not contain water and could no longer impound liquid prior to June 30, 2019—are not subject to Part 845. One such unit—the only unit of this type owned by Dynegy in Illinois—is the West Ash Pond at Dynegy's Joppa Steam Generating Plant, which IEPA has identified as a CCR surface impoundment. This unit has not received new CCR since the 1970s. Dynegy's records show that the unit was closed in the 1970s, at which time it was graded to direct precipitation off of the unit into drainage ditches. Over the decades, this 100 acre unit has accumulated soil and become heavily vegetated. Below are photos of the West Ash Pond as of June 2020, showing the thick vegetation, including large trees with trunk diameters of more than 18 inches.

<u>Photo 1</u>:

Photo 2:

Due to the grading, soil accumulation, and vegetation, the Joppa West Ash Pond was not designed to impound liquids as of the effective date of the CCR Rule (October. 19, 2015), nor was it as of the date that P.A.101-0171 was adopted (July 30, 2019). Therefore, Part 845, like the CCR Rule, does not apply. Because the unit's design was modified so that it is no longer impounding liquids, it is best characterized as "capped or otherwise maintained" as of October 19, 2015—a type of unit that U.S. EPA has acknowledged poses a low risk of leaching contaminants to the environment.

It is unnecessary to regulate the Joppa West Ash Pond under Part 845, particularly because doing so could mean clearing nearly 100 acres of trees and heavy vegetation in order to re-close the unit. Construction could last five years or more, potentially consuming large amounts of diesel fuel for dump trucks and other construction equipment both on and off site. Re-closure would therefore result in no environment benefit, could create adverse environmental effects, and would cost millions of dollars. Other existing regulatory programs, such as the Act's general prohibition against water pollution and the groundwater quality standards provided by 35 Ill. Adm. Code Part 620 are adequate to guard against any residual risks posed by closed units like Joppa West.

V. **IEPA's Part 845 Proposal Significantly Exceeds the Requirements of the CCR Rule, Imposing Unnecessary Costs on Owners and Operators.**

As noted in IEPA's Statement of Reasons, in accordance with Public Act 101-0171, one of the Agency's purposes in proposing Part 845 was to "adopt the federal CCR rules in Illinois and obtain federal approval of Illinois' CCR surface impoundment program." R20-19, IEPA's Statement of Reasons at 10 (Mar. 30, 2020). In order to gain federal approval, Part 845 must be "at least as stringent" as the federal rules. *Id.* at 6 (citing the Water Infrastructure Improvements for the Nation Act, P.L. No 114-322, 42 U.S.C. § 6945(d)(1)(B)).

Dynegy supports IEPA's goal of obtaining federal approval for Part 845 under the WIIN Act. But, as outlined below (and in the testimony of Dynegy's expert witnesses), rather than merely "adopt[ing] the federal rules in Illinois" IEPA's proposal adds myriad new requirements, making Part 845 *substantially* and *unnecessarily* more restrictive than the CCR Rule. In fact, Attachment A to my testimony identifies at least 29 ways in which the requirements of Part 845 exceed those of the CCR Rule, a number of which are outlined further below. These additional requirements could carry significant costs for owners and operators of CCR surface impoundments. The Board should therefore accept the more restrictive requirements that IEPA has proposed *only* where clear evidence has been presented that such requirements will lead to meaningful environmental benefits. With this framework in mind, Dynegy recommends a number of revisions designed to reduce unnecessary costs and the compliance burden associated with IEPA's proposal, without compromising its protectiveness.

a. Permitting

First, in addition to the numerous ways in which the substantive requirements of Part 845 are more stringent and more costly than the requirements of the CCR Rule—discussed below, Part 845 contains a number of administrative challenges that will raise costs for owners/ operators, with no associated environmental benefit.

One example is Section 845.220(c)(2)(E)&(d)(3)(E), which require owners/operators to "provide the Agency any necessary licenses and software needed to review and access both the model and the data contained within the model." Rather than just raising costs, this requirement is one that owners/operators may simply not be able to comply with. Dynegy often relies on third-party proprietary software, to which it lacks the ability to grant access. For example, Dynegy uses software developed by the Electric Power Research Institute (EPRI). Dynegy's consultants often rely on their own proprietary software. In both of these cases, Dynegy lacks the ability to grant or even purchase licenses on the Agency's behalf. IEPA has not requested such software licenses in the past when assessing closure of CCR surface impoundments, so, presumably, access to this software is not required to analyze and approve a closure plan. In lieu of this requirement, the Board should authorize the IEPA to specify that raw data be provided by owners/operators in such a format as to be compatible with the Agency's existing internal databases and software.

Another example of unnecessary administrative burden in IEPA's proposal is Sections 845.220(f)(2) and 845.230(e), which require renewal of construction permits for closure and operating permits every five years. Dynegy expects that corrective action, closure, and post-closure care under Part 845 will typically take more than five years to complete. The anticipated timeline for each activity will be presented for the Agency's review and comment in the relevant permit application, prior to approval. It would be inefficient to require renewal permits where the permitted activity has exceeded five years, but where that activity is otherwise proceeding in accordance with an approved permit. Dynegy therefore recommends that the Board eliminate the five-year limitation in proposed Sections 845.220(f)(2) and 845.230(e).

Finally, Dynegy recommends revisions to Section 845.700(h), which provides the schedule for closure applications, in order to ensure that Dynegy and the Agency each have sufficient time to complete and review closure applications. As currently drafted, the application schedule is unworkable for both Dynegy and the Agency, particularly in combination with public meeting requirements. Dynegy expects to submit applications for up to 7 – 10 units on the first deadline – January 1, 2022. Dynegy then expects to submit applications for 5 – 10 units on the second deadline – July 1, 2022. In addition to the issues identified by Dynegy's experts David Hagen and Mark Rokoff, there are several problems with this schedule:

(i) Dynegy anticipates that the Agency will have difficulty fully processing all of Dynegy's applications, not to mention those of other owner/operators, in the six months between the first and second submittal deadline.

(ii) After the first deadline, Dynegy will have just six months to finalize the applications for the second deadline—including incorporating any general guidance that it receives from the Agency following the first round of submittals.

(iii) During the five months following the first submittal deadline, Dynegy will also be required to hold between 10 and 20 public meetings, pursuant to proposed Section 845.240(a), which requires public meetings to be completed at least 30 days before the application deadline.

(iv) During that period, the pending application deadlines and public meeting requirements will reduce the availability of Dynegy's staff to meet with or otherwise respond to any questions or comments from the Agency regarding the first set of closure applications. The hurried deadline for the second set of applications could therefore result in a delay of the finalization of the first set of applications.

To ease some of the challenges presented by the current schedule, Dynegy recommends that the Board adopt the following revised application schedule:

- Category 1, 2, 3 – January 1, 2022 (unchanged)
- Category 4 – March 30, 2022 (delayed 3 months)
- Category 5 – September 30, 2022 (delayed 3 months)
- Category 6, 7 – July 1, 2023 (unchanged)

Such a schedule would extend the deadlines for the two categories of CCR surface impoundments that Dynegy expects will contain the most units—Categories 4 & 5—such that 12 months will be allowed for the preparation of applications for Category 4 units and 18 months will be allowed for preparation of applications for Category 5 units. But this revised schedule would not require lengthening the overall application process, because owners/operators and the Agency would still have nine months before the final application deadline on July 1, 2023.

b. Monitoring

Second, as discussed in the testimonies of Dynegy's expert witnesses Dr. Lisa Bradley, Andrew Bittner, and David Hagen, the groundwater monitoring requirements in IEPA's Part 845 proposal are substantially more stringent than those in the CCR Rule. For example, under the CCR Rule, groundwater quality and elevation monitoring are required only semi-annually. 40 C.F.R. §§ 257.93(c) & 257.94(b). The Part 845 proposal, however, requires quarterly groundwater monitoring and monthly measurements of groundwater elevations. Section 845.650(b)(1)&(2).

Additionally, under IEPA's proposal, monitoring is required for more constituents during each sampling event. The CCR Rule requires detection monitoring for only seven constituents, with more constituents added only after a statistically significant increase over background is detected. 40 C.F.R. §§ 257.94(a) & 257.95(b). In contrast, Part 845 requires monitoring for twenty constituents. Section 845.600(a).

Another way in which monitoring under Part 845 is more onerous than under the CCR Rule is Section 845.780(c)(1), which requires quarterly chemical monitoring and monthly elevation monitoring (both of which, as noted above, exceed the requirements of the CCR Rule) to continue for 30 years. This is inconsistent with the Board's site-specific rule for CCR ponds at the Ameren Hutsonville facility and previous IEPA approved closure plans. *See, e.g.*, 35 Ill. Adm. Code 840.114(b)&(c) (allowing reduction in monitoring where, inter alia, sufficient data has been collected and monitoring shows no statistically significant increasing trends in monitored constituents). Although Dynegy is not requesting that the Board reduce the mandatory 30-year post closure care period, Dynegy recommends that Section 845.780(c) at least be revised to allow for a reduction in monitoring frequency during the post closure care period—to semi-annual, as allowed under the CCR Rule.

Altogether, Dynegy estimates the additional monitoring requirements in IEPA's Part 845 proposal will cost an additional $150,000 to $200,000 per unit, per year. Dynegy therefore recommends that the requirements be revised to track the CCR Rule. At a minimum, Dynegy requests that Section 845.650(b)(2) be revised to require groundwater elevations to be measured on the same schedule as groundwater quality sampling—quarterly—and that the sampling frequency in Section 845.780(c) allow for adjustments over the post-closure care period consistent with 35 Ill. Adm. Code 840.114(b)&(c), previously approved closure plans, and the CCR Rule.

Dynegy also recommends revisions to Section 845.210(d)(1), which allows IEPA to approve the use of existing hydrological investigation or characterization, groundwater monitoring wells, and groundwater monitoring plans. The language does not, however, explicitly authorize the use of existing groundwater monitoring *data*. As noted above, several years of data has already been gathered for all of Dynegy's units that are subject to the CCR Rule. There is no basis to disallow the use of this existing data, particularly because allowing its use would save owners/operators the burden and expense of acquiring new data to fulfill the requirements of Part 845.

Further, Dynegy recommends changes to Section 845.650(b)(1)(A), which requires all units—including units that have not previously been regulated by the CCR Rule—to gather eight independent samples in just 180 days following the rule's effective date. This data will be used to establish baseline and background conditions for each unit. By comparison, the CCR Rule allowed for two years to initially gather such data. 40 C.F.R. § 257.94(b). For CCR units that do not have existing groundwater data, because they are not currently regulated by the CCR Rule, (for example, those at Dynegy's Vermilion Power Station) this time period is not sufficient to gather a representative sample of groundwater conditions. Instead, at least eighteen to twenty-four months should be allowed to gather monitoring data at existing, but newly-regulated units, so that this initial data set will reflect normal seasonal variations in groundwater levels and flow patterns.

c. Corrective Action

Third, as discussed in Dr. Lisa Bradley's and David Hagen's testimonies, proposed Part 845 is significantly more stringent than the CCR Rule because corrective action under proposed Part 845 can be triggered on just a single exceedance (after confirmation) of a groundwater protection standard.

The CCR Rule employs a two-step process to monitor groundwater: detection monitoring and assessment monitoring. Under the CCR rule, first, a SSI in a monitored constituent triggers assessment monitoring, after which, in "Step 2," a SSL must be observed before corrective action is triggered. 40 C.F.R. §§ 257.94-96. In contrast, Part 845 outlines a one-step groundwater monitoring process, whereby corrective action may be triggered on the first confirmed exceedance of a groundwater protection standard. Section 845.660(a)(1). As outlined in the testimony of David Hagen, because Part 845 departs from the CCR Rule's two-step process—specifically the use of statistical methods to identify exceedances—there is a high probability that IEPA's proposed groundwater monitoring provisions could trigger corrective action based on erroneous or insufficient sampling. Dynegy anticipates these additional, unwarranted, corrective measures could cost between $2 million and $20 million for each site. To ensure corrective action is triggered only where scientifically justified, Dynegy recommends, as outlined in the testimonies of Dr. Lisa Bradley and David Hagen, that corrective action be triggered only when there is a statistically significant level above a groundwater protection standard.

d. Alternatives Analysis

Fourth, as explained in Mark Rokoff and Andrew Bittner's expert testimony, proposed Part 845 is more stringent than the requirements in the CCR Rule with respect to evaluating closure options. Unlike the CCR Rule, which allows an owner/operator to select a closure method based on any criteria it choses, IEPA's Part 845 sets forth the criteria that must be used for considering and evaluating closure options. While many of the criteria are consistent with how Dynegy has historically evaluated closure options, the prescriptive nature of Section 845.710 takes away some of the flexibility afforded under the CCR Rule to select a closure methodology best suited to each site. Each closure alternative analysis performed under Section 845.710 is expected to cost between $500,000 and $1 million.

e. Closure

Fifth, as explained in Dr. Rudy Bonaparte's testimony, the requirements for final covers for CCR surface impoundments under proposed Part 845 are substantially more stringent than under the CCR Rule. Under both rules, final covers consist of two layers—a low-permeability layer and a protective layer. The CCR Rule requires earthen low permeability layers to be at least 18 inches thick, with a protective layer of at least six inches. 40 C.F.R. § 257.102(d)(3). Part 845, in contrast, requires earthen low permeability layers to be twice as thick—36 inches—and protective layers to be six times as thick—36 inches. Section 845.750(c)(1)(A) & (c)(2)(B). In addition to thickness, IEPA's Part 845 proposal also requires final covers for CCR surface impoundments to be two orders of magnitude less permeable than those allowed under the CCR Rule. *Compare* Section 845.750(c)(1) (requiring final cover system with permeability no greater than 1 x 10^{-7} cm/sec) *with* 40 C.F.R. § 257.102(d)(3)(i)(A) (requiring final cover system with permeability no greater than 1 x 10^{-5} cm/sec). Because the majority of its sites lack sufficient native borrow material, Dynegy anticipates that a requirement to use 18-inches of additional earthen material in the cover system could cost up to $50 – $100 million, with no associated environmental benefit.

Dynegy therefore recommends—as explained in the testimony of Dr. Rudy Bonaparte—that the Board reduce the required thickness of the earthen low permeability layer and of the protective layer for units that close using a geomembrane. IEPA has previously approved closures with similar cap requirements.[5] For example, on January 30, 2018 IEPA approved a closure plan for Ash Pond 2 at the Coffeen Power Station that called for "40-mil LLDPE

[5] First Supplement to IEPA's Prefiled Answers, Response to Dynegy Prefiled Question 81, at p. 54 (Aug. 5, 2020).

geomembrane, a geocomposite drainage layer, and a minimum 18-inch protective cover soil layer." The Agency also approved a similar Closure Plan for the West Ash Pond System at the Hennepin Power Station. As discussed in the testimony of David Hagan, and consistent with prior Agency approvals, Dr. Bonaparte's proposed revisions to the final cover system requirements are protective of human health and the environment.

f. Post-Closure & Financial Assurance

Finally, proposed Part 845 is more stringent than the requirements in the CCR Rule with respect to post-closure care. One example of this is Part 845's requirement that financial assurance be provided for corrective action and/or closure of CCR surface impoundments in Illinois. The federal rule has no such requirements. Dynegy expects to incur 1-2% a year in carrying costs associated with these financial assurance requirements. Across Dynegy's fleet, Part 845 could require hundreds of millions of dollars of financial assurance, meaning that annual carrying costs will likely be millions of dollars.

VI. CONCLUSION

As summarized in my testimony, revising IEPA's Part 845 proposal to adhere more closely to the federal CCR Rule will help create a rule that is technically feasible and economically reasonable, while also ensuring the protection of human health and the environment. Exceeding the requirements of the CCR Rule, without clear scientific justification, is not in the interests of the State of Illinois, particularly the communities surrounding CCR surface impoundments. Unnecessary costs of compliance and burdens of closure could serve to discourage the transfer and redevelopment of closed generating stations, depriving the state and its residents of tax revenue and new jobs. It is imperative, therefore, that additional requirements be enacted only where a demonstration has been made that the requirements are necessary to protect human health and the environment.

Dynegy has a history of working with the Agency to successfully close CCR surface impoundments in Illinois, and it looks forward to continuing that success under the Part 845 rules, once finalized. Dynegy appreciates the Board's efforts to solicit a complete record in this proceeding and looks forward to answering any questions that the Board and the other rulemaking participants may have.

Attachment A:

Ways in which Part 845 is More Stringent than the CCR Rule

	Part 845	**CCR Rule**	**Explanation**	**Dynegy Testimony**
1.	Owners/operators are required to purchase software access for the Agency. (845.220(c)(2)(E) & (d)(3)(E))	No analogous requirement.		C. Vodopivec at 12.
2.	Where a public meeting is required, two public meetings must be held. (845.240(a))	Where a public meeting is required, only one public meeting must be held. (257.96(e))		
3.	Notice of proposed construction project, and public meetings, must be delivered in hard copy to residents w/in 1 mile of the facility and advertised on social media and in towns w/in 10 miles. (845.240(b))	No analogous requirement.		
4.	Public notifications may be required in languages other than English in some locations. (845.240(c))	No analogous requirement.		
5.	Draft permit applications must be posted to public websites 14 days before a public meeting. (845.240(e))	No analogous requirement.		
6.	Weekly construction quality assurance reports must be placed in the facility's operating record. (845.290(b)(2))	No analogous requirement.		
7.	Leachate collection system for new units required to be placed above the liner. (845.420(a)).	No analogous requirement.		
8.	Owners/operators are required to develop and annually update a safety and health plan. (845.530)	No analogous requirement.		R. Bonaparte at 20-21.
9.	Structural stability assessments must be updated annually. (845.540(b)(1)(E))	Structural stability assessments must be conducted every 5 years. (257.73(d)&(f))		R. Bonaparte at 20-21.
10.	Safety factor assessments must be updated annually. (845.540(b)(1)(F))	Safety factor assessments must be conducted every 5 years. (257.73(e)&(f))		R. Bonaparte at 20-21.

11.	Inflow design flood control system must be updated annually. (845.540(b)(1)(G))	Inflow design flood control system plan must be updated every 5 years. (257.82(c)(4))		
12.	Mandatory monitoring for twenty constituents (845.600(a))	Detection monitoring for seven constituents (257.94(a))	Additional constituents are monitored under the CCR Rule only after triggered by a statistically significant increase over background (257.95(a))	C. Vodopivec at 14.
13.	Lead groundwater protection standard set at 0.0075 mg/L. (845.600(a))	Lead groundwater protection standard set at 0.015 mg/L. (257.95(h)(2)(ii)		
14.	Corrective action triggered by exceedance of GWPS for any of twenty constituents. (845.660(a)(1))	Corrective action triggered only by exceedance of GWPS for fifteen constituents (likely to be expanded to 16). (257.96(a)).		
15.	Corrective action triggered on first confirmed exceedance (845.650(d))	Two step process before corrective action is triggered (257.94-96)		C. Vodopivec at 16-17; D. Hagen at 29-31.
16.	Statistical analysis may be used only when comparing groundwater samples to background. (845.640(h))	Statistical analysis is used to compare groundwater samples both to background and to numerical groundwater protection standards. (257.93(h) & 257.95(g))		D. Hagen at 29-31.
17.	180 days to collect 8 initial independent samples from each monitoring well for existing units (845.650(b)(1)(A))	Two years to collect 8 initial independent samples from each monitoring well for existing units (257.94(b))		

18.	Quarterly Groundwater Monitoring (845.650(b)(1))	Semi-annual groundwater monitoring (257.94(a))		C. Vodopivec at 14; D. Hagen at 28.
19.	Monthly monitoring of groundwater elevations (845.650(b)(2))	Semi-annual groundwater monitoring (257.93(c))	CCR Rule requires elevation monitoring only when samples are taken for groundwater quality monitoring.	C. Vodopivec at 14.
20.	Owners and operators are allowed 60 days to make an alternative source demonstration (845.650(d)(4))	Owners and operators are allowed 90 days to make an alternative source demonstration (257.95(g)(3)(ii))		
21.	Agency approval is required to obtain an extension of time to complete assessment of corrective measures (845.660(a)(2))	Professional engineer certification is sufficient to obtain an extension of time to complete assessment of corrective measures (257.96(a))		
22.	Corrective action plan must be submitted within one year of completing the assessment of corrective measures (845.670(b))	No deadline provided.		
23.	Closure prioritization is dictated by regulation and by the Agency. (845.700(g))	No analogous requirement.	CCR Rule has closure deadlines, but owners/ operators may choose how to comply with those deadlines.	C. Vodopivec at 13-14.

24.	Prescriptive closure alternative analysis (845.710(b)-(d))	No specific closure alternative analysis requirements (257.101-102)		C. Vodopivec at 17; R. Bonaparte at 15-18; M. Rokoff at 25-28; & A. Bittner at 5-12.
25.	Final cover permeability no greater than 1 x 10^{-7} cm/sec (845.750(c)(1))	Final cover permeability no greater than 1 x 10^{-5} cm/sec (257.102(d)(3)(i)(A))		C. Vodopivec at 18-19.
26.	36 inch low permeability layer, when using compacted earth (845.750(c)(1)(A))	18 inch low permeability layer, when using compacted earth (257.102(d)(3)(i)(B))		C. Vodopivec at 18-19; R. Bonaparte at 7-10
27.	36 inch protective layer (845.750(c)(2)(B))	6 inch protective layer (257.102(d)(3)(i)(C))		C. Vodopivec at 18-19; R. Bonaparte at 7-10
28.	When consolidating ash between multiple units, the slope of final cover systems is limited, by default, to 5%. (845.750(d)(4)(A))	No analogous requirement.		R. Bonaparte at 13-15
29.	Financial assurance is required for all CCR surface impoundments. (845.900 – 990)	No analogous requirements.		C. Vodopivec at 19.

Testimony 2:

Dr. Lisa Bradley

www.haleyaldrich.com

PRE-FILED TESTIMONY OF LISA JN BRADLEY, PH.D., DABT REGARDING PROPOSED ILLINOIS ADMINISTRATIVE CODE TITLE 35, SUBTITLE G, CHAPTER I, SUBCHAPTER J, PART 845: STANDARDS FOR THE DISPOSAL OF COAL COMBUSTION RESIDUALS IN SURFACE IMPOUNDMENTS

By
Lisa JN Bradley, Ph.D., DABT
Haley & Aldrich, Inc.
Chicago, IL

for
Schiff Hardin, LLC
Chicago, Illinois

File No. 134576-002
August 2020

HALEY & ALDRICH, INC.
465 MEDFORD ST.
SUITE 2200
BOSTON, MA 02129
617.886.7400

SIGNATURE PAGE FOR

PRE-FILED TESTIMONY OF LISA JN BRADLEY, PH.D., DABT
REGARDING
PROPOSED ILLINOIS ADMINISTRATIVE CODE TITLE 35,
SUBTITLE G, CHAPTER I, SUBCHAPTER J, PART 845:
STANDARDS FOR THE DISPOSAL OF COAL COMBUSTION
RESIDUALS IN SURFACE IMPOUNDMENTS

PREPARED FOR
SCHIFF HARDIN, LLC
CHICAGO, ILLINOIS

PREPARED BY:

Lisa JN Bradley, Ph.D., DABT
Principal Toxicologist
Haley & Aldrich, Inc.

Page

Table of Contents

List of Tables **vi**

List of Figures **vi**

Acronyms **vii**

1. Introduction **1**

1.1 SUMMARY OF OPINIONS 1
1.2 PROFESSIONAL QUALIFICATIONS 2

2. Opinion 1: CCR is neither hazardous nor toxic, therefore, proposed Part 845 appropriately regulates CCR as a solid waste **4**

2.1 ENVIRONMENTAL PROTECTION 4
2.2 CCR IS NOT HAZARDOUS 4
2.3 THE HISTORY OF FEDERAL CCR RULEMAKING AFFIRMS THAT CCR IS A NON-HAZARDOUS WASTE 5
2.3.1 Legislative and Regulatory History Prior to the Federal CCR Rule 5
2.3.2 Federal CCR Rule 7
2.3.3 Updates to the Federal CCR Rule 7
2.3.3.1 The WIIN Act 7
2.3.3.2 Final Rule – Amendments to the National Regulations Finalized in 2018 (Phase One, Part One) 7
2.3.4 Summary of the Rulemaking 8
2.4 CCR IS NOT TOXIC 8
2.4.1 Toxicity Testing of CCR Under the EU REACH Program 8
2.4.2 “Acutely Toxic” Definition Under RCRA 10
2.4.3 Coal, CCR, and the Elements They Contain 11
2.4.4 Evaluating CCR on a Constituent-Specific Basis 11
2.4.5 CCR is Not Toxic 12
2.5 OPINION 1 SUMMARY 13

3. Opinion 2: Proposed Part 845 is patterned on the federal CCR Rule that is conservative and overly protective, thus, proposed Part 845 is also conservative and overly protective **14**

3.1 THE FEDERAL CCR RULE WAS DEVELOPED BASED ON A NATIONAL HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT OF CCR DISPOSAL UNITS THAT IDENTIFIED ONLY ONE SCENARIO AND A LIMITED NUMBER OF CONSTITUENTS AS A RISK DRIVER; YET, THE FEDERAL PROGRAM WENT BEYOND ADDRESSING JUST THAT SCENARIO AND JUST

Page

THOSE CONSTITUENTS, THUS, THE FEDERAL CCR RULE IS CONSERVATIVE AND OVERLY PROTECTIVE 14
3.1.1 Risk Assessment Basics 15
3.1.2 Summary of Risk Assessment Results 16
3.1.3 The Risk Assessment was Comprehensive and Thorough 18
3.1.4 The Risk Assessment was Conservative 21
3.2 THE FEDERAL CCR RULE IS PROTECTIVE AND VERY CONSERVATIVE BECAUSE IT WAS INTENDED TO APPLY TO ALL CCR UNITS IN THE U.S. WITHOUT THE BENEFIT OF REGULATORY OVERSIGHT AND, THEREFORE, IT WAS DESIGNED TO MITIGATE RISKS ASSOCIATED WITH ALL POTENTIAL SETTINGS, I.E., IT IS PROTECTIVE OF THE WORST-CASE SCENARIO 22
3.2.1 The CCR Risk Assessment is Conservative 22
3.2.2 USEPA Did Not have the Authority to Enforce the CCR Rule When Published – Thus the Rule is Protective of All Sites 23
3.3 OPINION 2 SUMMARY 24

4. Opinion 3: A single exceedance of a groundwater protection standard during assessment monitoring should not result in the initiation of corrective action 25

4.1 PROPOSED PART 845 APPROACH 25
4.2 OPINION 3 SUMMARY 28

5. Opinion 4: Proposed Part 845 closure prioritization Category 2 should be revised to address only conditions that could pose an imminent threat 29

5.1 LOCATION RESTICTIONS DO NOT POSE AN IMMINENT THREAT 29
5.2 OPINION 4 SUMMARY 30

6. Opinion 5: CCR units that are capped or otherwise maintained, and units that receive only de minimis amounts of CCR do not present a risk warranting regulation 31

6.1 CCR UNITS THAT ARE CAPPED OR OTHERWISE MAINTAINED 31
6.2 UNITS THAT RECEIVE ONLY DE MINIMIS AMOUNTS OF CCR 32
6.3 OPINION 5 SUMMARY 33

7. Opinion 6: OSHA regulations are applicable to work conducted under the proposed Part 845 and are effective for worker and community protection 34

7.1 OPINION 6 SUMMARY 35

8. References 36

Exhibit A – Resume: Lisa JN Bradley, Ph.D., DABT
Exhibit B – Detailed REACH Tables

HALEY ALDRICH

List of Tables

Table No.	Title
2-1	REACH Mammalian Toxicity Studies for "Ashes (residues), Coal" **Page 9**
2-2	REACH Aquatic Toxicity Studies for "Ashes (residues), Coal" **Page 10**
3-1	USEPA National CCR 90th Percentile Probabilistic Risk Assessment Results **Page 17**
3-2	USEPA National CCR Risk Assessment Results Summary – Results Above the RCRA Risk Criteria **Page 17**
3-3	List of Chemical Constituents Evaluated in the USEPA CCR Risk Assessment **page 20**
3-4	List of Chemical Constituents Retained for Probabilistic Analysis in the USEPA CCR Risk Assessment **Page 21**

List of Figures

Figure No.	Title
3-1	Example Comparison Between a Deterministic and a Probabilistic Calculation **page 16**
4-1	Counties with arsenic concentrations in groundwater exceeding specific concentrations in 10% or more of groundwater samples **Page 27**

Acronyms

ACAA	American Coal Ash Association
ACS	American Cancer Society
CCR	Coal Combustion Residuals
CERCLA	Comprehensive Environmental Response, Compensation, and Liability
ECHA	European Chemical Agency
EU	European Union
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
IEPA	Illinois Environmental Protection Agency
LC	Lethal Concentration
LD	Lethal Dose
MCL	Maximum Contaminant Level
OSHA	Occupational Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SL	Screening Level
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WMU	Waste Management Unit

1. Introduction

I have been retained as an employee of Haley & Aldrich, Inc. (Haley & Aldrich) to provide testimony on behalf of Dynegy Midwest Generation, LLC; Kincaid Generation, LLC; Illinois Power Resources Generating Company; Illinois Power Generating Company; and Electric Energy Inc. related to the Illinois Environmental Protection Agency (IEPA) Proposed Part 845 Rules, Illinois Administrative Code (Title 35, Subtitle G, Chapter I, Subchapter j). IEPA's proposed rule (referred to herein as Part 845) was filed by IEPA with the Illinois Pollution Control Board on March 30, 2020, and, if adopted, would set standards and requirements pertaining to the design, construction, operation, groundwater monitoring, corrective action, closure, and post-closure care of coal combustion residual (CCR) surface impoundments.

Proposed Part 845 is patterned on regulation from the U.S. Environmental Protection Agency (USEPA) titled "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule," and promulgated on April 17, 2015,[1] referred to herein as the federal CCR Rule.

1.1 SUMMARY OF OPINIONS

I offer the following opinions on proposed Part 845, including its reliance on the federal CCR Rule and related federal risk assessment, as listed below. Details of each opinion are provided in subsequent sections of this testimony.

Opinion 1: CCR is neither hazardous nor toxic, therefore, proposed Part 845 appropriately regulates CCR as a solid waste.

- The legislative and regulatory history of the federal CCR Rule demonstrates Congress and the USEPA do not regulate, nor intend to regulate, CCR as hazardous waste but as a solid waste.
- The scientific data available for CCR demonstrate that CCR is not toxic.

Opinion 2: Proposed Part 845 is patterned on the federal CCR Rule that is conservative and overly protective, thus, proposed Part 845 is also conservative and overly protective.

- The federal CCR Rule was developed based on a national human health and ecological risk assessment of CCR disposal units that identified only one scenario and a limited number of constituents as a risk driver. Yet, the federal program went beyond addressing just that scenario and just those constituents, thus, the federal CCR Rule is conservative and overly protective.
- The federal CCR Rule itself is protective and very conservative because it was intended to apply to all CCR units in the U.S. without the benefit of regulatory oversight and, therefore, it was designed to mitigate risks associated with all potential settings, i.e., it is protective of the worst-case scenario.

[1] https://www.federalregister.gov/documents/2015/04/17/2015-00257/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric – EPA-HQ-RCRA-2009-0640-11970 – Federal CCR Rule.

HALEY ALDRICH

- Because proposed Part 845 is patterned on the federal CCR Rule, it too is conservative and overly protective.

Opinion 3: A single exceedance of a groundwater protection standard during assessment monitoring should not result in the initiation of corrective action.

- In contrast to use of standard statistical methods as prescribed by the federal CCR Rule, proposed Part 845 inappropriately uses a single, confirmed exceedance of a groundwater protection standard during assessment monitoring as a trigger for the initiation of corrective action.

Opinion 4: Proposed Part 845 closure prioritization Category 2 should be revised to address only conditions that could pose an imminent threat.

- The conditions itemized in (A) through (E) in Section 845.700(g) do not all represent imminent threats. Item (B) (surface impoundments that have not demonstrated compliance with location restrictions in 845 Subpart C), and Item (D) (an exceedance of the groundwater protection standards in Section 845.600 has migrated off-site) should be removed from Category 2 as they do not represent imminent threats.

Opinion 5: CCR units that are capped or otherwise maintained, and units that receive only de minimis amounts of CCR do not present a risk warranting regulation. Imposing requirements upon such units under Part 845 goes beyond the federal CCR rule and is unnecessary and unsupported.

- The federal CCR Rule determined that these units are exempt from regulation and, in the absence of any specific study by IEPA to rebut USEPA's decision, these units should remain exempt from regulation under proposed Part 845.

Opinion 6: OSHA regulations are applicable to work conducted under the proposed Part 845 and are effective for worker and community protection.

1.2 PROFESSIONAL QUALIFICATIONS

My name is Lisa JN Bradley, Ph.D., DABT. I am a Principal with Haley & Aldrich, Inc. (Haley & Aldrich) where I have been employed since September 2014. I am a senior toxicologist and human health risk assessor at Haley & Aldrich. Previously I was employed in the same capacity by AECOM (and its predecessors) since October 1991.

Risk assessment is a process used to estimate the risk that contact with constituents in the environment may harm people, animals, or the environment now or in the future (USEPA, 1989, 1997). I conduct risk assessments and evaluations, provide toxicology support to my clients, conduct regulatory negotiations, and provide environmental communications support.

I earned a Ph.D. in Toxicology from the Massachusetts Institute of Technology in 1991, and a B.S. in Chemistry and Zoology, summa cum laude, from the University of Idaho in 1983, where I was inducted into Phi Beta Kappa.

I am certified as a Diplomate by the American Board of Toxicology (DABT). I earned that certification in 1994 and have successfully recertified every 5 years since then. The mission of the American Board of Toxicology is to identify, maintain, and evolve a standard for professional competency in the field of toxicology. The certification of Diplomate is a globally recognized credential in toxicology representative of competency and commitment to human health and environmental sciences.

I am a member of the Society for Toxicology. For over 25 years I have worked as a toxicologist and human health risk assessor. Toxicology is the study of constituents, or poisons, and their effects on biological systems. In the context of environmental investigations, risk assessment uses information from toxicology studies and information on potential human exposure to constituents in the environment to evaluate the potential health risk to humans.

During my job tenure I have conducted risk assessments under the federal Superfund program (CERCLA – the Comprehensive Environmental Response, Compensation, and Liability Act) and the Resource Conservation and Recovery Act (RCRA), and various similar state programs. During the course of my career I have conducted risk assessments and risk evaluations at over 15 Superfund sites, and have provided similar toxicology support to clients on numerous other projects. Three of the Superfund risk assessments I have prepared have been finalized and accepted by USEPA Region 5. These are Sauget Area 1 (Sauget, Illinois), Sauget Area 2 (Sauget, Illinois), and the Pines Area of Investigation (Town of Pines, Indiana). The latter site addresses coal combustion products present in a landfill and used as road base and fill in the community.

I have conducted training workshops and given numerous presentations at technical industry meetings on risk assessment and toxicology, with specific emphasis on coal ash/CCR.

A copy of my resume is attached as **Exhibit A**, which includes my publications from the last 10 years.

2. Opinion 1: CCR is neither hazardous nor toxic, therefore, proposed Part 845 appropriately regulates CCR as a solid waste

CCR is neither hazardous nor toxic, therefore, proposed Part 845 appropriately regulates CCR as a solid waste.

- The legislative and regulatory history of the federal CCR Rule demonstrates Congress and the USEPA do not regulate, nor intend to regulate, CCR as hazardous waste but as a solid waste.
- The scientific data available for CCR demonstrate that CCR is not toxic.

These are discussed below.

2.1 ENVIRONMENTAL PROTECTION

The purpose of all environmental regulations, whether federal, state, or local, is to protect human health and the environment, both the living environment and our natural resources. As noted on its website, "the mission of USEPA is to protect human health and the environment." To accomplish this mission, USEPA develops and enforces regulations in response to environmental laws enacted by Congress. In many cases, USEPA sets national standards that states and tribes enforce through their own regulations.[2]

RCRA gives USEPA the authority to control hazardous waste, and RCRA also sets forth a framework for the management of non-hazardous solid wastes.[3] State authorization for RCRA is a rulemaking process through which the USEPA delegates the primary responsibility of implementing the RCRA program to individual states in lieu of the USEPA. This process ensures national consistency and minimum standards while providing flexibility to states in implementing rules.[4]

Similarly, "the mission of the Illinois EPA is to safeguard environmental quality, consistent with the social and economic needs of the State, so as to protect health, welfare, property and the quality of life."[5] Illinois was initially authorized to implement the RCRA base program in 1986.[6]

2.2 CCR IS NOT HAZARDOUS

There is a specific definition in RCRA at 40 CFR Part 261 to identify whether a waste is hazardous based on four characteristics:

- 40 CFR 261.21 – Characteristic of ignitability.

[2] https://www.epa.gov/aboutepa/our-mission-and-what-we-do – USEPA Mission.
[3] https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act – RCRA.
[4] https://www.epa.gov/rcra/state-authorization-under-resource-conservation-and-recovery-act-rcra – State Authorization of RCRA.
[5] https://www2.illinois.gov/epa/about-us/Pages/default.aspx – IEPA Mission.
[6] https://www.epa.gov/sites/production/files/2019-11/documents/authall.pdf – Initial Illinois RCRA Authorization.

- 40 CFR 261.22 – Characteristic of corrosivity.
- 40 CFR 261.23 – Characteristic of reactivity.
- 40 CFR 261.24 – Toxicity characteristic.

CCR does not exhibit any of these characteristics. It is not ignitable, it is not corrosive, it is not reactive, nor does it meet the test for toxicity.

The toxicity characteristic is defined by the leachability of certain constituents from a material by the use of the Toxicity Characteristic Leaching Procedure (TCLP), which is USEPA test Method 1311[7] of SW-846. For a material to be meet the toxicity characteristic, it must leach in this test one or more constituents at levels above those defined in 40 CFR Part 260.24. CCR does not meet the toxicity characteristic, i.e., all leachate concentrations are below the regulatory levels in 40 CFR Part 260.24.[8]

USEPA's regulatory review of CCR, as detailed in the next section, affirms that CCR does not meet any of these characteristics for hazardous waste and, therefore, is non-hazardous.

2.3 THE HISTORY OF FEDERAL CCR RULEMAKING AFFIRMS THAT CCR IS A NON-HAZARDOUS WASTE

In 2015, USEPA published the "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule," on April 17, 2015.[9] In this rule, USEPA coined the term coal combustion residuals, or CCR, and the rule is generally referred to as the federal CCR Rule.

CCR is one of the largest waste streams in the U.S., second only to municipal solid waste. There is a long history of federal evaluation of CCR, and the federal CCR Rule is continuing to undergo changes in response to litigation and legislation.

2.3.1 Legislative and Regulatory History Prior to the Federal CCR Rule

USEPA provides a timeline for the history of legislation and regulation for CCR.[10] RCRA was passed by Congress in 1976, and USEPA proposed guidelines for hazardous waste in December 1978. In those guidelines, certain large volume wastes were identified, and the component of each of those wastes that were not defined as hazardous were "not regulated at all under Subtitle C" (where Subtitle C is the

---

[7] https://www.epa.gov/hw-sw846/sw-846-test-method-1311-toxicity-characteristic-leaching-procedure – TCLP Test Method 1311.

[8] Note that TCLP is a test method developed to mimic leaching of a material under conditions within a solid waste landfill; if a material does not "fail" the TCLP test, and is not ignitable, corrosive, or reactive, it can be safely disposed of in a sold waste landfill.

[9] https://www.federalregister.gov/documents/2015/04/17/2015-00257/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric – EPA-HQ-RCRA-2009-0640-11970 – Final CCR Rule.

[10] https://www.epa.gov/coalash/legislative-and-regulatory-timeline-fossil-fuel-combustion-wastes – USEPA CCR Timeline.

rule governing hazardous waste) – one of those large volume wastes was "Utility Waste (fly ash, bottom, ash, scrubber sludge)."[11]

In May 1980, USEPA issued a final rule for the identification and listing of hazardous wastes. In that rule at §261.4 (b) (4), USEPA identified "solid wastes which are not hazardous wastes," one of which was "fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste generated primarily from the combustion of coal or other fossil fuels."[12]

This designation of CCR as exempt from regulation under Subtitle C as a hazardous waste was further confirmed in an amendment to the Solid Waste Disposal Act by Congressional legislation known as the Bevill amendment.[13] The Bevill amendment required that the exemption would continue until six months after a comprehensive study of CCR be conducted and submitted to Congress, at which time USEPA would make a final regulatory determination as to whether CCR should be regulated as hazardous waste or as solid waste.

USEPA submitted its first Report to Congress on "Wastes from the Combustion of Coal by Electric Utility Power Plants" in February 1988.[14] In this report, USEPA stated:

> "First, EPA has concluded that coal combustion waste streams generally do not exhibit hazardous characteristics under current RCRA regulations. EPA does not intend to regulate under Subtitle C fly ash, bottom ash, boiler slag, and flue gas desulfurization wastes…The Agency prefers that these wastes remain under Subtitle D authority."

In 1993, USEPA issued its "Final Regulatory Determination on Four Large-Volume Wastes From the Combustion of Coal by Electric Utility Power Plants."[15] USEPA therein stated:

> "EPA has concluded that regulation under Subtitle C of RCRA is inappropriate for the four waste streams [fly ash, bottom ash, boiler slag, and flue gas emission control waste] that were studied because of the limited risks posed by them and the existence of generally adequate State and Federal regulatory programs….Therefore, the Agency will continue to exempt these wastes from regulation as hazardous wastes under RCRA Subtitle C."

USEPA's second Report to Congress in 1999 addressed the remaining wastes from the combustion of fossil fuels (comanaged wastes, coburning wastes, fluidized bed combustion wastes, oil wastes, and

---

[11] https://www.epa.gov/coalash/proposed-rule-first-set-hazardous-waste-management-standards at 58991-58992 – USEPA Proposed Hazardous Waste Rule.
[12] https://nepis.epa.gov/Exe/ZyPDF.cgi/10003N6F.PDF?Dockey=10003N6F.PDF at 33120 – USEPA Final Rule for Hazardous Waste Listing.
[13] https://www.govinfo.gov/content/pkg/STATUTE-94/pdf/STATUTE-94-Pg2334.pdf – Bevill Amendment.
[14] https://www.epa.gov/sites/production/files/2015-08/documents/coal-rtc.pdf – First Report to Congress.
[15] https://www.epa.gov/sites/production/files/2015-08/documents/080993.pdf – 1993 Final Regulatory Determination.

natural gas wastes) and concluded that disposal of these wastes also should be exempt from RCRA Subtitle C hazardous waste regulation.[16]

The "Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels" was published in May 2000,[17] and in it USEPA stated:

> "The Agency has concluded these wastes do not warrant regulation under subtitle C of RCRA and is retaining the hazardous waste exemption under RCRA section 3001(b)(3)(C). However, EPA has also determined national regulations under subtitle D of RCRA are warranted for coal combustion wastes when they are disposed in landfills or surface impoundments… So that coal combustion wastes are consistently regulated across all waste management scenarios, the Agency also intends to make these national regulations for disposal in surface impoundments and landfills…applicable to coal combustion wastes generated at electric utility and independent power producing facilities that are not comanaged with low volume wastes."

2.3.2 Federal CCR Rule

USEPA published its proposed CCR Rule in June 2010, and its final CCR Rule was published in April 2015.[6] This national regulation provided a comprehensive set of requirements for the disposal of CCR as solid non-hazardous waste under Subtitle D of RCRA.

2.3.3 Updates to the Federal CCR Rule

Updates to the federal CCR Rule have been implemented in response to court rulings and Congressional legislation.

2.3.3.1 The WIIN Act

The lack of direct enforcement authority for USEPA under the federal CCR Rule was addressed by Congress in December 2016 when it passed the Water Infrastructure Improvements for the Nation (WIIN) Act (S. 612),[18] which under Title II – Subtitle C – Control of Coal Combustion Residuals, authorizes USEPA to approve state permitting programs for CCR.

2.3.3.2 Final Rule – Amendments to the National Regulations Finalized in 2018 (Phase One, Part One)

On July 30, 2018, in a Final Rule identified as Amendments to the National Minimum Criteria, Phase One, Part One,[19] USEPA finalized certain revisions to the federal CCR Rule including:

---

[16] https://www.epa.gov/coalash/reports-congress-wastes-combustion-coal-and-fossil-fuels. Second Report to Congress.
[17] https://www.federalregister.gov/documents/2000/05/22/00-11138/notice-of-regulatory-determination-on-wastes-from-the-combustion-of-fossil-fuels – 2000 Regulatory Determination.
[18] https://www.congress.gov/bill/114th-congress/senate-bill/612/text – The WIIN Act.
[19] https://www.federalregister.gov/documents/2018/07/30/2018-16262/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric - Final Rule – Amendments (Phase One, Part One).

- Providing states with approved CCR permit programs under the WIIN Act or USEPA where USEPA is the permitting authority the ability to use alternate performance standards; and
- Revising the groundwater protection standard for constituents which do not have an established drinking water standard (known as a maximum contaminant level or MCL) for cobalt, lead, lithium, and molybdenum.

2.3.4 Summary of the Rulemaking

The history of the federal CCR rulemaking has reaffirmed at each step that CCR is appropriately regulated as a solid, non-hazardous waste.

2.4 CCR IS NOT TOXIC

CCR is not toxic. How do we know this?

- When evaluating the material as a whole, there is a wealth of information on the toxicity testing of CCR in mammalian and aquatic species that demonstrates that CCR is not toxic.
- The constituents in coal, and CCR, are naturally occurring in the world around us.
- When looking at the trace elements present in CCR on an individual basis, comparison of concentrations to screening levels developed by the USEPA for a child's and adult's daily exposure to soil in a residential setting demonstrates that all are below the screening levels with the exception of the upper bound concentrations of a few constituents.
- Adverse health effects can only be caused by the constituents in CCR, or CCR itself, if one is (a) exposed to the material, and (b) exposed at a level high enough to elicit a response.

2.4.1 Toxicity Testing of CCR Under the EU REACH Program

The European Chemical Agency (ECHA)[20] of the European Union (EU) has developed a comprehensive program of toxicity testing of materials that are put into commerce. This program is referred to as REACH – the "Registration, Evaluation, Authorisation and Restriction of Chemicals"[21] – and has been in place since 2006. CCR has been registered for commerce under REACH and the dossier for "Ashes (residues), coal," registration number EC# 931-322-8, is available for review.[22] The REACH program requires a battery of toxicity testing be conducted to support the registration dossier, including mammalian (human health) and aquatic toxicity studies.

Table 2-1, below, summarizes the mammalian toxicity study results, which are relevant to human health. Studies have been conducted to address 10 different toxicity endpoints, for acute (short-term)

---

[20] https://echa.europa.eu/home – ECHA Home page.
[21] https://echa.europa.eu/regulations/reach/understanding-reach – ECHA – Understanding REACH.
[22] https://echa.europa.eu/registration-dossier/-/registered-dossier/15573/7/1 and https://echa.europa.eu/brief-profile/-/briefprofile/100.151.318 – ECHA – REACH – Ashes (residues), coal.

and chronic (long-term) exposure durations considering oral (ingestion), dermal, and inhalation pathways. As shown on Table 2-1, a total of 47 mammalian toxicity studies have been conducted on CCR – as a whole material. The REACH system classifies materials by hazard category – if no hazards are identified, based on their classification system definitions, then the conclusion is that no classification is warranted due to "data conclusive but not sufficient for classification." The terminology is a bit cumbersome but means there is no hazard to classify. In other words, when that label is used, it means that testing shows the material does not pose a hazard, or "no hazard." This is the terminology used in the GHS (Globally Harmonized System of Classification and Labelling of Chemicals) section of the dossier. Detailed information on these tables is provided in Exhibit B.

Table 2-1. REACH Mammalian Toxicity Studies for "Ashes (Residues), Coal"
Source: http://echa.europa.eu; EC# 931-322-8

Endpoint	Publications and Reports	Conclusion
Acute Oral Toxicity	3	No Hazard
Acute Inhalation Toxicity	1	No Hazard
Acute Dermal Toxicity	2	No Hazard
Skin Irritation	12	No Hazard (11) Inconclusive (1)
Eye Irritation	6	No Hazard (5) Inconclusive (1)
Skin Sensitization	4	No Hazard
Repeated Dose Inhalation Toxicity	3	No Hazard
Repeated Dose Oral Toxicity	2	No Hazard
Genetic Toxicity	7	No Hazard
Reproductive Toxicity	2	No Hazard
Worker Epidemiology	5	No Hazard
Carcinogenicity	NA	No Hazard
Total	**47**	

The conclusion under REACH is that CCR does not pose a hazard to mammalian species or humans and, thus, does not warrant a hazard classification.

Table 2-2, below, provides similar information for the aquatic toxicity testing regimen. In all, 39 tests were conducted including both acute and chronic exposures, and in all cases the conclusion is that no classification is warranted due to "data conclusive but not sufficient for classification," or "no hazard."

Table 2-2. REACH Aquatic Toxicity Studies for "Ashes (Residues), Coal"
Source: http://echa.europa.eu; EC# 931-322-8

Endpoint	Publications and Reports	Conclusion
Acute Toxicity to Fish	4	No Hazard
Acute Toxicity to Aquatic Invertebrates	8	No Hazard
Toxicity to Aquatic Algae and Cyanobacteria	16	No Hazard
Toxicity to Microorganisms	8	No Hazard
Chronic Toxicity to Fish	1	No Hazard
Chronic Toxicity to Aquatic Invertebrates	2	No Hazard
Total	**39**	

The conclusion under REACH is that CCR does not pose a hazard to aquatic species and, thus, does not warrant a hazard classification.

An additional table in Exhibit B summarizes the terrestrial ecological studies on CCR that have been conducted under the REACH program. REACH does not require terrestrial ecological testing to be performed and does not have a system for classification for terrestrial ecological study results. However, the dossier concludes that the studies show only low toxicity at high concentrations.

One of the important aspects of these data is that by conducting the studies on CCR as a whole material, the studies account for any cumulative, additive, synergistic, and/or antagonistic effects that single constituents may have in these complex mixtures.

Taken together, this series of detailed and comprehensive toxicity testing and the conclusions of no hazard support the conclusion that CCR is not toxic.

2.4.2 "Acutely Toxic" Definition Under RCRA

As discussed above, CCR does not meet the toxicity characteristic under RCRA as defined by the TCLP test method. RCRA also defines a material as acutely toxic at 40 CFR Part 261.11(a)(2) if:

> "It has been found to be fatal to humans in low doses or, in the absence of data on human toxicity, it has been shown in studies to have an oral LD 50 toxicity (rat) of less than 50 milligrams per kilogram, an inhalation LC 50 toxicity (rat) of less than 2 milligrams per liter, or a dermal LD 50 toxicity (rabbit) of less than 200 milligrams per kilogram or is otherwise capable of causing or significantly contributing to an increase in serious irreversible, or incapacitating eversible, illness. (Waste listed in accordance with these criteria will be designated Acute Hazardous Waste.)" [Where LD refers to Lethal Dose and LC refers to Lethal Concentration.]

As shown in Exhibit B, CCR does not meet the RCRA definition of acutely toxic by any of these pathways.

2.4.3 Coal, CCR, and the Elements They Contain

Coal is formed from the remains of plants in ancient forests and marshes that have been compacted and metamorphosed by heat and pressure over geologic time.[23] Plants take up minerals as they grow. CCR is the unburnable residuals from the combustion of coal for electricity production – mainly inorganic elements and compounds. Because coal is a natural geologic material, the inorganic elements and compounds in CCR are also naturally occurring.

The U.S. Geological Survey (USGS) conducted a survey of elemental concentrations in surface soils in the U.S. and the information can be accessed on-line by linking to each element in the posted periodic table.[24] These maps and additional constituent data are provided in a USGS publication (USGS, 2014).

News stories commonly refer to CCR as "toxic coal ash," and commonly list elements it contains, for example, arsenic, mercury, selenium, chromium, and lead, as though that is proof of CCR toxicity. However, all of these elements are naturally occurring, and the USGS has a map for their occurrence in soils in the U.S. for each of them. We are also exposed to soils and these elements everyday – at home, at school, in parks.

Because plants grow on soil and take up minerals (inorganics and elements) from the soil, these elements are also naturally present in the foods we eat. The ATSDR does a good job of summarizing the presence of elements in the food we eat in their publications.[25]

Therefore, we are exposed to these elements every day from our diet and from our incidental/inadvertent ingestion of soil when we are outside.

2.4.4 Evaluating CCR on a Constituent-Specific Basis

The bulk of rocks/shales and CCR are made up of silicon, aluminum, iron, and calcium (90%), with sulfur, sodium, potassium, magnesium, and titanium making up the minor elements (8%); the remaining elements are termed "trace elements" and make up less than 1% of the total content (EPRI, 2010). The USGS conducted a survey of elements and inorganic compounds in CCR from five different power plants each using a coal sourced from one of the five different coal regions in the U.S.[26] Thus, we have detailed compositional data for fly ashes and bottom ashes from each of these coal sources.

---

[23] https://www.usgs.gov/faqs/what-coal?qt-news_science_products=0#qt-news_science_products – USGS – What is Coal?
[24] https://pubs.usgs.gov/sir/2017/5118/sir20175118_geo.php – Geochemical and Mineralogical Maps, with Interpretation, for Soils of the Conterminous United States.
[25] https://www.atsdr.cdc.gov/toxprofiledocs/index.html – ATSDR Toxicological Profiles.
[26] https://pubs.usgs.gov/ds/635/ - Geochemical Database of Feed Coal and Coal Combustion Products (CCPs) from Five Power Plants in the United States.

The USEPA semi-annually updates a set of tables that provide risk-based screening levels for over 750 elements and compounds.[27] Risk-based screening levels are provided for soil, air, and water. The risk-based screening levels for soils include a residential scenario, where it is assumed that a residential child and adult can contact soil in a yard daily over a 26-year residential lifetime. The residential soil pathway assumes incidental ingestion of soil, and inhalation of wind-generated dusts on a daily basis. In the User's Guide[28] USEPA notes: "The SLs [screening levels] presented in the Generic Tables are chemical-specific concentrations for individual contaminants in air, drinking water and soil that may warrant further investigation or site cleanup. **It should be emphasized that SLs are not cleanup standards.**" [Note the text is bolded by USEPA in the User's Guide.]

The detailed compositional data for fly ashes and bottom ashes from the USGS can be compared to the USEPA risk-based screening levels for residential soil, which can be used to assess their relative potential "toxicity." By doing so we are essentially assuming that the soil in a residential yard is replaced with CCR. A detailed report on this comparison is available from the American Coal Ash Association (ACAA),[29] and a summary of the analysis was presented in an article in the trade journal Ash at Work.[30] Of the 20 trace elements evaluated in the full report, 15 are present in all CCR included in the evaluation at concentrations less than the USEPA screening levels for residential soils. These are: antimony, barium, beryllium, cadmium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, strontium, uranium, and zinc. Only the upper end of the range of the measured concentrations of five constituents in the coal ashes studied are above the residential soil screening level in some but not all of the coal ashes: arsenic, chromium, cobalt, thallium, and vanadium. Moreover, these concentrations are only slightly above the screening levels. This comparison demonstrates that there would be no basis for health risk for incidental contact with CCR on a daily or less frequent basis.

2.4.5 CCR is Not Toxic

Every element on the periodic table can elicit an adverse effect if administered at high doses. It has been common for some groups to scare people about CCR by listing all of the adverse effects that can occur for each element in CCR and showing where those effects occur in the body. But the same graphic would be just as true if the words "coal ash" or "CCR" were replaced with "soil." The graphic is even more misleading because it suggests that any exposure to CCR (and, really, soil) will result in these adverse health effects. This is just not true. The information provided here demonstrates that:

- CCR is not toxic – even at the high exposure levels used in animal tests;
- There are safe levels of exposure to each of the constituents in CCR (and in soil), as defined by USEPA; and,
- Exposure must occur and at a high enough level before an adverse effect can occur.

---

[27] https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables – USEPA Regional Screening Levels (RSLs) - Generic Tables.
[28] https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide – USEPA RSL User's Guide.
[29] https://www.acaa-usa.org/publications/freepublications.aspx – ACAA – Coal Ash Material Safety; under Technical Reports.
[30] https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2012.pdf – ACAA – pages 21-26.

2.5 OPINION 1 SUMMARY

It is my opinion based on the wealth of data provided here, that CCR is neither hazardous nor toxic. Therefore, proposed Part 845 appropriately regulates CCR as a solid waste. This is supported by the legislative and regulatory history of the federal CCR Rule which demonstrates that Congress and the USEPA do not regulate, nor intend to regulate, CCR as hazardous waste but as a solid waste. Moreover, the wealth of scientific data available for CCR demonstrate that CCR is not hazardous and is not toxic.

3. Opinion 2: Proposed Part 845 is patterned on the federal CCR Rule that is conservative and overly protective, thus, proposed Part 845 is also conservative and overly protective

Proposed Part 845 is patterned on the federal CCR Rule that is conservative and overly protective, thus, proposed Part 845 is also conservative and overly protective.

- The federal CCR Rule was developed based on a national human health and ecological risk assessment of CCR disposal units that identified only one scenario and a limited number of constituents as a risk driver. Yet, the federal program went beyond addressing just that scenario and just those constituents, thus, the federal CCR Rule is conservative and overly protective.
- The federal CCR Rule is protective and very conservative because it was intended to apply to all CCR units in the U.S. without the benefit of regulatory oversight and, therefore, it was designed to mitigate risks associated with all potential settings, i.e., it is protective of the worst-case scenario.
- Because proposed Part 845 is patterned on the federal CCR Rule, it too is conservative and overly protective.

Each of these is discussed in more detail below.

3.1 THE FEDERAL CCR RULE WAS DEVELOPED BASED ON A NATIONAL HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT OF CCR DISPOSAL UNITS THAT IDENTIFIED ONLY ONE SCENARIO AND A LIMITED NUMBER OF CONSTITUENTS AS A RISK DRIVER; YET, THE FEDERAL PROGRAM WENT BEYOND ADDRESSING JUST THAT SCENARIO AND JUST THOSE CONSTITUENTS, THUS, THE FEDERAL CCR RULE IS CONSERVATIVE AND OVERLY PROTECTIVE

The federal CCR Rule was based on a national human health and ecological risk assessment of CCR disposal units that identified only one scenario as a risk driver – however the regulation went beyond that single scenario and the few constituents identified as warranting regulation to regulate a broader range of disposal practices.

The USEPA published the “Human and Ecological Risk Assessment of Coal Combustion Residuals” (USEPA, 2014a), herein referred to as the CCR Risk Assessment, as a technical support document for the CCR Rule.

The CCR Risk Assessment was based on a characterization of the “current” state of CCR disposal practices across the county, identification of potential releases from the CCR disposal units, and an evaluation of potential risks posed to human and ecological receptors. USEPA used mathematical models to determine the rate at which constituents may be released from different CCR units, to predict the fate and transport of these constituents through the environment, and to estimate the resulting risks to human and ecological receptors. USEPA then designed the CCR Rule to manage those risks, and other potential risks, to satisfy the RCRA requirement[31] that there will be "no reasonable probability of adverse effects on health or the environment from disposal."

A brief over-view of the risk assessment process and how the results are used in regulatory programs are provided below to provide context for the CCR Risk Assessment and its results.

3.1.1 Risk Assessment Basics

The potential for materials or the constituents in those materials to pose a risk to human health and the environment is evaluated using methods USEPA developed and are referred to as human health risk assessment or ecological risk assessment. This methodology evaluates the potential for a material to be toxic and the potential for human or ecological exposure to the material to evaluate risk.

To understand the CCR Risk Assessment results, it is necessary to understand how regulatory decision making is based on estimates of risk to human health or the environment.

Two types of risk are evaluated in a human health risk assessment: noncancer and cancer (USEPA, 1989). Ecological risk assessment is similar to the evaluation of noncancer risks in a human health risk assessment (USEPA, 1997).

For noncancer effects, USEPA develops toxicity values that identify a level of exposure that is expected to not produce adverse effects. This safe level is the toxicity value and is very conservative. The estimated level of exposure is divided by the toxicity value to estimate the noncancer risk. Values below one (1) indicate no probability of adverse effects based on that exposure. Values above one (1) do not indicate that an adverse effect will occur, or at what probability, only that additional investigation of that exposure is warranted.

For constituents classified as potential carcinogens, the predicted level of exposure to a constituent is multiplied by a toxicity value developed by the USEPA that is used to predict the chance of cancer occurring as a result of the exposure, and the result is referred to as the excess cancer risk (USEPA, 1989), i.e., the cancer risk over and above the background cancer risk.

For national risk assessments conducted under RCRA, USEPA uses a "point of departure" for decision making of a target for noncancer and ecological risk of one (1), and a target excess cancer risk of one in one hundred thousand (1 in 100,000 or $1x10^{-5}$). To understand the USEPA target risk in context, it is important to recognize that the background cancer risk in the U.S. is generally between one in two (0.5 or $5x10^{-1}$) to one in three (0.33 or $3.3x10^{-1}$) for men and women based on statistics published annually by the American Cancer Society (ACS, 2020). Thus, the RCRA point of departure for risk for regulatory rulemaking of $1x10^{-5}$ is 4 orders of magnitude <u>lower</u> than the background cancer rates in the U.S.

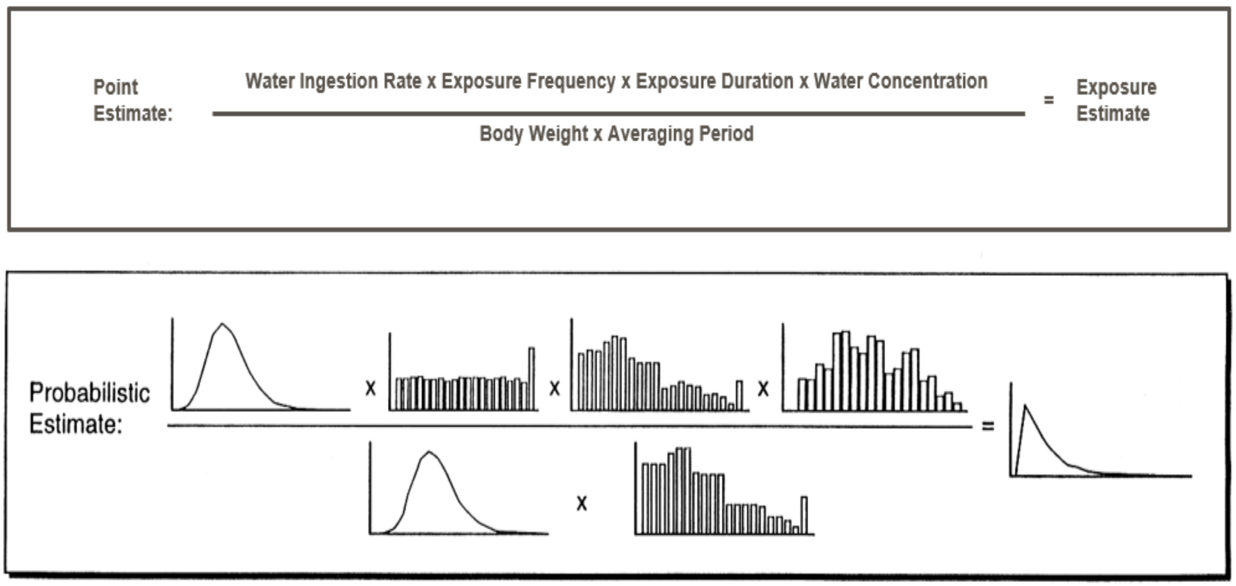
Finally, when calculating risks, risk assessments generally use equations and single point estimates for each parameter in the equation (body weight, water ingestion rate, etc.) to calculate a single estimate of

[31] https://www.govinfo.gov/content/pkg/STATUTE-90/pdf/STATUTE-90-Pg2795.pdf – RCRA Section 4004(a), and cited in the CCR Rule, p21310.

HALEY ALDRICH

risk; this type of risk assessment is generally referred to as a point estimate approach. Alternatively, a risk assessment can be conducted as a probabilistic analysis, where each factor in the analysis is represented by a distribution of values, where possible, rather than a single point estimate. The result is a distribution of risk estimates (see Figure 3-1, below). This latter approach was used by USEPA for the CCR Risk Assessment.

Figure 3-1. Example comparison between A Deterministic and a Probabilistic Calculation



3.1.2 Summary of Risk Assessment Results

The CCR Risk Assessment addressed disposal of CCR in surface impoundments and landfills. As discussed in detail in Section 3.1.3 below, the risk assessment evaluated potential human and ecological exposure to CCR and its component constituents through a broad range of exposure pathways. The CCR Risk Assessment used the probabilistic approach to develop a distribution of risks for each constituent and pathway evaluated to determine which exceeded the RCRA risk point of departure of one (1) for non-cancer and $1x10^{-5}$ for cancer.

Because USEPA used a probabilistic risk assessment, it needed to select a point from the distribution of risk estimates to use to base its regulatory conclusions. USEPA chose to use the 90^{th} percentile risk result, for each scenario evaluated, upon which to base its regulatory conclusion, i.e., 90% of the risk results are below that value, and only 10% of the risk results are above that value. USEPA notes that the 90^{th} percentile risks represent highly exposed individuals for each scenario evaluated, and the 50^{th} percentile risks represent more moderately exposed individuals under those same scenarios. These potential exposures are discussed in detail in Section 3.1.3 below.

The CCR Risk Assessment results above the RCRA point of departure for regulating a waste, an excess cancer risk 1 x 10^{-5} and a noncancer risk of 1, are shown in Table 3-1 below.

Table 3-1. USEPA National CCR 90th Percentile Probabilistic Risk Assessment Results	
	Ingestion of Groundwater
	Surface Impoundments
Constituent	**Excess Cancer Risks**
Arsenic III	2 x 10^{-4}
Arsenic V	1 x 10^{-5}
	Noncancer Risks
Arsenic III	5
Lithium	2
Molybdenum	2

Thus, from the full probabilistic risk assessment, the only scenario with risks above the risk criteria for RCRA is the human health scenario of ingestion of groundwater as drinking water for surface impoundments, but only at the 90th percentile of the risk range. As shown in Table 3-2, below, none of the other disposal scenarios posed a risk to human health or the environment above the RCRA point of departure for regulatory rulemaking.

Table 3-2. USEPA CCR National Risk Assessment Results Summary – Results Above the RCRA Risk Criteria					
Human Health Risks			**Ecological Risks**		
	Surface Impoundment	**Landfill**		**Surface Impoundment**	**Landfill**
Groundwater as Drinking Water			**Ecological Exposure to Sediment**		
90th Percentile	*See **Table 3-1** Above*	None	**90th Percentile**	None	None
50th Percentile	None	None	**50th Percentile**	None	None
Fish Ingestion			**Ecological Exposure to Surface Water**		
90th Percentile	None	None	**90th Percentile**	None	None
50th Percentile	None	None	**50th Percentile**	None	None

USEPA notes that "EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water."[32]

The risk assessment that USEPA conducted was comprehensive, thorough, and was designed by USEPA to be conservative, i.e., it is more likely to overestimate than under-estimate exposure and risk. This is discussed in more detail below.

3.1.3 The Risk Assessment was Comprehensive and Thorough

- The initial list of constituents for EPA's comprehensive risk assessment was developed by including all inorganic constituents present in CCR that also had at least one numerical toxicity benchmark (USEPA had previously determined that organic constituents that may be present in CCR are not of concern).[33] The list is provided in Table 3-3.
- The conceptual site model for the setting of surface impoundments assumed that CCR sluiced to the impoundment settles to the bottom and that a constant ponding depth of water is present throughout the life of the impoundment, i.e., a constant hydraulic head is assumed.
- The conceptual site model for potential migration of constituents in the surface impoundments assumed that constituents are released from the CCR via four mechanisms:
  - CCR constituents could solubilize into the wastewater in a surface impoundment.
  - CCR constituents could leach into the water and percolate down into the subsurface and groundwater, and that groundwater could migrate to surface water.
  - CCR in the impoundment could become dry and be dispersed as windblown fugitive dusts.
  - CCR constituents in runoff and due to erosion could impact soil, surface water, and surface water could serve as a source to sediments.
- The conceptual site model for potential human exposures to these environmental media included:
  - Drinking water exposure to groundwater by a residential adult/child.
  - Inhalation of ambient air by a residential adult/child.
  - Ingestion of produce, beef, and milk that may be impacted by dusts and runoff/erosion of CCR, by a residential adult/child.
  - Ingestion of fish by a recreational fisher adult/child.
- The conceptual site model for potential ecological exposures to these environmental media included:
  - Direct contact with wastewater and ingestion of biota in a surface impoundment by aquatic receptors.
  - Direct contact with soil and ingestion of biota by terrestrial receptors.

---

[32] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21342.
[33] https://www.epa.gov/coalash/reports-congress-wastes-combustion-coal-and-fossil-fuels – Second Report to Congress.

  - Direct contact with sediment and ingestion of biota by benthic receptors.
  - Direct contact with surface water by aquatic receptors.

- Data to characterize CCR for the surface impoundments included:
  - Pore water concentration distributions for each constituent.
  - Wastewater concentration distributions for each constituent.
  - CCR concentration distributions for each constituent, i.e., for the CCR itself.

- Toxicity benchmarks were identified for the following:
  - Human health – chronic (long-term) ingestion, chronic inhalation, and acute (1-hour) inhalation.
  - Ecological – surface water, sediment, and soil.

- The resident adult/child receptor was evaluated using eight (8) different age groups to account for higher exposure to constituents in various environmental media by children due to their body weight and intake rates: Infant (< 1 year); 1 to < 2 years; 2 to < 3 years; 3 to < 6 years; 6 to < 11 years; 11 to < 16 years; 16 to < 21; Adult (> 21 years).

- The screening analysis phase of the risk assessment evaluated all of the constituents in Table 3-3, below, by using a single point estimate concentration that was the 90^{th} percentile of all concentrations, for all of the human health and ecological exposure scenarios presented above (in a point-estimate risk assessment). The constituents retained for the detailed probabilistic risk assessment are shown in Table 3-4, below.

Table 3-3. List of Chemical Constituents Evaluated in the USEPA CCR Risk Assessment (a)	
Constituents that were Ultimately Identified for Appendix III	
Boron*	
Calcium	
Chloride*	
Fluoride*	
Sulfate	
Constituents that were Ultimately Identified for Appendix IV	
Antimony*	
Arsenic*	
Barium*	
Beryllium*	
Cadmium*	
Chromium*	
Cobalt*	
[Fluoride*]	
Lead*	
Lithium*	
Mercury*	
Molybdenum*	
Selenium*	
Thallium*	
Constituents that were not Included for Regulation under the Final CCR Rule	
Aluminum*	Nitrate/Nitrite
Ammonia	Silicon
Antimony	Silver*
Copper*	Sodium
Iron*	Strontium
Lanthanum	Sulfide
Magnesium	Uranium
Manganese	Vanadium*
Nickel*	Zinc*

Notes:

Bold - Denotes those constituents that posed a risk above RCRA risk criteria in the probabilistic risk assessment.

* - These constituents were carried on to the probabilistic risk assessment, as shown in Table 3-4.

CCR - Coal Combustion Residuals.

(a) All of these constituents were evaluated in the Screening Analysis at the 90th percentile concentration for all of the human health and ecological exposure pathways discussed in Section 3.1.3 of the text.

Table 3-4. List of Chemical Constituents Retained for Probabilistic Analysis in the USEPA CCR Risk Assessment (a) (b)			
Human Health		**Ecological**	
Ingestion of Groundwater	**Ingestion of Fish**	**Surface Water Exposure**	**Sediment Exposure**
Antimony	Arsenic	Aluminum	Antimony
Arsenic	Cadmium	Arsenic	Arsenic
Boron	Mercury	Barium	Silver
Cadmium	Selenium	Beryllium	Vanadium
Cobalt	Thallium	Boron	
Fluoride		Cadmium	
Lead		Chloride	
Lithium		Chromium	
Molybdenum		Cobalt	
Thallium		Copper	
		Iron	
		Lead	
		Molybdenum	
		Nickel	
		Selenium	
		Silver	
		Vanadium	
		Zinc	

Notes:
CCR - Coal Combustion Residuals.
(a) Of the constituents in this table evaluated for human health risk, only arsenic, lithium, and molybdenum posed 90th percentile risks above the RCRA criteria. None of the constituents posed risks above the RCRA criteria at the 50th percentile of the risk distribution
(b) Of the constituents in this table evaluated for ecological risk, none of them posed a risk above the RCRA criteria at the 90th or 50th percentiles of the risk distribution.

3.1.4 The Risk Assessment was Conservative

The CCR Risk Assessment casted a wide net and used progressive screening steps to refine the scope of the detailed probabilistic analysis. As USEPA notes, the risk assessment was intended to represent a broad range of potential conditions.[34]

One of the conservative assumptions made by USEPA in its risk assessment is that all populations downgradient of a CCR management unit use groundwater, and specifically, shallow groundwater, as a

[34] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21436.

source of drinking water. "EPA acknowledges that there may be a large percentage of the population that does not rely on groundwater as a source of potable water; however, the aim of the risk assessment is to estimate the magnitude of potential risk to the exposed population."[35] This is an important distinction. The risk assessment results do not mean that the calculated risks apply to anyone living near a CCR surface impoundment. Thus, at most, the results may only apply in a situation where shallow groundwater is used as drinking water immediately downgradient from a CCR surface impoundment.

Because proposed Part 845 is patterned on the federal CCR Rule, and the supporting risk assessment, proposed Part 845 is also necessarily conservative and over-protective. **In fact, where proposed Part 845 goes beyond the federal CCR Rule requirements it is not supported by the CCR Rule and its supporting documentation.**

3.2 THE FEDERAL CCR RULE IS PROTECTIVE AND VERY CONSERVATIVE BECAUSE IT WAS INTENDED TO APPLY TO ALL CCR UNITS IN THE U.S. WITHOUT THE BENEFIT OF REGULATORY OVERSIGHT AND, THEREFORE, IT WAS DESIGNED TO MITIGATE RISKS ASSOCIATED WITH ALL POTENTIAL SETTINGS, i.e., IT IS PROTECTIVE OF THE WORST-CASE SCENARIO

3.2.1 The CCR Risk Assessment is Conservative

USEPA states:

> "…the [2014] risk assessment is not intended to capture the exact risks at each disposal site. Instead, the revised assessment combines the best resolution of site-based, regional and national data available to provide an estimate of potential risks that may occur from current disposal practices. While the assigned data for any given model iteration may not reflect the exact conditions at a real-world site, the resulting sum of all model iterations reflect the range of potential conditions near each WMU [waste management unit], weighted by prevalence, across the conterminous United States."[36]

Thus, the CCR Risk Assessment is a "national" risk assessment not based on any one location – it was designed to capture a broad range of scenarios. The risk assessment uses a wide range of data from many sources to estimate distributions of many exposure parameters. These distributions were then used to conduct the risk assessment, as discussed above.

The probabilistic risk assessment captures a wide range of data for many parameters and conditions – and produces a range of results. USEPA used the 90th percentile of that range as the basis for its CCR Rule. In essence, the CCR Rule is regulating not to mitigate the risks from an average case or the most common case, but as described above, to mitigate the risks from a worst-case scenario. Thus, the requirements in the CCR Rule are overly conservative.

[35] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21437.
[36] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21437.

3.2.2 USEPA Did Not have the Authority to Enforce the CCR Rule When Published – Thus the Rule is Protective of All Sites

USEPA did not have the direct authority to enforce the CCR Rule when it was promulgated and did not envision that it would be granted that authority. Therefore, USEPA decided that the requirements in the Rule had to be protective of the most sensitive CCR disposal scenario. As discussed in the previous section, the risk assessment was designed to predict the upper bound risk for all of the various disposal configurations and exposure scenarios – the worst-case scenario.

USEPA notes the following in the CCR Rule:

- "Because the regulations have been promulgated under sections 1008(a), 4004(a), and 4005(a) of RCRA, the rule does not require permits, does not require states to adopt or implement these requirements, and EPA cannot enforce these requirements."[37]
- "EPA has no role in the planning and direct implementation of the minimum national criteria or solid waste programs under RCRA subtitle D, and has no authority to enforce the criteria... While Congress developed the statutory structure to create incentives for states to implement and enforce the federal criteria, it does not require them to do so. As a result, subtitle D is also structured to be self-implementing."[38]
- The rule was promulgated "…under the provisions of sections 1008(a), 4004, and 4005(a) of RCRA (i.e., subtitle D of RCRA). These authorities, however, do not provide EPA with the ability to issue permits, require states to issue permits, approve state programs to operate in lieu of the federal program, or to enforce any of the requirements addressing the disposal of CCR. Consequently, EPA designed the proposed RCRA subtitle D option to ensure that the requirements will effectively protect human health and the environment within those limitations. The final rule establishes self-implementing requirements—primarily performance standards—that owners or operators of regulated units can implement without any interaction with regulatory officials."[39]
- "In an effort to ensure that the proposed RCRA subtitle D requirements would achieve the statutory standard of 'no reasonable probability of adverse effects on health and the environment' in the absence of guaranteed regulatory oversight, EPA also proposed to require facilities to obtain third party certifications and to provide enhanced state and public notifications of actions taken to comply with the regulatory requirements."[40]
- "…the regulatory structure under which this rule is issued effectively limits the Agency's ability to develop the type of requirements that can be individually tailored to accommodate particular site conditions. Under sections 1008(a) and 4004(a), EPA must establish national criteria that will operate effectively in the absence of any guaranteed regulatory oversight (i.e., a permitting program), to achieve the statutory standard of 'no reasonable probability of adverse effects on

[37] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21309.
[38] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21310.
[39] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21330.
[40] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21331.

> health or the environment' at all sites subject to the standards. EPA was unable to develop a performance standard that would allow for alternatives to closure, but would also be sufficiently objective and precise to minimize the potential for abuse."[41]

Thus, as CCR is a solid, not a hazardous, waste, the CCR Rule was written as a RCRA subtitle D program to ensure that its requirements would effectively and conservatively protect human health and the environment in the worst case scenario given the lack of enforcement authority.

3.3 OPINION 2 SUMMARY

It is my opinion that because proposed Part 845 is patterned on the federal CCR Rule, it also is conservative and overly protective. The federal CCR Rule was designed to be conservative and protective of the worst-case scenario (as determined by the CCR Risk Assessment) in the face of a lack of direct enforcement authority. **Where proposed Part 845 goes beyond the federal CCR Rule requirements it is not supported by the CCR Rule and its supporting documentation.** Since adoption of that rule, Congress via the WIIN Act has provided USEPA permitting authority where states do not implement CCR regulation, and IEPA is proposing such regulation of CCR surface impoundments in proposed Part 845 patterned on the federal CCR Rule. Thus, proposed Part 845 is also conservative, and here, overly conservative as the State does have the enforcement authority to implement the requirements in proposed Part 845.

[41] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21371.

4. Opinion 3: A single exceedance of a groundwater protection standard during assessment monitoring should not result in the initiation of corrective action

In contrast to the federal CCR Rule, proposed Part 845 inappropriately uses a single, confirmed exceedance of a groundwater protection standard during assessment monitoring as a trigger for the initiation of corrective action.

4.1 PROPOSED PART 845 APPROACH

IEPA has described a groundwater monitoring program in Section 845.650 that is inconsistent with the federal CCR Rule by modifying the trigger for entry into corrective action using a method that is not scientifically valid. Specifically, Section 845.650 d) states:

> "If one or more constituents are detected, and confirmed by an immediate resample, in exceedance of the groundwater protection standards in Section 845.600 in any sampling event, the owner or operator must notify the Agency which constituent exceeded the groundwater protection standard and place the notification in the facility's operating record…"

Thus, under proposed Part 845, corrective action is triggered by a single, confirmed exceedance of the Section 845.600 groundwater protection standards in a single downgradient well. This is in contrast to the federal CCR Rule which states at §257.96(g):

> "If one or more constituents in appendix IV to this part are detected at **statistically significant levels** above the groundwater protection standard established under paragraph (h) of this section in any sampling event, the owner or operator must prepare a notification identifying the constituents in appendix IV to this part that have exceeded the groundwater protection standard…" [emphasis added]

The salient difference in language and approach is that the federal CCR Rule identifies an exceedance that triggers corrective action only when the concentration of regulated constituent is statistically significantly above the groundwater protection standard – corrective action is not triggered by a single, confirmed exceedance.

The reason for taking a statistical approach has been summarized by Lynn E. Dunaway in his pre-filed testimony[42] on page 10 where he discusses the establishment of background groundwater quality:

> "The establishment of background necessarily includes the application of statistical methods to the analytical results. Since the quality of groundwater is known to have natural variations both spatially and temporally, statistics must be applied to the measured analytical results to estimate **the total possible variation that could be expected**. Statistics are applied because no

[42] Pre-filed testimony to the Illinois Pollution Control Board in the matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New 35 Ill. Adm. Code 845; R 2020-019; June 2, 2020.

> groundwater system can produce samples from all upgradient locations for all times. Therefore, a **representative sample** that can also account for seasonality is used as a reasonable substitute. The concentrations at which constituents occur, their minimum concentrations of detection, the **range of variability and distribution of the analytical results** are also factors. While acceptable statistical methods vary in the way they represent the likely variability in groundwater quality, all the statistical methods must be able to approximate actual conditions within a specified margin of error. The statistical calculations are used to determine if a statistically significant increase over background has occurred. This comparison will be between background groundwater quality and groundwater quality down gradient of the CCR surface impoundment(s)." [emphasis added]

The variability in constituent concentrations in groundwater upgradient of a surface impoundment is also characteristic of the variability in constituent concentrations in groundwater at the downgradient edge of a surface impoundment. Just as background conditions are not consistent and uniform, neither are the conditions in a surface impoundment. The contents of a surface impoundment can represent many years of facility operation with a range of characteristics – this variability is not captured by a single confirmatory downgradient groundwater sample result. Using a non-statistical approach to determine whether the downgradient data are above a groundwater protection standard is arbitrary. Such an approach can result in "false starts" to corrective action where not warranted.

Despite IEPA's support for using statistics to evaluate upgradient groundwater, Mr. Dunaway on page 4 of his testimony supports the arbitrary use of a non-statistical comparison to groundwater protection standards for evaluation of downgradient groundwater quality:

> "This approach makes it clear that concentrations in excess of the GWPS, in down gradient wells, do not need to have further increases in their current concentration, to initiate corrective action. An absolute numerical concentration also forestalls the application of different statistical methods which may result in a change to the trigger levels for either the initiation of or termination of corrective action. Such a change in statistical methods is quite possible due to the long monitoring history during post-closure care, which could change the statistical character of the groundwater monitoring data, necessitating the use of a different statistical method."

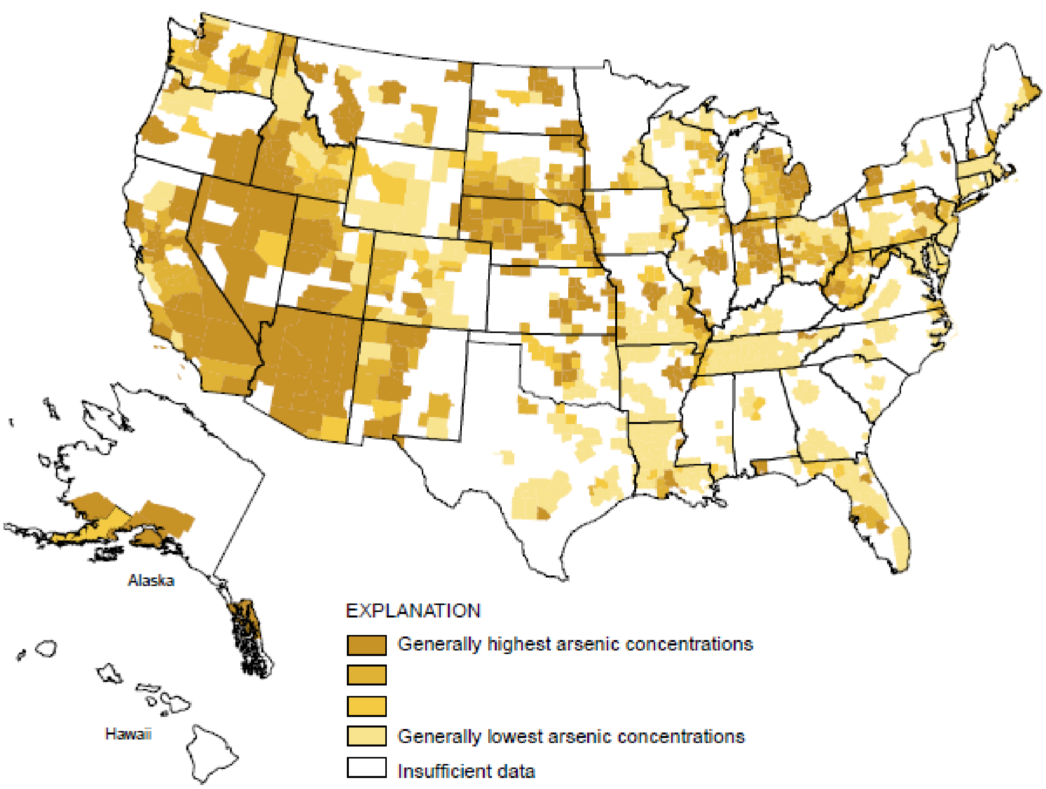
There is no compelling reason why variability would not apply to the downgradient well results, and why statistics suddenly become burdensome for evaluating downgradient groundwater quality, when (with good reason) statistics are necessary for evaluating upgradient groundwater quality. Moreover, this "simplification" in Section 845.650 is not any easier to implement because such statistics on the downgradient well data are currently required under the federal CCR Rule.

For example, arsenic can naturally be present in groundwater and those concentrations can be variable. Figure 4-1 is from a USGS report[43] and shows arsenic concentrations in groundwater across the U.S. by county. Focusing on Illinois, several counties have some of the highest concentrations of arsenic in

[43] https://pubs.usgs.gov/fs/fs063-00/pdf/fs063-00.pdf. USGS. 2000. Arsenic in Ground-Water Resources of the United States. Fact Sheet FS–063–00.

groundwater (concentrations above 10 ug/L), and several have some of the lowest concentrations. This graphic reflects the variability within the state. Arsenic is also a constituent listed in Section 845.600 with a groundwater protection standard of 10 ug/L. In the middle of the state where background concentrations of arsenic in groundwater are high, the background variability could result in a single downgradient result that is above the groundwater protection standard (whether based on background or a CCR surface impoundment) in one round of downgradient groundwater sampling but not in another.

Figure 4-1. Counties with arsenic concentrations in groundwater exceeding specific concentrations in 10% or more of groundwater samples.



- Counties with arsenic concentrations exceeding 10 µg/L in 10 percent or more of samples.
- Counties with arsenic concentrations exceeding 5 µg/L in 10 percent or more of samples.
- Counties with arsenic concentrations exceeding 3 µg/L in 10 percent or more of samples.
- Counties with fewer than 10 percent of samples exceeding 3 µg/L, representing areas of lowest concentration.
- Counties with insufficient data in the USGS data base to make estimates.

4.2 OPINION 3 SUMMARY

Therefore, it is my opinion that to ensure that corrective action is initiated based on sound statistical interpretation of both upgradient and downgradient groundwater monitoring results, the text in Section 845.650 d) should be revised to be consistent with the federal CCR Rule and refer to a "statistically significant increase above the groundwater protection standard."

5. Opinion 4: Proposed Part 845 closure prioritization Category 2 should be revised to address only conditions that could pose an imminent threat

Proposed Part 845 at Section 845.700 g) provides a classification for closure prioritization that is tiered from highest priority (Category 1) to lowest priority (Category 6). Category 1 includes surface impoundments that have impacted, or are within the setback of, an existing water supply. Such situations can reasonably be considered to pose an imminent threat to human health. Category 2 includes surface impoundments vaguely characterized as posing an imminent threat to human health or the environment, as further defined in Section 845.700 g) 5). However, the conditions itemized in (A) through (E) in that section do not all represent imminent threats. Item (B) (surface impoundments that have not demonstrated compliance with location restrictions in 845 Subpart C), and Item (D) (an exceedance of the groundwater protection standards in Section 845.600 has migrated off-site) should be removed from Category 2 as they do not represent imminent threats.

5.1 LOCATION RESTICTIONS DO NOT POSE AN IMMINENT THREAT

The Illinois Environmental Protection Act states, "'substantial and imminent damage' means a danger with a likelihood of serious or irreversible harm."[44] In proposed Part 845, neither Item (B), location restrictions, nor Item (D), exceedance of a groundwater protection standard moving off-site, meet this definition.

The condition described in Item (D) can occur without human exposure or potential exposure to that groundwater at those concentration levels—that groundwater may not be used as a source of drinking water. In fact, it is Category 1 of the prioritization tiers that addresses an impact on an existing water supply or an impact within the setback of an existing potable water supply. It is the Category 1 condition that addresses the imminent threat, not Category 2 Item (D).

The proposed Part 845 location restrictions for surface impoundments, referred to in Item (B) are the same as those found in the federal CCR Rule (§ 257.60-64) and are the following:

Section 845.300 – Placement above the Uppermost Aquifer
Section 845.310 – Wetlands
Section 845.320 – Fault Areas
Section 845.330 – Seismic Impact Zones
Section 845.340 – Unstable Areas

None of these conditions necessarily pose an imminent risk to human health or the environment. Indeed, USEPA characterized in the preamble to the Final Rule these same location restrictions as those necessary "to ensure that there will be no reasonable probability of adverse effects on health or the environment,"[45] which does not equate to the Category 2 condition of "an imminent threat to human health or the environment."

---

[44] http://www.ilga.gov/legislation/ilcs/ilcs5.asp?ActID=1585&ChapterID=36 – Illinois Environmental Protection Act – 415 ILCS 5/31 (c)(3)(B).
[45] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21360.

- Placement of an impoundment below/within the uppermost aquifer does not itself constitute an imminent threat. Groundwater data for upgradient and downgradient locations will be available for each impoundment, and those data and site-specific circumstances (e.g., are there users of the uppermost aquifer as drinking water downgradient of the impoundment?) will be used to determine if an imminent threat exists – which is the subject of Category 1 of the prioritization scheme.
- Placement in a wetland does not itself constitute an imminent threat. In fact, development can occur in wetlands, and a CCR unit can expand into a wetland as long as certain conditions are met.[46] One of these, "4) demonstrate that steps have been taken to attempt to achieve no net loss of wetlands," is used in commercial and residential development. In such cases, land can be purchased and a wetland established and maintained to mitigate the loss of wetland for a development. These activities do not constitute an imminent threat.
- With respect to the IEPA prioritization scheme, while location in a fault area, seismic impact area, or unstable area, may present an indeterminant risk at some point in the future, these are not immediate risks and do not need to be prioritized as Category 2.

5.2 OPINION 4 SUMMARY

Thus, it is my opinion that units that do not meet the location restrictions as described in Category 2 Item (B), and units where an exceedance of a groundwater protection standard moving off-site as described in Category 2 Item (D), do not pose an imminent threat to human health and the environment, and these items should be removed from the list of closure prioritization Category 2 factors in Section 845.700 g) 5). These items could more reasonable be added to Category 4 or Category 5 in the closure prioritization.

[46] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21364.

6. Opinion 5: CCR units that are capped or otherwise maintained, and units that receive only de minimis amounts of CCR do not present a risk warranting regulation

CCR units that are capped or otherwise maintained, and units that receive only de minimis amounts of CCR do not present a risk warranting regulation.

- The federal CCR Rule determined that these units are exempt from regulation and they should remain so under proposed Part 845. **To the extent proposed Part 845 applies to such units, Part 845 goes beyond the federal CCR Rule requirements and is not supported or necessary.**

6.1 CCR UNITS THAT ARE CAPPED OR OTHERWISE MAINTAINED

There is a functional difference between an inactive surface impoundment that no longer receives CCR but contains water and CCR, and one that contains CCR but no longer contains water and can no longer contain water (e.g., it has been capped or otherwise maintained). As USEPA notes "EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water."[47] USEPA goes on to state:

> "…the Agency has concluded that inactive CCR surface impoundments require regulatory oversight. The sole exception is for 'inactive' CCR surface impoundments that have completed dewatering and capping operations (in accordance with the capping requirements finalized in this rule)… EPA considers these units to be analogous to inactive CCR landfills, which are not subject to the final rule. As noted, EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water."

And,

> "EPA did not propose to require 'closed' surface impoundments to 'reclose.' Nor did EPA intend, as the same commenters claim, that 'literally hundreds of previously closed . . . surface impoundments—many of which were properly closed decades ago under state solid waste programs, have changed owners, and now have structures built on top of them—would be considered active CCR units. Accordingly, the final rule does not impose any requirements on any CCR surface impoundments that have in fact 'closed' before the rule's effective date—i.e., those that no longer contain water and can no longer impound liquid."[48]

These closed units are similar to CCR landfills, which do not contain free liquids and do not pose risks in the CCR Risk Assessment above the RCRA point of departure. Therefore, they do not warrant regulation under the federal CCR Rule, and they also do not warrant regulation under proposed Part 845.

[47] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21342.
[48] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21343.

6.2 UNITS THAT RECEIVE ONLY DE MINIMIS AMOUNTS OF CCR

USEPA specifically did not include units such as wastewater and holding ponds that "receive only de minimis amounts of CCR,"[49] as regulated units under its federal CCR Rule. USEPA supported that conclusion, including by noting that:

> "EPA reviewed the risk assessment and the damage cases to determine the characteristics of the surface impoundments that are the source of the risks the rule seeks to address. Specifically, these are units that contain a large amount of CCR managed with water, under a hydraulic head that promotes the rapid leaching of contaminants…" and "that units containing only truly ''de minimis'' levels of CCR are unlikely to present the significant risks this rule is intended to address."

USEPA then elaborated as follows:

> "…units that present significantly lower risks, such as process water or cooling water ponds,… although they will accumulate any trace amounts of CCR that are present, they will not contain the significant quantities that give rise to the risks modeled in EPA's assessment."

Therefore, USEPA did not regulate units containing de minimis amounts of CCR, such as those that contain small amounts of CCR from stormwater, air deposition, or pond overflows, nor should Part 845.

Nonetheless, IEPA apparently determined that Part 845 should apply to units that contain de minimis amounts of CCR, or at least some of them. See First Supplement to IEPA's Pre-Filed Answers, Dynegy Questions 14 and 15, R 2020-019 before the Illinois Pollution Control Board (referred to her as "IEPA Answers"). IEPA has conceded that it did not perform any risk assessment, or any other study, to understand any risks from such units or otherwise to support its deviation from USEPA's risk assessment and related conclusions. This is clear from IEPA Answers, Dynegy Question 16; IEPA's Statement of Reasons, page 44, R 2020-019 before the Illinois Pollution Control Board, which states, "The Illinois EPA did not perform any new studies, nor did the Illinois EPA contract with any outside entities to perform any studies for the development of this rulemaking proposal. Because no studies were conducted, there is no underlying data…" While IEPA did not assess any risks associated with de minimis units, USEPA did evaluate such units, as explained above, and found that such units presented no risk warranting regulation.

Further, IEPA's position could yield absurd results. For instance, very small amounts of CCR could be deposited through stormwater, air deposition, or pond overflows into process or stormwater ponds that have never been used to receive direct discharge or placement of CCR, in contrast to true CCR ponds that are designed to and do directly receive large amounts of CCR. Under IEPA's proposal all of these ponds, both those containing large amounts of CCR by design and those containing incidental, tiny amounts of CCR, could be subject to the same regulatory requirements under Part 845 even though they present very different risk profiles, as USEPA determined. Only units that contain significant amounts of CCR may present risks supporting regulation, as determined by USEPA's comprehensive and protective

[49] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21357.

risk assessment. IEPA has offered no risk assessment or other study to rebut USEPA's resulting decision to exclude units that contain de minimis amounts of CCR.

6.3 OPINION 5 SUMMARY

CCR units that are capped or otherwise maintained, and units that receive only de minimis amounts of CCR do not present a risk warranting regulation.

7. Opinion 6: OSHA regulations are applicable to work conducted under the proposed Part 845 and are effective for worker and community protection

Occupational Safety and Health Administration (OSHA) regulations, which ensure safe working conditions in the U.S., are applicable to work conducted under the proposed Part 845 and are effective for worker and community protection.

The federal CCR Rule made it clear in the preamble in "F. Operating Criteria—Air Criteria" that:

> "As evidenced in 42 U.S.C. 6971(f), Congress intended that the Occupational Safety and Health Administration (OSHA) be able to enforce its regulations to protect workers exposed to hazardous waste and that EPA and OSHA would work together to ensure that. EPA is clarifying that it intends that the CCR disposal rule not preempt applicable OSHA standards designed to protect workers exposed to CCRs; thus EPA's final rule on CCR disposal will apply in addition to any applicable OSHA standards." [50]

I agree with Lauren Martin's testimony[51] that:

> "Although the Preamble is not the actual regulation, other federal regulations, 29 CFR 1910 and 29 CFR 1926, provide air criteria requirements for site worker safety. Part 257 does not overrule or override worker safety protections. Worker safety protections when properly implemented will also protect the surrounding communities by controlling the hazards within the worksite. Worker safety protections on site, by extension, prevents the hazardous materials from traveling offsite in quantities that could impact the health and wellbeing of the surrounding community."

Furthermore, IEPA's proposed fugitive dust standard, which is patterned after the CCR Rule, provides additional protections as USEPA stated:

> "Therefore, rather than requiring a potentially redundant and challenging-to-implement quantitative standard, EPA is substituting a performance standard for fugitive dust control. This standard requires owners or operators of a CCR unit to adopt measures that will effectively minimize CCR from becoming airborne at the facility, including CCR fugitive dust originating from CCR units, CCR piles, roads, and other CCR management activities. The Agency considers this standard to be consistent with the intent of the proposed rule, with the added advantage of allowing facilities the flexibility to determine the appropriate measures to achieve regulatory compliance at their individual site. This standard and the accompanying regulatory requirements supporting its implementation, will achieve the statutory obligation of ''*no reasonable probability of adverse effects on human health and the environment*.''[52] [original emphasis]

[50] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21386.
[51] Pre-filed testimony to the Illinois Pollution Control Board in the matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New 35 Ill. Adm. Code 845; R 2020-019; June 2, 2020.
[52] CCR Rule. EPA-HQ-RCRA-2009-0640-11970; p21387.

7.1 OPINION 6 SUMMARY

Therefore, it is my opinion that proposed Part 845 is protective and effective both for worker safety and off-site receptors.

8. References

1. ACS. 2020. Cancer Statistics, 2020. RL Siegel, KD Miller, A Jemal, American Cancer Society. Ca Cancer J Clin 2020; 70:7–30. doi: 10.3322/caac.21590. Available at: https://acsjournals.onlinelibrary.wiley.com/doi/epdf/10.3322/caac.21590

2. EPRI. 2010. A Risk-Based Comparison between Coal Combustion Product Landfills and Impoundments and Municipal Solid Waste Landfills. EPRI Research Report No. 1020555. Available for download at www.epri.com.

3. USEPA. 1989. Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. Washington, D.C.: U.S. Environmental Protection Agency. EPA 540/1-89/002. Available at: http://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part.

4. USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for designing and conducting ecological risk assessments. US Environmental Protection Agency, Solid Waste and Emergency Response, OSWER 9285.7-25. PB97-963211. EPA 540-R-97-006. Available at: http://www.epa.gov/risk/ecological-risk-assessment-guidance-superfundprocess-designing-and-conducting-ecological-risk.

5. USEPA. 2014a. Human and Ecological Risk Assessment of Coal Combustion Residuals. Final. December 2014. U.S. Environmental Protection Agency. Regulation Identifier Number: 2050-AE81. EPA-HQ-RCRA-2009-0640-11993. Available at: https://www.regulations.gov/

6. USGS. 2014. 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014–1082, 386p. Available at: http://dx.doi.org/10.3133/ofr20141082.

Exhibit A

Resume
Lisa JN Bradley, Ph.D., DABT

HALEY ALDRICH

LISA J.N. BRADLEY, PH.D., DABT

Principal Toxicologist | Senior Client Leader

EDUCATION

Ph.D., Toxicology, Massachusetts Institute of Technology
B.S., Zoology, University of Idaho,
B.S., Chemistry, University of Idaho, Summa Cum Laude

PROFESSIONAL REGISTRATIONS

American Board of Toxicology, Diplomate

PROFESSIONAL SOCIETIES

American Board of Toxicology
Society of Toxicology

Lisa has a Ph.D. in toxicology from the Massachusetts Institute of Technology and has 25 years of experience in risk assessment and toxicology and is certified by the American Board of Toxicology. She has managed risk assessments for hazardous waste sites in many U.S. Environmental Protection Agency (USEPA) Regions, and under many state programs. Lisa is experienced in agency negotiations, as well as public speaking and environmental communications, and she has published articles in peer reviewed scientific journals based on both her laboratory and risk assessment work. She has also conducted risk assessments for coal ash landfills, environmental communications for proposed landfills, and has worked with clients to evaluate and comment on state groundwater standards for coal ash related constituents. Lisa has been active with utilities and industry trade groups in responding to USEPA's proposed rulemaking. She has published and given many talks on various aspects of coal combustion product (CCP) risk assessment issues and the proposed rules. She has served as an expert witness on coal ash, risk assessment, and toxicology for litigation on coal ash. She has been active with American Coal Ash Association (ACAA), served an elected 2-year term on the ACAA Executive Committee, and began a 2-year term as Secretary/Treasurer of ACAA in June 2014, and is serving her third two-year term. In May 2014, Lisa was appointed to the National Coal Council (NCC) by the U.S. Secretary of Energy to provide risk assessment and toxicology expertise to the NCC, and has been reappointed each year since; she served as the chair of the Communications Committee and served on the Executive Committee, 2017-2019, and is a member of the Coal Policy Committee. In 2015, Lisa was recognized as one of the top women in mining by the non-profit organization, Women in Mining UK, in its 100 Global Inspirational Women in Mining 2016 report.

RELEVANT PROJECT EXPERIENCE

Representative Coal Ash Project Experience

Pines Area of Investigation, Indiana, USEPA Region 5. Lisa served as the project manager for a multi-disciplinary team that conducted the Remedial Investigation/Feasibility Study (RI/FS) for the Respondents of an Administrative Order on Consent (AOC) administered under the Superfund Alternative program in USEPA Region 5. The AOC addresses the placement of coal combustion by-products (CCBs) within a local permitted landfill and allegedly used as fill in other locations within the area of investigation. Activities included agency negotiations on the AOC and scope of work; submission of a Site Management Strategy document, and subsequent approval by the Agency; submittal of the RI/FS Work Plan (including a Field Sampling Plan, Human Health and Ecological Risk Assessment Work Plans, Health & Safety Plan, Quality Assurance Project Plan, and a Quality Management Plan), and subsequent approval by the agency; submission of additional Sampling and Analysis Plans; and communications activities (including a website – www.pinesupdate.com - and regular mailings of information updates to the community).

Regular communications with the agency is also a cornerstone of the project. As the site covers not a facility, but a town and surrounding area, executing access agreements with the landowners for sampling and well installation was a critical task. The Final RI Report has been approved and posted to USEPA's website, and the Human Health Risk Assessment Report and the Ecological Risk Assessment Report have been approved. The Final FS has been approved by the agency, and the ROD was issued on September 20, 2016. Project documents are available on USEPA's website: http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0508071.

Ameren UE, St. Louis, Missouri. Lisa is serving as toxicology and risk assessment expert for the coal ash management areas at four Missouri coal-fired power plants. Conducted risk evaluations for groundwater, provided guidance on surface water sampling and analysis plans, and used these data a data for groundwater and publicly available data to develop risk evaluation reports for each of the facilities. These reports were used to provide context to the groundwater results developed under the USEPA Coal Combustion Residuals Rule. Participated in public meetings for each facility.

Duke Energy, North Carolina. Lisa is providing communications support on various risk assessment and toxicology topics. Have conducted interviews with various member of the press at the client's request. Have most recently developed a white paper on the occurrence of thyroid cancer in a specific area of North Carolina that was published on the Duke Energy website, available here: https://news.duke-energy.com/our-perspective/science-instead-of-speculation-examining-coal-ash-and-health-concerns

AES, Puerto Rico. Lisa is serving as toxicology and risk assessment expert for the coal ash management area at the AES Puerto Rico facility. Developed a risk evaluation of groundwater at the facility. Updated the risk information to provide context for the Corrective Measures Assessment, a report required under the USEPA Coal Combustion Residuals Rule. She provided support for a public meeting on the report.

Duke Energy, North Carolina. Lisa served as the toxicology and risk assessment expert in a variety of projects, including: development of a risk assessment work plan for a 14-site program, and review of the risk assessments prepared by other contractors; risk-based review of private well data collected by the state agency for 14 sites, and managing a team providing a detailed evaluation of the data including comparison to risk-based screening levels, detailed statistical comparisons to background, groundwater flow evaluation, and groundwater geochemistry evaluations. She has prepared expert reports for state and federal cases and has been deposed.

Ameren UE, St. Louis, MO. Lisa served as an expert for a landfill siting project in Missouri, for issues related to exposure, toxicity and risk assessment. Provided public testimony at a county board meeting as well as written comments that have been submitted into the record. The landfill operating permit was obtained in October 2016.

Ameren UE, St. Louis, MO. Lisa served as an expert for the development of site-specific regulation for the closure of former Ameren coal ash impoundments in Illinois. Participated in the development of a risk-based system for prioritization closure of the impoundments and developed a white paper on the program that was submitted to the State as part of the rule-making process.

Ameren UE, St. Louis, MO. Lisa is currently providing toxicology and risk assessment support for various projects in Illinois and Missouri.

Tennessee Valley Authority, Tennessee. Lisa is currently serving as toxicology and risk assessment expert in a variety of projects, including federal and state court cases for the Gallatin Fossil Plant, development of conceptual site models for the TVA fossil plants, and developing post-excavation sample evaluation plans.

Confidential Client, West Coast. Lisa developed a beneficial use evaluation for coal ash being used as void fill and fire suppressant in a construction landfill, following the definition of beneficial use in the USEPA Coal Combustion Residuals (CCR) Rule. The report was accepted by the permitting agency.

Aurora Energy, Fairbanks, AK. Lisa provided a detailed beneficial use evaluation for a local project following the 4 criteria outlined in the USEPA CCR Final Rule. The project team developed an engineering checklist for this and similar projects than can be used with local contractors.

Confidential Client, Midwest. Lisa evaluated an Imminent and Substantial Endangerment (ISE) Claim. She conducted an evaluation of surface water, sediment, and soil data used by USEPA to support an Imminent and ISE claim in a draft AOC. The evaluation included a review of USEPA's approach to evaluating the risks associated with the placement of fill material containing fly ash in a wetland and the potential for downstream impacts. The review concluded that the data did not support USEPA's ISE claim, and the Agency agreed.

Utility Solid Waste Activities Group (USWAG), Washington, DC. Lisa worked with USWAG on developing comments on USEPA's October 2011 Notice of Data Availability (NODA), specifically on the risk assessment aspects of the NODA. Comments were submitted to USEPA under USWAG cover, November 2011.

USWAG, Washington, DC. Lisa reviewed and developed comments on the risk assessment aspects of USEPA's June 2010 proposed rulemaking for the disposal of coal combustion residuals (CCRs). Comments focused on a critique of the USEPA's updated human health and ecological risk assessment, a critique of the USEPA's fugitive dust model report, and a critique of USEPA's proposed listing of CCRs as a hazardous waste under RCRA Subtitle C. Comments were submitted to USEPA under USWAG cover, November 2010.

USWAG, Washington, DC. Lisa reviewed and developed comments on the USEPA's risk assessment for CCR. The risk assessment was released in 2007, and comments were submitted under USWAG cover in January 2008. She addressed all aspects of the risk assessment including human health, ecological risk, and fate and transport. She provided oral comments during a national teleconference.

USWAG, Washington, DC. Lisa developed an information sheet on "What is Coal Ash" for use by the USWAG membership for community relations.

Electric Power Research Institute, Palo Alto, CA. Lisa developed the report "Comparison of Risks for Leachate from Coal Combustion Product Landfills and Impoundments with Risks for Leachate from Municipal Solid Waste Landfill Facilities," EPRI Report Number 1020555, available at www.epri.com.

Prairie State Energy Campus, Washington County, IL. Lisa provided presentation to county board on coal ash composition and health risk issues as part of a coal ash landfill siting matter. She provided a similar presentation to the public in an informational meeting.

We Energies, Milwaukee, WI. Lisa reviewed the basis of the state and USEPA screening levels and toxicity values for molybdenum, and demonstrated the over-conservatism used in their derivation. She provided the review to the state agency and developed a fact sheet on molybdenum in groundwater for communications with a local community.

We Energies, Milwaukee, WI. Lisa reviewed the basis of the state screening levels and toxicity values for aluminum as part of review of the Wisconsin Department of Natural Resources proposed groundwater standards under NR 140. She provided testimony for a board hearing, and met with the state regulators and demonstrated the over-conservatism used in their derivation.

Ameren UE, St. Louis, MO. Lisa developed a human health and ecological risk assessment to support the regulatory closure under the state agency of a former ash impoundment located along a major river at the Hutsonville, IL Power Station. Boron and molybdenum were constituents of interest. Pathways evaluated in the risk assessment included use of groundwater for irrigation purposes and the migration of groundwater to the river and potential impact on the benthic community. Work included negotiation meeting with the local agency.

South Carolina Electric & Gas, Columbia, South Carolina. Lisa provided presentation materials for use in a landfill siting and zoning process. Materials addressed the comparison of arsenic and other metals and radionuclides in coal ash and in our natural environment, and background levels of arsenic in foods and background levels of exposure to radioactivity in our natural environment.

Confidential Client, Multi-state Midwest. Lisa provided coal ash material-specific beneficial use evaluations from 10+ facilities in the midwest to support future project-specific evaluations. She developed a tiered screening approach to evaluate the suitability of each material for a range of potential beneficial uses.

Ameren UE, Missouri. Evaluation of Imminent and Substantial Endangerment (ISE) Claim. Conducted an evaluation of surface water, sediment, and soil data used by USEPA to support an ISE claim in a draft AOC. The evaluation included a review of USEPA's approach to evaluating the risks associated with the placement of fill material containing fly ash in a wetland and the potential for downstream impacts. The review concluded that the data did not support USEPA's ISE claim, which was later withdrawn.

Charah, Inc., Louisville, KY. Lisa developed a Safety Data Sheet (SDS) for a flue gas desulfurization (FGD) gypsum project for commercial use. Helped to develop fact sheets, frequently asked questions and answers, and worked to respond to distributor questions about the product.

Charah, Inc., Louisville, KY. Lisa provided a detailed beneficial use evaluation for a structural fill project following the 4 criteria outlined in the USEPA CCR Final Rule. Provided an environmental justice evaluation of the project at the request of the reviewing agencies.

Representative Superfund Experience

Pines Area of Investigation, Indiana, USEPA Region 5. [See above under Representative Coal Ash Experience.]

Aurora Energy, Fairbanks, AK. Lisa provided consulting services for a USEPA HRS scoring investigation of the coal-fired power plant. Activities have included fact sheet preparation, frequently asked questions and answers, document review, strategy development, and risk-based evaluation of detailed coal and coal ash data sets for the facility.

Potentially Responsible Party (PRP) Group for Urban River Superfund Site, Region 2. Lisa provided senior review for the HHRA of an urban waterway. The risk assessment included fish consumption as a critical exposure pathway, with dioxins and polychlorinated biphenyls (PCBs), as well as non-traditional contaminants including pathogens and emerging contaminants, as exposures of interest. Work included agency negotiations.

Delaware Sand & Gravel Remedial Trust, Delaware, USEPA Region 3. Lisa prepared an HHRA focusing on evaluation of the vapor intrusion exposure pathway for the PRPs at a former drum disposal area to evaluate the effectiveness of a bioremediation system installed as a result of a USEPA Superfund Record of Decision Amendment. A tiered vapor intrusion assessment was performed consistent with USEPA guidance using groundwater and then soil gas data. It was successfully concluded, with acceptance from USEPA Region 3, that no unacceptable risk to human health was posed to occupants of on-site buildings via the vapor intrusion inhalation pathway.

Solutia, Inc., Sauget Area 1, Illinois, USEPA Region 5. Lisa prepared an HHRA work plan to follow Superfund guidelines for several abandoned landfill areas and areas down gradient of the landfills. The work plan was accepted by USEPA Region 5. A comprehensive human health risk assessment was prepared that evaluated the former land fill areas, as well as local residential areas, a creek, and a borrow pit lake. A total of 64 receptor and area scenarios were quantitatively evaluated. Supporting risk modeling included indoor and outdoor air from subsurface soil and groundwater. Activities included site visits, meetings with personnel from USEPA Region 5 and their contractors, and preparations of responses to comments and document revisions. The HHRA has been accepted by the agency, and the results have been used to guide the FS and remedy selection. Constituents of interest included PCBs in ditch sediments. The final report is available on USEPA's website:
http://www.epa.gov/region5/cleanup/saugetarea1/pdfs/sauget1_deadcreek_final_remedy_200604.pdf

Sauget Area 2 Sites Group, Illinois, USEPA Region 5. Lisa served as the senior human health risk assessment manager for a multi-party PRP group. Prepared a human health risk assessment work plan to follow Superfund guidelines for a set of sites that include abandoned landfill areas. Conducted the multi-receptor, multi-pathway human health risk assessment, including vapor intrusion modeling for both indoor and outdoor air for the multiple multi-acre sites within the project area. Activities included a site visit, meetings and negotiations with USEPA Region 5 and their contractors, and preparation of responses to comments. The HHRA was approved by USEPA Region 5, and the results have been used to guide the FS and remedy selection.

Columbia Gas Transmission, West Virginia, USEPA Region 3. Lisa served as strategic risk assessment advisor to a multi-site, 10-state AOC with USEPA Region 3 to assess environmental conditions along their pipeline system in the mid-Atlantic states. She provided strategic risk assessment advice and technical support on the design and implementation of the program and developed a programmatic approach to the evaluation of risk across the program. Was responsible for: review of other contractor reports; development of a common strategy for total petroleum hydrocarbon (TPH) and mercury to be used across the program; review and summary of risk assessment regulations and guidance for each of the states (Ohio, Pennsylvania, West Virginia, Virginia, Kentucky, North Carolina, Delaware, New Jersey, Maryland, New York, and Louisiana); conducted risk assessments; provided critical review of individual site characterization reports prepared by other contractors; and provided support in negotiations and meetings with regulators. Additional constituents of interest included PCBs, arsenic, and polycyclic aromatic hydrocarbons (PAHs).

Tippecanoe Landfill, Indiana, USEPA Region 5. Lisa conducted agency negotiations (USEPA Region 5) concerning the HHRS for a Superfund site. Because arsenic concentrations in groundwater were of concern to the agency, researched and reviewed the toxicological information available for arsenic and prepared a literature review and evaluation of the dose-response values developed by the USEPA for arsenic.

Industri-Plex CERCLA Site, Risk Assessment Review and Strategy for PRP Group, Massachusetts, USEPA Region 1. Lisa provided risk assessment review and strategy for PRP group and developed risk assessment work plan to address surface water and groundwater exposure pathways.

Tennessee Valley Authority, Tennessee, USEPA Region 4. Lisa prepared an HHRA and developed target cleanup levels for an abandoned battery manufacturing site. Primary constituent was lead and both child and adult lead models were used in the evaluation.

Confidential Client, New Jersey, USEPA Region 5. Lisa conducted an HHRA for a school district's baseball fields located adjacent to a potential Superfund site. Report was prepared for community distribution and results presented at a public meeting.

Motco Superfund Site, Texas, USEPA Region 6. Lisa reviewed USEPA-developed acute inhalation criteria (AIC) for volatile organics. She developed a consistent and scientifically defensible methodology for AIC development and applied this methodology to provide alternative AICs for use at the site.

Brio Site Task Force, Texas, USEPA Region 6. Lisa developed acute inhalation criteria for use in a remedial program for benzene, 1,1-dichloroethane, 1,2-dichloroethane, ethyl benzene, methylene chloride, styrene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and vinyl chloride.

Representative RCRA Experience

Solutia, Inc., J.F. Queeny Facility, St. Louis, MO. Lisa provided oversight for the HHRA prepared for the facility under an order with USEPA Region 6. The risk assessment is designed to meet the requirements of both USEPA and the State of Missouri Risk-Based Corrective Action Program.

Solutia, Inc., W.G. Krummrich Facility, Sauget, IL, USEPA Region 5. Lisa developed the HHRA work plan and report for the Resource Conservation and Recovery Act (RCRA) Sampling Plan for Solutia's W.G. Krummrich Facility. The work plan was designed to permit evaluation of the "Human Exposures Environmental Indicator" as well as human health risk. Used risk assessment and data visualization to identify extent of areas for remediation such that total site risk would not exceed target risk levels once remediation is complete. Also used the risk assessment to identify remedial treatment objectives for soils and groundwater. Target chemicals included PCBs and chlorinated compounds. Used the risk assessment as the basis for evaluating the effectiveness and protectiveness of soil vapor extraction remedies to inform shut-down decision-making.

U.S. Steel, Gary, IN, USEPA Region 5. Lisa developed the RCRA RFI Human Health Risk Assessment Work Plan for the U.S. Steel (USS) Gary Works. Activities included response to regulatory comments on previous reports, site visits, review of reports generated both by USS and by local groups about the facility and its environs, development of the risk-related portions of the facility-wide RCRA RFI work plan, in addition to the HHRA work plan, and agency negotiation. She participated in strategy development for and preparation of the human health sections of the Sampling and Analysis Plans for each of the Solid Waste Management Areas being addressed at Gary Works under RCRA (13 in total). Managed and prepared the human health risk evaluation of perimeter groundwater data. Work included conducting a two-tiered, well-by-well screening (55 wells total). The first-tier comparison was to generic and readily available standards, and the second tier took into account background and dilution into receiving water bodies and evaluated construction worker and indoor air scenarios.

U.S. Steel, Fairless Hills, PA, USEPA Region 3. Lisa prepared the human health risk evaluation under RCRA Corrective Action for a parcel of property to be leased by USS at Fairless Works. The work was conducted to satisfy Pennsylvania Department of Environmental Protection (PADEP) requirements under the Pennsylvania Act 2 program, as well as USEPA Region 3 requirements. Activities included site visit, meetings, and presentations to both agencies, as well as preparation of memoranda and reports. Included in the evaluation was a sensitivity analysis of the parameters used to evaluate a construction worker scenario; site-specific parameters, parameters from the scientific literature, and parameters provided by the agency were evaluated.

U.S. Steel, Fairfield, AL, USEPA Region 4. Lisa developed the RCRA RFI HHRA Work Plan for the USS Fairfield Works under USEPA Region 4 and Alabama Department of Environmental Management (ADEM) requirements. Activities included site visits, preparation of strategy, review of the full RFI work plan to ensure consistency with risk objectives, and preparation of responses to agency comments. Work included a detailed evaluation of USEPA's current and proposed adult soil ingestion rates.

Hartford Working Group, Hartford Hydrocarbon Plume Site, Hartford, IL, USEPA Region 5. Lisa provided toxicology and risk assessment services to the PRP group for the Hartford Hydrocarbon Plume site in Hartford, IL. She provided review of indoor air screening levels developed by the agencies for benzene, butane, isopentane, trimethylbenzene, and other petroleum-related constituents used in vapor intrusion evaluations.

Representative Risk Assessment Experience Under Other Programs

NiSource, Risk Assessment Issues, Columbus, OH. Lisa is currently serving as the HHRA expert for NiSource's environmental programs. She has addressed issues related to PCBs (including conducting employee informational meetings), manufactured gas plant (MGP) related constituents (benzene, PAHs), radon, and mercury.

Confidential Utility, Midwest. Lisa has provided PCB expert support for issues related to PCBs in natural gas pipeline systems and potential residential and commercial exposures.

Bureau of Land Management, Environmental Impact Statement, Western U.S. Lisa developed an HHRA to evaluate five pesticides proposed for use in Bureau of Land Management (BLM) vegetation treatment programs. The risk assessment used standard USEPA Office of Pesticide Policy risk assessment methods and includes use of the AgDRIFT model to evaluate off-site spray drift and deposition, and transport models to evaluate surface water impacts. Worker, public, and Native American subsistence receptors were evaluated. Work included interagency scoping meetings. 2007.

Bureau of Land Management, Environmental Impact Statement (EIS), Western U.S. Lisa conducted an HHRA for additional pesticides for BLM vegetation treatment programs following the protocol developed for the 2007 BLM Vegetation EIS.

U.S. Steel, Pennsylvania. Lisa worked in conjunction with another firm and USS personnel to develop a standardized Risk Evaluation Guidance Manual for USS. The manual addressed important issues in human health and ecological risk assessment, provides background for the issues, USS strategy to address the issues, and examples of standard language and references to be used in future USS reports. The manual allowed for more cost-effective and consistent risk evaluations to be conducted for USS facilities and sites.

U.S. Steel, Indiana. Lisa reviewed several draft versions of Indiana's "Risk Integrated System for Closure" (RISC) guidance and submitted comments to the agency. Detailed comments were provided on the following topics: construction worker soil ingestion rate, soil saturation limit, and arbitrary caps for metals concentrations in soil. Prepared comments on Indiana's draft groundwater policy and The User's Guide that details how the RISC program will be applied to RCRA sites under state authority.

U.S. Steel, Fairfield, AL. Lisa conducted a human health risk evaluation for a parcel of property to be leased by USS at Fairfield Works. Activities included evaluation of a construction worker scenario and use of the Johnson & Ettinger and ASTM models to evaluate indoor and outdoor air.

West Virginia Manufacturer's Association (WVMA), West Virginia. Lisa worked with the WVMA on a committee to review and provide language to the West Virginia Department of Environmental Protection in development of their tiered site closure guidance.

Indiana Department of Environmental Management (IDEM), Indiana. Lisa served on an IDEM committee to review and provide language in the development of revisions to the RISC guidance.

Representative Toxicology Experience

USWAG, Washington, DC. Lisa provided oversight of comments developed on the proposed listing of naphthalene as a carcinogen by the National Toxicology Program, and on the USEPA's childhood cancer document.

Electric Power Research Institute, California. Lisa worked with another ENSR toxicologist to develop a critique of the benzo(a)pyrene toxicity value developed by the United Kingdom for their Contaminated Lands program.

Confidential Natural Gas Client, Ohio. Lisa provided toxicity assessment of cleaning compounds proposed for use in the decommissioning of a natural gas pipeline laid on the bed of a reservoir that serves as the primary drinking water source for a community. Demonstrated that even should a catastrophic release of cleaning fluid and/or PCBs occur, human and ecological health would not be adversely affected and that concentrations at the drinking water intake would be much lower than health-based values or detection limits.

Confidential Client, Indiana. Lisa provided a review of the toxicology and potential carcinogenicity of two structurally similar proprietary industrial chemicals. Used recent data on the nongenotoxic/ cytotoxic mechanism of action of a class of potential carcinogens to demonstrate that a safe level for worker exposure exists.

USEPA, Literature Review. Lisa developed a strategy for evaluating absorption data in the literature and applied it to the development of absorption adjustment factors for oral and dermal exposures to soil and water for five metals of concern at hazardous waste sites (arsenic, cadmium, chromium III, chromium VI, inorganic mercury, organic mercury, and nickel) based on a thorough review of the literature.

Representative MGP Experience

Natural Gas Company, Ohio. Lisa is currently serving as strategic risk assessment advisor to the manager of MGP sites. Work includes conducting risk assessments for MGP sites under various state programs, evaluation of program-wide vapor intrusion data, regulatory negotiations, environmental communications, and employee meetings.

Natural Gas Company, Former MGP Site Advisor, Wisconsin. Lisa reviewed remediation plans and fenceline monitoring plans, presented at public meetings discussing the air monitoring plan, and reviewed fenceline monitoring data for a remediation project.

Energy Company, Former MGP Site Review, Rhode Island. Lisa provided senior review of an air monitoring program and identified where flexibility can be used in the development of fenceline air monitoring standards.

Village of Oak Park, Former MGP Site Advisor, Illinois. Lisa provided senior review of remediation plans and fenceline monitoring plans and provided air monitoring data evaluation. Was involved in regulatory meetings, negotiations, and presentations to the Village council, including public meetings concerning air monitoring aspects of the project.

Representative Litigation Experience

Ameren UE, St. Louis, Missouri. Lisa served as an expert for a landfill siting project in Missouri, for issues related to exposure, toxicity, and risk assessment. She provided public testimony at a county board meetings, utility board meetings, and opinions for litigation, as well as written comments that have been submitted into the record. The landfill received the permit and is currently operating.

AES, New York. Lisa provided expert testimony on the lack of human health effects of ammonia in groundwater associated with coal ash landfills. She developed expert opinion, reviewed and critiqued opposing opinions, and testified at hearing.

AES, Puerto Rico. Lisa provided review and synthesis of data associated with a beneficial use product, AGREMAX™, manufactured by AES Puerto Rico using bottom ash and fly ash from the coal-fired power plant. Specifically, she conducted an evaluation of data on metals content, leaching of metals, and radionuclides were shown not to pose a human health or environmental risk based on the beneficial uses of AGREMAX™. She testified twice on behalf of AES at Puerto Rico Senate subcommittee hearings on coal ash issues.

AES, Puerto Rico. Lisa served as an expert on the presence of polycyclic aromatic hydrocarbons (PAH) in coal ash, and the lack of toxicity based on content and exposure.

- ANAJAI CALCAÑO PALLANO, et al., v. THE AES CORPORATION, et al., No. N09C-11-021 JRJ (Del. Super. Ct.); deposition, April 10, 2015.

Duke Energy, North Carolina. Lisa is serving as expert witness in litigation concerning coal ash impoundments. She provided expert report, rebuttal, and has been deposed in the matter.

7-Eleven, Indiana. Lisa evaluated groundwater and soil gas data for vapor intrusive to indoor air using the USEPA version of the Johnson and Ettinger model. She used the Johnson (2002) sensitivity analysis method to ensure that critical model parameters were within acceptable/ realistic ranges. She provided deposition testimony and testimony in a court hearing on both the vapor intrusion pathway risk assessment and the toxicology of benzene. The case settled out of court.

Tennessee Valley Authority, Gallatin Fossil Plant, Tennessee. Lisa served as risk assessment and toxicology expert for litigation in Federal and in State courts. She provided an expert report on the matter.

Columbus, Ohio. Lisa served as risk assessment and toxicology expert for a case involving pesticides in a residential community. Provided an expert report and was deposed. The case settled out of court.

COMMITTEES

Elected Secretary/Treasurer of the American Coal Ash Association Executive Committee, and member of the Government Relations Committee, and the Women's Leadership Forum.

Appointed to the National Coal Council by the U.S. Secretary of Energy to provide counsel on toxicology and risk assessment issues; served as Chair of the Communications Committee, and serving on the Coal Policy Committee.

PUBLICATIONS AND PRESENTATIONS

Publications

"Coal Ash in Context," LJN Bradley. In "Coal Combustion Products (CCP's) – Characteristics, Utilization and Beneficiation," edited by T Robl, A Oberlink, and R Jones. Woodhead Publishing, Elsevier. 2017. ISBN: 978-0-08-100945-1. dx.doi.org/10.1016/B978-0-08-100945-1.00018-6

"Coal Ash in Context," LJN Bradley. OpEd piece for the El Regional, a Puerto Rican news publication. 24 August, 2016. Translated into Spanish. Available at: https://issuu.com/regionaldigital.com/docs/el_regional_882

"Coal Ash Ecological Risk Assessment in Context: Lessons Learned from the Kingston Fossil Plant Ash Spill," LJN Bradley, Special Series: Ecological Risk Assessment for Residual Coal Fly Ash at Watts Bar Reservoir, Tennessee. Integrated Environmental Assessment and Management. 2015. Available at: http://onlinelibrary.wiley.com/doi/10.1002/ieam.v11.1/issuetoc

"Using Good Science to Communicate Toxicity, Exposure, and Risk," LJN Bradley, EM, Air & Waste Management Association, April 2013. www.awma.org

"Coal Ash Material Safety: A Health Risk-Based Evaluation," with L. Bradley, American Coal, Issue 2, 2012. Available at: www.americancoalonlime.com.

"Coal Ash Material Safety: A Health Risk-Based Evaluation of USGS Coal Ash Data from Five US Power Plants," with L. Bradley, Ash at Work, Issue 1, 2012. Available at: www.acaa-usa.org.

"Coal Ash Material Safety: A Health Risk-Based Evaluation of USGS Coal Ash Data from Five US Power Plants," June 2012. Report prepared for the American Coal Ash Association. Available at: www.acaa-usa.org.

"Coal Ash in Context: Separating Science from Sound Bites as Regulatory and News Media Debates Continue," with L. Bradley and J. Ward, Ash at Work, Issue 1, 2011. Available at www.acaa-usa.org.

"Management of Coal Ash Disposal and Household Trash – Do They Need to be Different?" with L. Bradley, Energeia, Volume 22, No. 4, 2011. Available at: http://www.caer.uky.edu/energeia/enerhome.shtml.

"Comparison of Risks for Leachate from Coal Combustion Product Landfills and Impoundments with Risks for Leachate from Municipal Solid Waste Landfill Facilities," with L. Bradley, EPRI Report Number 1020555, available at www.epri.com.

Presentations

"When Science, Advocacy, Public Health, and Politics Collide: What You Need to Know About Hexavalent Chromium." Presentation at the ACAA Fall Meeting. Birmingham, AL. September 2016.

"Vanadium – What Should Constitute a "Do Not Drink" Warning?" Poster presented at the annual Society of Toxicology meeting. New Orleans, LA. March 2016.

"Coal Ash Risk Assessments – What Do They Tell Us?" Presentation at the World of Coal Ash. Nashville, TN. May 2015.

"Putting Toxicity and Risk into Context for CCP Disposal and Beneficial Use." Presentation at the World of Coal Ash Short Course. Nashville, TN. May 2015.

"The Truth About Coal Ash – What No One Else Will Say." Presentation at the EUCI Workshop – Coal Combustion Residuals: Policy, Handling, and Management of Ash. Nashville, TN. April 2, 2015.

"Groundwater and Surface Water Investigation Approach to Evaluate Potential Environmental Impact of Coal Ash Management Practices at Coal-Fired Power Plants." Presentation at Electric Power 2015, Chicago, IL, April 2015; and The World of Coal Ash, Nashville, TN, May 2015.

In-house presentations on coal ash topics to Duke Energy, Tampa Electric, and Santee Cooper, 2015.

"Conceptual Site Models for Coal Ash Use and Disposal, and Putting Toxicity and Risk into Context." Invited presentation at the World of Coal Ash (WOCA) Short Course on The Science of Ash Utilization, Lexington, KY, April 2013.

"Coal Ash Material Safety: A Health Risk-Based Evaluation of USGS Coal Ash Data from Five US Power Plants," with L. Bradley, poster presented at the Society of Toxicology Annual meeting, San Antonio, TX, March 2013. Abstract 2211, The Toxicologist, Volume 132, Issue 1. Available at: www.toxci.osfordjournals.org.

"Key Decisions in Establishing National Ambient Air Quality Standards," with L. Fraiser and L. Bradley, poster presented at the Society of Toxicology Annual meeting, San Antonio, TX, March 2013. Abstract 1567, The Toxicologist, Volume 132, Issue 1. Available at: www.toxci.osfordjournals.org.

"Health Hazards and Risk Issues: Sorting Fact from Fear," invited presentation at the Coal Combustion Products Utilization & Management: A Practical Workshop, Lexington, KY, October 9-10, 2012.

"Is this Risk for Real? Putting Risk Results into Context," invited presentation at the Midwest Energy Association meeting, Minneapolis, MN, September 2012.

"Coal Ash Material Safety: A Health Risk-Based Evaluation of USGS Coal Ash Data from Five US Power Plants."

- American Coal Ash Association Summer Meeting, Portsmouth, VA. June 2012; and webinar July 2012 with ACAA.
- Press Conference, National Press Club, Washington, DC. June 6, 2012.
- Technical Focus Group, Environmental & Energy Committee Meetings, Council of Industrial Boiler Owners (CIBO), Washington, DC, December 2012.
- World of Coal Ash (WOCA), Lexington, KY, April 2013.
- National Ready Mix Concrete Association (NRMCA), Redwood City, CA, May 2013.
- Electric Power 2013, Chicago, IL, May 2013.
- Fluid Bed & Stoker Fired Boiler Operations And Performance Conference, CIBO, Louisville, KY, May 2013.
- Air & Waste Management Association (AWMA), Chicago, IL, June 2013.

"Health Risk of CCPs: Is Coal Ash Toxic?" Presentation at the South Carolina SWANA Meeting, Myrtle Beach, SC, May 2012.

"Health Risk of CCPs: Is Coal Ash Toxic?" Presentation at Electric Power 2012, Baltimore, MD, May 2012.

"Hexavalent Chromium in Perspective," presentation and invited Chair – Human Health Risk Panel, MGP 2012, Chicago, IL, March 29, 2012.

"Health Risk of CCPs," invited presentation at the Coal Ash Consortium, Scottsdale, AZ, March 28, 2012.

"Health Risk of CCPs," presented at the EUCI conference on CCR Management: Impacts of Regulations and Technological Advances. Nashville, TN, February 28-29, 2012.

"Risk Assessment: How the EPA Looks at Coal Combustion Products," presented at the ACAA Fall meeting, Indianapolis, IN, September 27, 2011.

"Risk assessment: An overview of how the U.S. Environmental Protection Agency looks at coal combustion residuals," presented at the American Chemical Society meeting in Denver, CO, August 28, 2011.

"Is Coal Ash Toxic?" Keynote Presentation at the World of Coal Ash May 10-12, 2011, and invited presentation at The Coal Institute/NCCI meeting July 11, 2011.

"Potential Effect of Proposed Coal Combustion Residuals Regulation and Alternative Leach Testing on Beneficial Reuse," World of Coal Ash May 10-12, 2011.

"Comparison of Risks for Leachate from Coal Combustion Product Landfills and Impoundments with Risks for Leachate from Municipal Solid Waste Landfill Facilities," World of Coal Ash May 10-12, 2011, and poster at Society of Toxicology March 6-10, 2011.

"Overview of Coal Ash Regulatory Issues," NCASI Northern Regional Meeting May 18-19, 2011.

"Perspectives on Health Risks Associated with Beneficial Re-Use of Byproducts of Coal Combustion," McIlvaine Hot Topic Hour, April 28, 2011.

"Risk Assessment: How the EPA Looks at Coal Combustion Products," presented at the EUCI conference on Future of Coal Combustion Products (CCPs): Regulatory, Legal, Technical, and New Markets, Denver, CO, March 2011.

"Development of a Realistic Risk Assessment Conceptual Site Model for an Urban River Sediment Site," with B. Ruffle, L. Bradley, K. Durocher, and L. Fraiser, Battelle Sediment Conference, February 7-10, 2011.

Press Conference with ACAA (American Coal Ash Association), Knoxville, TN, October 27, 2010.

"USEPA's Proposed rule for Coal Combustion Residual (CCRs): Beneficial Use Aspects," with L. Bradley and A. Ellis, keynote address given at the American Coal Ash Association, Baltimore, MD, June 2010.

"Overview of a CCP Site Investigation Conducted Under the Superfund Alternative Program," presented at the ACAA spring meeting, Nashville, TN, March 2010.

"Coal Ash Business Planning and Management: Addressing Risks and Liabilities in a Changing Regulatory Environment," with L. Bradley, J. Trast, J. Matus, and A. Kier, workshop presented at the EUCI Conference on the Future of Coal Combustion Products, Houston, TX, March 2010.

"In Vivo Bioavailability of Arsenic in Coal Combustion By-Products." Bradley, L.J.N., G.M. Fent, and S.W. Casteel. Poster presented at the Society of Toxicology 2008 annual meeting in Seattle, WA; and the World of Coal Ash 2009 meeting in Lexington, KY.

"PAHs and Dioxins Not Present in Fly Ash at Levels of Concern," World of Coal Ash, May 2009 and Society of Toxicology, March 2009.

Exhibit B

REACH Detailed Tables

Table B-1
REACH Toxicity Data for "Ashes (residues), coal" Relevant to Human Health

REACH Human Health Toxicity Data (a, b)				
Endpoint	**Publications and Reports**	**Conclusion (c)**	**Classification Conclusion**	**Interpretation**
Acute Oral Toxicity	3	Practically nontoxic	The test substance does not fulfill the requirements to be classified according to CLP (EU-GHS) criteria.	Animals exposed to "Ashes (residues), coal" by ingestion do not exhibit adverse effects, even at high dosing levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Acute Inhalation Toxicity	1	Practically nontoxic	Ashes (residues) are considered as non-toxic upon acute inhalation exposure and no classification is needed according to the CLP (EU-GHS) criteria for classification and labelling.	Animals exposed to the respirable fraction (i.e., PM2.5) of "Ashes (residues), coal" by inhalation do not exhibit adverse effects, even at high exposure levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Acute Dermal Toxicity	2	Practically nontoxic	The test substance does not fulfill the requirements to be classified according to CLP (EU-GHS) criteria.	Animals exposed to "Ashes (residues), coal" dermally do not exhibit adverse effects, even at high dosing levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Skin Irritation/Corrosion	12	Not irritating - rabbit (6) Not irritating - human (2) Not corrosive - human (3) Not irritating but study information not sufficient for classification, thus, inconclusive (1)	The test substance does not fulfill the requirements to be classified according to CLP (EU-GHS) criteria.	Animals exposed to "Ashes (residues), coal" dermally do not exhibit adverse effects of skin irritation or corrosion, even at high dosing levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Eye Irritation	6	Not irritating (5) Not irritating but study information not sufficient for classification, thus, inconclusive (1)	The test substance does not fulfill the requirements to be classified according to CLP (EU-GHS) criteria.	Animals exposed to "Ashes (residues), coal" by application to the eye do not exhibit irritation or other adverse effects, even at high dosing levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Skin Sensitization	4	Not sensitising (4)	No classification is needed according to the CLP (EU-GHS) criteria for classification for skin sensitization.	Animals exposed to "Ashes (residues), coal" dermally do not exhibit adverse effects of skin sensitisation, even at high dosing levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Repeated Dose Inhalation Toxicity	3	Based on these findings, 4.2 mg/m³ of respirable coal fly ash was considered a NOAEC (No Observed Adverse Effect Concentration) for systemic effects and a LOEC (Low Observed Effect Concentration) for local effects.	The available data on the repeated dose toxicity of Ashes (residues) as well as of the respirable fraction of fly ashes is conclusive but not sufficient for classification.	Animals were exposed to the respirable fraction (i.e., PM2.5) of "Ashes (residues), coal" by inhalation in two main studies. In the key study, "significant toxic effects" (as defined by ECHA) were not seen at or below ~4.2 mg/m³. Higher doses were tested in the second study, and 100 mg/m³ was identified as the NOAEC. The authors noted that the respirable fraction (PM2.5) typically represents 10% of the total mass of "Ashes (residues), coal," thus, the NOAEC would be 1000 mg/m³ for the total material. This concentration is above the classification range and, moreover, is not associated with "significant toxic effects." Therefore, the material does not meet the requirements to be classified as Hazardous.
Repeated Dose Oral Toxicity	2	Based on the results of laboratory investigations in clinical biochemistry, haematology and urinalysis and histopathological examination, the NOAEL (No-Observed-Adverse-Effect-Level) was considered to be 1000 mg/kg bw/day for both male and female rats.	The available data on the repeated dose toxicity of Ashes (residues) is conclusive but not sufficient for classification.	Animals exposed to "Ashes (residues), coal" by daily ingestion do not exhibit adverse effects, even at high dosing levels; therefore, the material does not meet the requirements to be classified as Hazardous.
Genetic Toxicity	7	The available data indicate that ashes (residues) are not genotoxic. In vitro: Negative Ames tests with S. typhimurium TA 1535, TA 1537, TA 98 and TA 100, and E. coli WP2 uvr A, with and without metabolic activation. Negative results in a mammalian cell gene mutation test using mouse lymphoma L5178Y cells, with and without metabolic activation. In vivo: Negative results in a mammalian erythrocyte micronucleus test in rats. Endpoint Conclusion: No adverse effect observed (negative)	Negative	As noted, the available data indicate that "Ashes (residues), coal" are not genotoxic. Therefore, no classification is needed according to the CLP (EU GHS) criteria for classification for genetic toxicity; and therefore, the material does not meet the requirements to be classified as Hazardous.
Reproductive Toxicity	2	There are no indications that the main components of ashes (residues) induce toxic effects to fertility in animals or humans.	Based on available information, there are no alerts for reproductive toxicity.	According to the criteria, "Ashes (residues), coal" is not considered a suspected human reproductive toxicant. Therefore, no classification is needed according to the CLP (EU-GHS) criteria for classification for reproductive toxicity; and therefore, the material does not meet the requirements to be classified as Hazardous.
Epidemiology for Workers	5	The results of all these studies indicate that pulverized fuel ash is unlikely to give risk to pneumoconiosis under similar working conditions. Pneumoconiosis in the general population of South Wales was associated with work as an underground coal miner.	NA	NA
Carcinogenicity	NA			
Total	**47**			

Notes:

CLP - Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures.
EU - European Union.
GHS - Globally Harmonised System of Classification and Labelling of Chemicals.
LOEC - Lowest Observed Effect Concentration.
mg/kg bw - Milligrams per kilogram body weight.
mg/m3 - Milligrams per cubic meter.
NOAEC - No Observed Adverse Effect Concentration.
NOAEL - No Observed Adverse Effect Level.

(a) European Chemicals Agency (ECHA). Registration Dossier for Ashes (residues), coal). EC# 931-322-8.Toxicological Information. Accessed April 2020. Available at:
https://echa.europa.eu/registration-dossier/-/registered-dossier/15573/7/3/1
(b) European Chemicals Agency (ECHA). Guidance on the Application of the CLP Criteria Guidance to Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures. Version 5.0, July 2017. Available at:
https://echa.europa.eu/documents/10162/23036412/clp_en.pdf/58b5dc6d-ac2a-4910-9702-e9e1f5051cc5
Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP) is based on the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) and implements the provisions of the GHS within the EU.
(c) Numbers of studies in parentheses; if no number, all studies had the same conclusion.

Table B-2
REACH Aquatic Toxicity Studies for "Ashes (residues), coal"

REACH Aquatic Toxicity Studies (a, b)			
Endpoint	**Publications and Reports**	**Classification Conclusion**	**Classification Notes**
Short-term (Acute) Toxicity to Fish	4	No classification is warranted due to “data conclusive but not sufficient for classification”	Effect level is > 1 mg/L, therefore Acute Category 1 (the only Acute category) does not apply.
Short-term (Acute) Toxicity to Aquatic Invertebrates	8	No classification is warranted due to “data conclusive but not sufficient for classification”	Effect level is > 1 mg/L, therefore Acute Category 1 (the only Acute category) does not apply.
Toxicity to Aquatic Algae and Cyanobacteria	16	No classification is warranted due to “data conclusive but not sufficient for classification”	Effect level is > 1 mg/L, therefore Acute Category 1 (the only Acute category) does not apply.
Toxicity to Microorganisms	8	No classification is warranted due to “data conclusive but not sufficient for classification”	"Ashes (residues), coal" are not harmful to microorganisms.
Long-term (Chronic) Toxicity to Fish	1	No classification is warranted due to “data conclusive but not sufficient for classification”	In addition, chronic studies for invertebrates and algae result in no classification; therefore, no further long term studies with fish are necessary.
Long-term (Chronic) Toxicity to Aquatic Invertebrates	2	No classification is warranted due to “data conclusive but not sufficient for classification”	"Ashes (residues), coal" are concluded to not to be harmful to aquatic invertebrates; the effect level is > 1 mg/L, therefore, neither chronic hazard category applies.
Total	**39**		

Notes:
mg/L - Milligrams per liter.

(a) European Chemicals Agency (ECHA). Registration Dossier for Ashes (residues), coal). EC# 931-322-8. Ecotoxicological Information. Accessed April 2020. Available at: **https://echa.europa.eu/registration-dossier/-/registered-dossier/15573/6/2/1**
(b) European Chemicals Agency (ECHA). Guidance on the Application of the CLP Criteria Guidance to Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures. Version 5.0, July 2017. Available at: **https://echa.europa.eu/documents/10162/23036412/clp_en.pdf/58b5dc6d-ac2a-4910-9702-e9e1f5051cc5**
Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP) is based on the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) and implements the provisions of the GHS within the EU.

Table B-3
REACH Terrestrial Toxicity Studies for "Ashes (residues), coal"

REACH Terrestrial Toxicity Studies (a)						
Endpoint	**Publications and Reports**	**Test Guideline for Key Experimental Result**	**Study Duration**	**Effect Level**	**Conclusion**	**Classification Notes**
Toxicity to Soil Macroorganisms Except Arthropods	11	ISO 11268-1	14 days	LC50 = >32 <66.7 g/kg soil dw NOEC = 32 g/kg soil soil dw	The lowest effect level was identified in one of the earthworm studies, no mortality was observed at a test substance concentration of 32 g/kg soil dw (NOEC). However, at a concentration of 67 g/kg soil dw all earthworms were dead after an exposure period of 14 days. LC50 was not calculated but must be between 32 and 67 g/kg soil dw. EC50 values in other tests ranged between 66 g/kg soil to >1000 g/kg soil.	Terrestrial studies with earthworm, plants and microorganisms are available and show only low toxicity at high test concentrations. As the test substance is not classified as toxic or harmful, the substance is not considered to cause toxic effects in predators. Additionally, the bioaccumulation potential is low and thus the test substance is considered to cause low hazard to predators. -- The substance is not classified for the environment.
Toxicity to Terrestrial Arthropods	NA	NA	NA	No test was proposed, the PNEC soil is derived from the short term microorganism study (EC50 of 8.4 g/kg soil dw)	A test should only be proposed by the registrant if the results of the chemical safety assessment according to Annex I indicates the need to investigate further the effects of the substance and/or degradation products on terrestrial organisms. As the ashes are not classified and data for terrestrial macroorganisms, plants and terrestrial microorganisms are available and these endpoints are in the same order of magnitude for the ashes and there was no sign, that terrestrial arthropods are more sensitive than other soil macroorganisms, plants or microorganisms. Therefore, no further test was proposed and the PNEC is derived from available data for soil microorganisms.	
Toxicity to Terrestrial Plants	12	ISO 11269-2	14 days	EC50 = >32 <66.7 g/kg soil dw	EC50 for growth rate was not calculated but must be between 32 and 67 g/kg soil dw for both test species Avena sativa (oats) and Brassica napus (rapeseed). EC50 values in other tests ranged between 66 g/kg soil to >1000 g/kg soil.	
Toxicity to Soil Microorganisms	11	DIN 38412-L48	3 hours	EC50 = > 8.4 - < 17 g/kg soil dw	EC50 for inhibition of dehydrogenase activity in Arthrobacter globiformis was not calculated but must be between a test substance concentration of 8.4 g/kg and 17 g/kg soil dw.	
Toxicity to birds	NA	NA	NA	PNEC oral is derived from mammalien data.	According to chapter R16 of the Guidance on information requirements and chemical safety assessment published by ECHA (2008), a substance can be assessed in a first step based on classification on the basis of mammalian toxicity data whether it has a potential to cause toxic effects if accumulated in higher organisms. For substances that are classified as Very Toxic (T+) or Toxic (T) or harmful (Xn) with at least one of the risk phrases R48, R60, R61, R62, R63 or R64, secondary poisoning is a relevant route of exposure. As ash (residues), coal is not classified as toxic or harmful, the substance is not considered to cause toxic effects in predators. Additionally, the substance has only a low potential for bioaccumulation. In conclusion, Ash is considered to cause low hazard to predators. Thus, a study with birds is not needed due to animal welfare reasons and the PNEC oral is derived from data on mammalian toxicity.	
Total	**34**					

Notes:
dw - Dry weight.
EC50 - Effective Concentration 50.
g/kg - Grams per kilogram.
LC50 - Lethal Concentration 50.
NOEC - No Observed Effect Concentration.
PNEC - Predicted No-Effect Concentration. The PNEC value is the concentration of a substance below which adverse effects in the environment are not e

(a) European Chemicals Agency (ECHA). Registration Dossier for Ashes (residues), coal). EC# 931-322-8. Ecotoxicological Information. Available at:
https://echa.europa.eu/registration-dossier/-/registered-dossier/15573/6/4/1

Testimony 3:

Dr. Melinda Hahn

Pre-Filed Testimony of Melinda Hahn, PhD

Drinking Water Evaluation near Illinois Coal-Fired Power Plant Sites

August 27, 2020

In November 2018, a collection of environmental non-profit groups[1] released a report titled *Cap and Run: Toxic Coal Ash Left Behind by Big Polluters Threatens Illinois Water* (the "Cap and Run report"), which purports to provide an evaluation of groundwater data near coal ash disposal units at current or former coal-fired power plants in Illinois, including 10 plants currently owned by Dynegy Midwest Generation, LLC; Kincaid Generation, LLC; Illinois Power Resources Generating Company; Illinois Power Generating Company; and Electric Energy Inc. or one of their affiliates (collectively referred to herein as Dynegy). The Cap and Run report compares publicly available groundwater sampling data at coal ash surface impoundments at each site to "health-based thresholds" derived mostly from maximum contaminant levels (MCLs) and EPA's Regional Screening Levels (RSLs).[2] The report authors use vague and superlative language to describe groundwater impacts from coal ash as "unsafe," "severe," and "widespread" which suggests that many people are being exposed to drinking water above health-based standards. Table titles read, for example, "the groundwater at Waukegan is unsafe for drinking," which gives the false impression that the community water supply is impacted and residents are exposed to unacceptable health risks. All data reviewed and presented in the Cap and Run report were collected on the plant sites near the surface impoundments. Although the report authors admit that they are unaware to what extent the tested groundwater at the sites is used for drinking, they allege that groundwater at these sites is "unsafe" and threatens drinking water resources. Allegations of the lack of "safety" imply an exposure to groundwater and a risk to human health that is not demonstrated. A proper assessment of risk to human health would include a determination that the drinking water exposure pathway is complete, and if complete, an estimate of dose and exposure duration, and a calculation of risk based on scientifically valid toxicological factors. The Cap and Run report provides no such assessment.

Without making the necessary statistical calculations, the Cap and Run report also claims that statistically significant increases (SSIs) in contaminant concentrations are likely to exist in downgradient wells and suggests that additional characterization and corrective action may be needed. The Cap and Run report's authors opine that the proposed closure in-place strategies for many of the ash disposal units will be inadequate to prevent future deterioration of groundwater quality surrounding the sites.

The Illinois Environmental Protection Agency (IEPA) began an extensive assessment of groundwater risks from coal ash surface impoundments in Illinois in 2009. The results of this assessment were first reported in the Groundwater Protection Program Biennial Report for calendar years 2010 and 2011 (the "2010-2011 GPPB report"), prepared by the Illinois Interagency Coordinating Committee on Groundwater (ICCG).[3] The assessment included an evaluation of geological vulnerability to groundwater impacts and the presence of potential users (receptors) of groundwater near each coal-fired power plant site to evaluate these risks and assigned priority levels to each site (1 = highest risk; 2 = elevated risk; or no priority). The evaluation of potential users of local groundwater was

[1] The non-profit groups include the Environmental Integrity Project, Earth Justice, Prairie Rivers Network, and Sierra Club.

[2] The three exceptions include the EPA Life-time Health Advisory for manganese, and EPA's Drinking Water Advisory for boron and sulfate.

[3] Illinois Interagency Coordinating Committee, Illinois Groundwater Protection Program Bienial Comprehensive Status and Self-Assessment Report, January 2012.

completed by conducting a well survey. The sites that were identified as Priority 1 or 2 sites were requested to conduct further evaluations.

The 2010-2011 GPPB report concluded that:

> "*Potable well surveys have been conducted at all facilities to field verify the proximity of drinking water supply wells off-site. These surveys have shown that currently there appear to be no drinking water supply wells that are being threatened down gradient of these sites.*"

No subsequent IEPA and ICCG report[4] reviewed by Ramboll regarding groundwater protection topics contained further discussion of individual sites or the general threat to drinking water posed by coal ash surface impoundments. The purpose of this report is to update the well survey completed by IEPA for the 2010-2011 GPPB report. Using currently available database information, Ramboll completed a well and water supply survey for the 23 coal-fired power plant sites identified in the Cap and Run report that contain a coal ash surface impoundment to determine the extent to which drinking water supplies in Illinois, both public and private, are present downgradient from these sites, and potentially at risk of impact. For sites where potential drinking water wells or surface water intakes are identified in the downgradient direction of an identified site, further review of site-specific information was conducted to evaluate the potential for impacts from coal ash.

Ramboll conducted well surveys for 23 sites located in Illinois that currently or formerly operated as coal-fired power generation plants (see Table 1) and contain a coal ash surface impoundment identified by the IEPA in its Statement of Reasons submitted to the Illinois Pollution Control Board in March 2020.[5]

Table 1: Illinois Coal-Fired Power Plants included in Receptor Survey Scope			
Owned by Dynegy or an affiliate		**Not Owned by Dynegy**	
Baldwin Coffeen Duck Creek Edwards Havana	Hennepin Joppa Kincaid Newton Vermilion	Crawford Dallman/Lakeside Hutsonville Joliet 9 Joliet 29 Marion Meredosia	Pearl Powerton Venice Waukegan Will County Wood River

Ramboll conducted a water well and water supply survey for each site noted in Table 1 in accordance with 35 IAC 1600.210 to identify all private, semi-private, and non-community water system (non-CWS)[6] wells and surface water intakes located at the site or within 2,500 feet of the site property

[4] The other documents reviewed by Ramboll include the publicly available "Illinois Groundwater Protection Program: Biennial Status and Self-Assessment Report" dated June 2014 (for calendar years 2012 through 2013) and "Illinois Groundwater Protection Program Biennial Report" dated December 2019 (for calendar years 2018 through 2019), as well as the IEPA "Annual Groundwater and Drinking Water Program Review" or "Annual Drinking Water Program Review" for reporting years 2014 through 2017.

[5] Illinois Environmental Protection Agency, 2020. "Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New 35 Ill. Adm. Code 845," prepared for the Illinois Pollution Control Board, March.

[6] According to the Illinois Department of Public Health (IDPH), non-community water systems are defined as "facilities, such as schools, factories, restaurants, resorts, and churches, served by their own water supply (usually a well)." Non-CWSs are regulated under the Safe Drinking Water Act (SDWA).

boundaries, all community water system (CWS)[7] wells and surface water intakes located at the site or within one mile of the site property boundaries[8], and all setback zones and regulated recharge areas (i.e., wellhead protection areas [WHPAs]) associated with non-CWS or CWS wells in which all or any portion of the site is located. Owned site boundaries were identified using local tax assessor information. The search radii were measured from the search site boundaries determined by Ramboll based on site ownership or on plant boundaries. In many cases, power generators or their affiliates own property beyond the power plant boundaries (in some cases, these holdings are extensive), so the search site boundary may exclude owned property located on the opposite side of a hydrogeologic divide relative to the power plant, large areas of undeveloped property, or other miscellaneous land (e.g., agricultural land, rail lines, roads).

To complete the well surveys for the identified search site boundaries, Ramboll reviewed records of local public water supply entities and associated water sources, determined local groundwater flow directions, and searched publicly available databases for well and water supply information to determine the presence of private/semi-private wells, non-CWS wells and surface water intakes, and CWS wells and surface water intakes within their respective search radii to evaluate whether off-site wells may be present at hydraulically downgradient locations from the 23 sites. The well survey was limited to publicly available information (mostly searchable databases and GIS mapping services), and as such, practical limitations apply, such as the potential for incomplete or imprecise/ inaccurate well information. Public databases identifying private and semi-private wells do not necessarily provide information regarding the use of the water well (e.g., potable, irrigation, sanitation, cooling water, etc.) and often include wells which are no longer in service.

Ramboll reviewed the following information sources to determine the local water supply entity and associated water sources in the vicinity of each site:

- IEPA's Source Water Assessment Protection Program (SWAPP) Factsheets database, which provides summary versions of the completed Source Water Assessments for CWSs in Illinois;
- IEPA and USEPA Safe Drinking Water Information System (SDWIS) databases, which provide information on public water supply systems (i.e., CWSs, non-CWSs, and non-transient non-CWSs);
- 2019 annual Consumer Confidence Report prepared by the local water supply entity; and
- if applicable, a review of the local municipality's groundwater ordinance.

Ramboll reviewed information contained in the following public state datasets to determine the water supply wells and surface water intakes present within the search radii noted above:

- IEPA's SWAPP Geographic Information System (GIS) online map, which provides extensive information related to risk assessment of water sources in Illinois, including all CWS and non-CWS wells and surface water intakes (as well as setback zones and regulated recharge areas for wells). The IEPA's SWAPP GIS online map includes a copy of the Illinois State Geological Survey (ISGS) Illinois Water and Related Wells Interactive Map (ILWATER) dataset (see below);
- ISGS ILWATER, which provides water and related (e.g., monitoring, dry, engineering, stratigraphic, observation, mineral test, outcrop, or mine-related) well records based on copies of well construction reports provided by the Illinois State Water Survey (ISWS) and other sources; and

[7] According to the United States Environmental Protection Agency (US EPA), a community water system is defined as a public water system that supplies water to the same population year-round.

[8] These distances are greater and more conservative than that required in 35 IAC 1600.210.

- IEPA and USEPA SDWIS databases (described on previous page) to provide supplemental information for non-CWS and CWS wells identified through the IEPA SWAPP dataset.

Ramboll reviewed topographic maps, historical reports (e.g., coal ash impoundment corrective action and closure reports, Phase I Hydrogeological Assessment reports), and other readily available information to determine the site hydrogeology and presumed groundwater flow direction. This information was used to identify which wells, if any, are located hydraulically downgradient from a site.

To determine the extent to which drinking water supplies identified as potentially downgradient of coal-fired power plant sites are potentially at risk of impacts from coal ash, Ramboll evaluated the well survey results within the hydrogeological context of each site and surrounding area and also considered other well characteristics, such as location, depth, installation date, status (e.g., inactive or abandoned), likely use (e.g., potable vs. non-potable), accuracy of the mapped location, and, in some cases, groundwater chemistry. The "risk of impact" is defined herein as the potential that an Illinois Part 620 Class I groundwater quality standard might be exceeded at a private well or surface water intake. Coal ash constituents are naturally occurring in soil and groundwater, so it is important to consider regulatory standards. These evaluations were conducted for the 23 sites listed in Table 1, including, 10 Dynegy-owned sites and 13 sites owned by others.

Based on Ramboll's evaluation, five Dynegy-owned sites were identified as having potable water supply wells and/or surface water intakes located potentially downgradient from the sites within the search radii: Baldwin, Edwards, Havana, Hennepin, and Joppa. Based on these results, Ramboll then reviewed site-specific information regarding surface impoundment location, well location and characteristics, hydrogeology and groundwater quality for these five sites in order to determine whether the identified downgradient potable water supply wells and/or surface water intakes are at risk from potential coal ash impacts. At Baldwin, an off-site groundwater investigation was conducted that determined that the private wells were not impacted. At Edwards, the private wells were determined to be not at risk from coal ash constituents. At Havana, there are no reported exceedances of groundwater quality standards. At Hennepin, no active potable water wells were determined to be at risk. Similarly, at Joppa, the private wells were determined to be not at risk from coal-ash constituents. Ramboll's conclusion based on the information reviewed, is that no identified off-site water supply wells or surface water intakes are at risk of coal ash-related impacts at Dynegy-owned sites.

The evaluation for the 13 non-Dynegy-owned sites identified two sites as having potable water supply wells and/or surface water intakes located potentially downgradient from the sites: Joliet 9 and Wood River. The downgradient private wells identified at Joliet 9 included shallow wells that have been sealed and abandoned, and deeper wells that are unimpacted by site activities. Additional private wells, located cross-gradient from the site have been sampled by IEPA and determined to be unimpacted by the site. At Wood River, the potentially downgradient wells are either incorrectly mapped, or unlikely to be used for potable purposes, based on their location. Based on the information reviewed, Ramboll's conclusion, is that no identified active off-site water supply wells or surface water intakes are at risk of coal ash-related impacts at non-Dynegy-owned coal ash impoundment sites.

Ramboll did identify a number of water supply wells and surface water intakes in state databases that mapped within 2,500 feet or 1 mile of the sites. However, upon Ramboll's review and detailed evaluation of hydrogeological data, well and surface water intake characteristics, and in some cases, groundwater quality data, consistent with IEPA's 2012 conclusion, Ramboll did not identify active potable water supply wells or surface water intakes at risk of impact from coal ash impoundments.

This detailed assessment performed by Ramboll does not support the conclusion and allegations of the Cap and Run report of "widespread" and "unsafe" groundwater impacts from coal ash surface impoundments. The groundwater cannot be "unsafe" if the groundwater drinking water pathway is not complete.

Illinois was one of the first states in the country to promulgate groundwater quality protection standards, and to require groundwater monitoring and corrective action at coal ash surface impoundment sites.[9] In response to the 2008 Tennessee Valley Authority (TVA) spill, the IEPA implemented more aggressive monitoring and assessment requirements.[10] As described above in the 2010-2011 GPPB report, the IEPA tracks and assesses coal ash surface impoundments at coal-fired power plant sites. The USEPA published final federal rules in 2015 that established technical requirements for CCR surface impoundments. Currently, the State of Illinois is in the process of adopting another set of rules for CCR surface impoundments intended to be at least as protective as the federal rules, that include additional provisions for permitting of surface impoundments, increased public participation, prioritization of impoundments for closure, closure alternative analyses, and financial assurance.[11] However, based on Ramboll's conclusion regarding the lack of "widespread" and "unsafe" groundwater impacts, it does not appear that additional regulation beyond what is required by the federal program is necessary to protect drinking water supplies.

Signature:____

Dr. Melinda Hahn is a senior manager at Ramboll US Corporation. She holds a Ph.D. in Environmental Engineering from the Johns Hopkins University, as well as a B.S. in Mathematics and a B.S. in Physics from the University of Texas at Austin. Dr. Hahn has 25 years of experience in environmental engineering, with particular emphasis on site investigation, chemical fingerprinting, contaminant fate and transport in groundwater and other media, the statistics of environmental data, and site remediation. Her professional profile is provided as Exhibit A.

[9] Illinois Interagency Coordinating Committee, Illinois Groundwater Protection Program Bienial Comprehensive Status and Self-Assessment Report, January 2012, p. 41.

[10] *Ibid*.

[11] https://www2.illinois.gov/epa/topics/water-quality/watershed-management/ccr-surface-impoundments/Pages/default.aspx

EXHIBIT A

PROFESSIONAL PROFILE OF MELINDA HAHN, PHD

ENVIRONMENT
& HEALTH

RAMBOLL

MELINDA W. HAHN, PH.D.

Senior Manager

Dr. Hahn's practice areas include site investigation and remediation, contaminant fate and transport modelling, statistics of environmental data, forensic analysis, litigation support, and due diligence. Regulatory areas include RCRA, CERCLA, TSCA, and Voluntary Cleanup/Risk-Based Corrective Action. Dr. Hahn has experience in the following industry categories: energy (electric utilities, petroleum dispensing, pipeline operations, former manufactured gas plant sites), industrial equipment manufacturing, metal working and metal recycling, automobile manufacturing, ink and chemical manufacturing, wood treating, mining, cement manufacturing, milling and smelting operations, secondary aluminum production, and dry cleaning.

EDUCATION

1995
PhD, Environmental Engineering
John Hopkins University

1990
BS, Physics
The University of Texas at Austin

1990
BS, Mathematics
The University of Texas at Austin

ACADEMIC HONORS

1992-1995
Graduate Fellow, National Science Foundation

1995
Most Distinguished Environmental Engineering Dissertation, Association of Environmental Engineering Professors

CAREER

1998-Present
Senior Manager, Ramboll Environ

1997-1998
Consultant, Roy Ball, PC

1995-1997
Senior Project Engineer, Environmental Resources Management-North Central, Inc.

CONTACT INFORMATION

Melinda W. Hahn, PhD

mhahn@ramboll.com
+1 (512) 219-4020

Ramboll Environ
11782 Jollyville Road
Suite 108
Austin, TX 78759
United States of America

PROJECTS

- Provided technical litigation support for over 50 matters regarding extent, severity, timing, and source of soil and ground water contamination and vapor intrusion, necessity for and costs of remediation, human health risk assessment, toxic tort liability, Superfund cost allocation (including consistency with the NCP), insurance cost recovery, and the siting and monitoring of a hazardous waste landfill. The regulatory frameworks included Illinois Voluntary Cleanup Program, Illinois Leaking Underground Storage Tank Program, RCRA, CERCLA, TSCA, NCP, and California Proposition 65.
- Provided expert testimony in matters involving Superfund cost allocation, statistics of environmental data, and contaminant fate and transport.
- Conducted environmental forensic evaluations to determine sources of observed environmental contamination in soil, groundwater and sub-slab/indoor air for sites in litigation and pre-litigation phases.
- Provided litigation support for a real estate transaction dispute at a site with groundwater and indoor air contamination.
- Provided litigation support for environmental liability estimation for a Potentially Responsible Party at a large site with sediments contaminated with PCBs. Evaluated historical information on industrial processes and wastewater treatment, along with recent facility data to estimate the contribution of PCB mass to the river from the facility.
- Directed RCRA closure activities at a site with soil, groundwater and indoor air contamination.
- Conducted chemical isotope dating analysis of PCB contamination of river sediments to identify the likely potentially responsible party. This project included preparation of sampling plan, implementation of sediment core sampling, and interpretation of sample results.
- Retained as an expert witness to evaluate a claim of chemical crop damage from herbicide use along a utility right-of-way. Developed opinions based on chemical analysis and theories of fate and transport.
- Retained as an expert witness and provided technical support for litigation involving the sources of chlorinated solvent contamination at dry cleaning facilities. Developed opinions based on chemical analysis and theories of fate and transport.
- Retained as an expert witness and provided opinions regarding timing of releases and groundwater contaminant fate and transport.
- Evaluated claims of residents living near a scrap metal facility of transport and deposition of lead-containing particles in their homes using statistical analysis of plaintiffs' chemical data. Provided expert testimony based on this analysis.
- Evaluated the hydrogeological setting of a proposed petroleum pipeline pumping station and estimated the likelihood of a release and groundwater contamination. Provided expert testimony based on this analysis.
- Directed and assisted in the closure of a number of sites in the Illinois Voluntary Cleanup Program and the Illinois Leaking Underground Storage Tank Program.
- In several cases, evaluated the potential contribution of urban industrial sources of heavy metals to residential soil using simple data comparisons and statistical techniques.
- Performed ground water and contaminant fate and transport modeling using MODFLOW and MT3D for use as a Superfund cost allocation tool in support of expert testimony. Relative mass of TCE entering the Superfund Site from sources on two PRP's properties was used as a basis for cost

allocation. A Monte Carlo analysis was also performed to evaluate the sensitivity of the proposed allocation to changes in key variables.

- Performed Monte Carlo analysis of risk to ground water posed by a proposed petroleum pipeline in support of expert testimony. The analysis examined the likelihood of the exceedance of the Illinois Class I ground water standard for benzene per mile of proposed pipeline.
- Conducted Monte Carlo statistical risk assessment for residential exposure to benzo(a)pyrene in soil for an Illinois Site Remediation Program closure of a former industrial facility. The calculations resulted in a distribution of cleanup objectives that correspond to an excess cancer risk of 10^{-6}. A Tier 3 (Risk-Based Corrective Action) site-specific remediation objective was selected from the calculated distribution.
- Performed Monte Carlo cost allocation among four PRPs for a Superfund Site in support of expert testimony. Total volume, volume of hazardous substances, and volume of drummed materials were considered.
- Utilized 3-D geostatistical interpolation techniques to visualize environmental data, to estimate excavation volumes for remediation, and to identify and distinguish source areas and potential preferential pathways of migration for a number of contaminated sites.
- Provided litigation support for a number of insurance cost recovery projects, including a former wood treating facility and a jewelry manufacturer. Tasks included the identification of likely sources and timing of contamination.
- Provided consulting services for several aluminum companies regarding new Land Disposal Restriction (LDR) treatment standards. ENVIRON assisted these companies with a DC circuit court challenge to improper LDR treatment standards.
- Performed multivariate statistical analyses of data as part of human health and ecological risk assessments.
- Performed research and analysis of remedial activities and associated costs to determine compliance with the NCP for cost recovery matters for a number of sites.
- Performed a number of due diligence environmental site assessments for commercial and industrial properties for prospective buyers and lenders.

PUBLICATIONS AND PRESENTATIONS

1993

Stochastic Models of Particle Deposition in Porous Media

Paper presented at the 1993 Midwest Regional Conference on Environmental Chemistry, University of Notre Dame

Authors: Hahn, M.W., and C. F. O'Melia

1994

Deposition and Reentrainment of Particles in Porous Media

Poster presented at the 1994 Gordon Research Conference on Environmental Science, Water, New Hampshire

Authors: Hahn, M.W., D. Abadzic, and C. R. O'Melia

1994

Colloid Transport in Groundwaters: Filtration of Fine Particles at Low Filtration Rates

Presented at the 1994 ASCE National Conference, Boulder, Colorado

Authors: Hahn, M.W., D. Abadzic, and C. R. O'Melia

1995
Deposition and Reentrainment of Brownian Particles under Unfavorable Chemical Conditions
Presented at the 1995 ACE National Conference, Environmental Chemistry Division
Authors: Hahn, M.W., D. Abadzic, and C. R. O'Melia

1995
Deposition and Reentrainment of Brownian Particles under Unfavorable Chemical Conditions
Doctoral Dissertation, Johns Hopkins University
Author: Hahn, M.W.

1997
Some Effects of Particles Size in Separation Processes Involving Colloids
Wat. Sci. Tech. Vol. 36, No. 4 pp. 119–126
Authors: O'Melia, C.R., M.W. Hahn, and C. Chen

1997
Literature Review 1997: Storage, Disposal, Remediation, and Closure
Water Environment Research, Vol. 69, No. 4, pp 6389-719
Authors: Millano E.F. and M.W. Hahn

1998
The Statistics of Small Data Sets
Accepted for publication, Superfund Risk Assessment in Soil Contamination Studies: Third Volume, ASTM STP 1338, K.B. Hoddinott Ed., American Society for Testing and Materials
Authors: Ball, R.O., and M.W. Hahn

1998
RBCA Compliance for Small Data Sets
Battelle Conference Proceedings, Remediation of Chlorinated and Recalcitrant Compounds: Risk, Resource and Regulatory Issues
The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, pp. 73-78
Authors: Hahn, M.W., A.E. Sevcik, and R.O.Ball

1998
Contaminant Plume and using 3D Geostatistics
Battelle Conference Proceedings, Remediation of Chlorinated and Recalcitrant Compounds: Risk, Resource and Regulatory Issues
The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, pp. 85-90
Authors: Ball, R.O., M.W. Hahn, and A.E. Sevcik

1998
RBCA Closure at DNAPL Sites
Battelle Conference Proceedings, Remediation of Chlorinated and Recalcitrant Compounds: Risk, Resource and Regulatory Issues
The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, pp.181-186
Authors: Sheahan, J.W., R.O. Ball, and M.W. Hahn

1998
RBCA Closure at DNAPL Sites, Ground Water Monitoring and Research
Authors: Sheahan, J.W., R.O. Ball, and M.W. Hahn

2004
Deposition and Reentrainment of Brownian Particles in Porous Media under Unfavorable Chemical Conditions: Some Concepts and Applications
Environmental Science & Technology, Vol. 38, pp 210-220
Authors: Hahn, M.W. and C.R. O'Melia

2010
Making the Case for Causation in Toxic Tort Cases: Superfund Rules Don't Apply
Environmental Law Reporter, News & Analysis, July 2010, pp. 10638-10641
Authors: More, J.R. and M.W. Hahn

Testimony 4:

David Hagen

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

27 August 2020

Attention: Illinois Pollution Control Board

Subject: Pre-Filed Testimony Regarding Proposed Illinois Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments

Please find herein my testimony on selected portions of the proposed Illinois Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments.

Relevant Experience

I have over 30 years of experience on various environmental and waste management matters including remediation of groundwater at a variety of industrial settings related to releases from processes and waste management units. With respect to waste management, I am also experienced in the design and closure of landfills, surface impoundments, underground storage tanks, storage pads, etc. I have worked extensively on solid waste compliance including design and installation of groundwater monitoring systems, implementing groundwater monitoring including obtaining representative groundwater samples to determine detection of landfill-related constituents, statistical evaluation of groundwater sampling results, designing and implementing assessment groundwater monitoring programs, evaluation of groundwater remedies and landfill closures options, and implementation of groundwater remedies and landfill closure options.

Within the past several years, I have worked extensively on 40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (the "CCR Rule"). In my capacity as Program Manager and Lead Hydrogeologist, I have led teams of professionals that have implemented compliant groundwater monitoring systems, completed statistical evaluations, made groundwater exceedance determinations of both detection and assessment monitoring results, and evaluated corrective measures to remedy the groundwater exceedances including the use of closure techniques integrated into groundwater remedies. I have utilized groundwater flow models extensively to evaluate the various groundwater remedy alternatives to determine compliance to corrective measures criteria. In addition, I have utilized the models, as well as other information, to compare the alternatives to one another, thereby resulting in the selection of appropriate remedies based on the unique characteristics of each evaluated unit. I have completed the aforementioned process on over 20 CCR surface impoundments.

My resume is attached in Appendix A.

Executive Summary

The following is summary of my opinions.

- Site-specific conditions should dictate selection of appropriate closure and groundwater corrective measures (“remedy”) for a surface impoundment (Page 3).
- One important remedy component available for use is Monitored Natural Attenuation (MNA) (Page 10).
- Removal is not always necessary when CCR material is below the groundwater table or situated within a floodplain (Page 15).
- Removal will not always result in achieving the groundwater protection standards earlier (Page 21).
- Closure in place (CIP) of surface impoundments coupled with MNA or groundwater extraction has been effective at controlling and mitigating groundwater contamination in Illinois (Page 21).
- The purpose of Part 845 is to perform CCR surface impoundment specific evaluations and determine whether a CCR surface impoundment is impacting groundwater, then address those impacts through closure and groundwater corrective measures (Page 28).
- The requirement to perform quarterly groundwater monitoring should allow for monitoring frequency adjustments over the post-closure care period depending on site-specific conditions (Page 28).
- The frequency of groundwater level monitoring does not need to be undertaken more frequently than the sampling of the analytes (Page 28).
- Statistical methods consistent with the Unified Guidance Document should be used to determine an exceedance of a groundwater protection standards (GWPS) (Page 29).
- The timeframes to remedy groundwater, regardless of the remedies being evaluated, is most often long, spanning decades; therefore, it is inappropriate to require corrective measures and post closure care to be completed within 30 prescribed years (Page 31).
- Appropriate cap and cover configuration including cap permeability and thickness is dependent on site-specific conditions (Page 32).
- The proposed Part 845 as written does not provide sufficient time to complete a Closure Construction Permit Application (CCPA) (Page 34).
- The proposed Part 845 does not account for site-specific conditions in the development of the CCPA (Page 38).

Comments/Opinions on Illinois Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments

1. Site-specific conditions should dictate selection of appropriate closure and groundwater corrective measures ("remedy") for a surface impoundment. Several source control (closure) and other corrective measures are available to remedy groundwater parameter exceedences depending on site-specific conditions – it is not simply an issue of either closure by removal (CBR) or CIP with a cap.

    a. Selection of an appropriate remedy is made using the multiple criteria that are provided in 845.710 and 845.670. Given these criteria, there are numerous source control and corrective measure combinations available for closure and groundwater remediation depending on site-specific conditions – it is not either CBR or CIP with a cap. Consistent with Illinois Environmental Protection Agency's (IEPA's) proposal, groundwater remedy and closure selection starts with understanding risks. IEPA's proposal (845.710 and 845.650) ensures closure and corrective action are protective.

    The criteria listed in 845.670 include those that a groundwater remedy **must** meet (commonly termed threshold criteria). Once a remedy is determined to meet these threshold criteria, the remedies are compared to one another (the comparison analysis) using another set of criteria (commonly termed balancing criteria). For any remedy to be considered for the comparison analysis, they must meet the threshold criteria inclusive of:

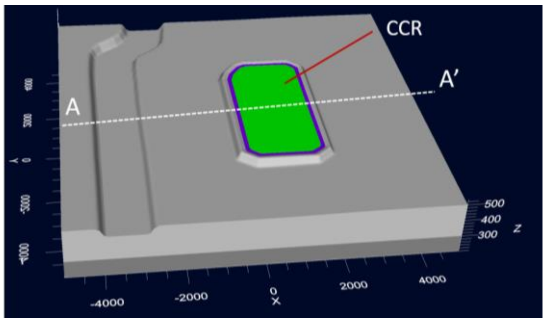
    - Protect human health and the environment;
    - Attain the GWPS;
    - Control sources;
    - Remove contamination released from the CCR impoundment; and
    - Comply with waste management standards.

    Simulating remedies and their performance through time using groundwater flow models can, but may not always be necessary to, assist with the determination of the above threshold criteria. As a demonstration of several different combinations of remedies to achieve compliance with the GWPS, models representative of various site conditions encountered in Illinois, including simulation of natural attenuation, were developed based on the input parameters provided in Appendix B. All sites are adjacent to a river; compliance is achieved when the maximum groundwater concentration upgradient of the river falls below the Illinois GWPS. To illustrate this, model results are shown as maps with the color scale indicating whether boron concentration exceed (orange) or are below (blue) the GWPS.

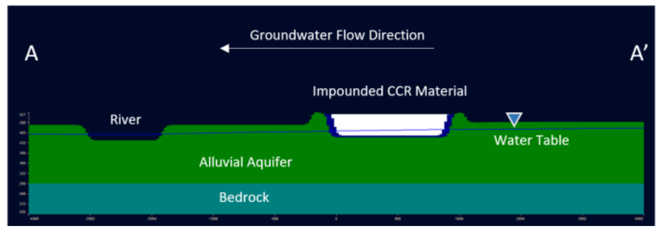
Several remedy alternatives were simulated for each of the representative site examples as provided below:

Site 1. This model simulates a CCR impoundment located on the floodplain of a small river with a thick alluvial aquifer with moderate to low hydraulic conductivity. Groundwater gradients are low, surface recharge is low, and the CCR material is partially submerged beneath the water table.

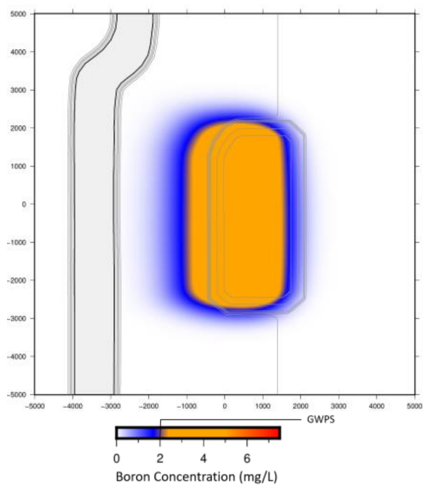
3D View of Model Area



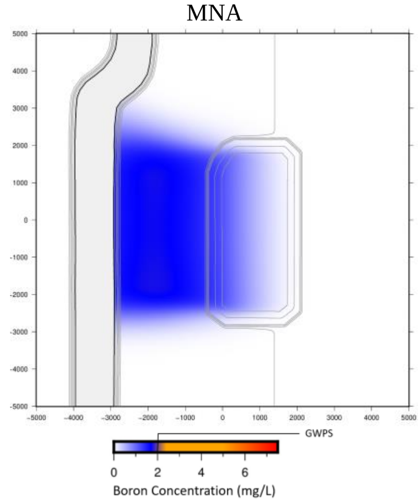
Cross Section Through Model



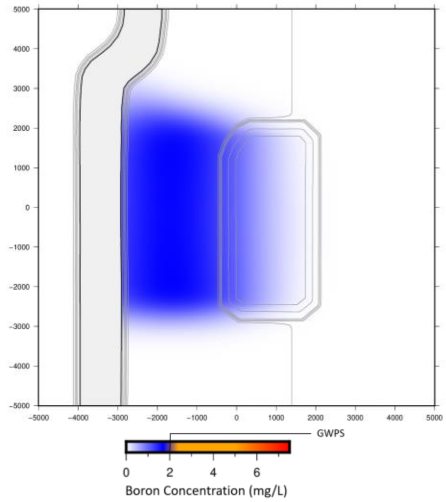
Present Concentration in Alluvial Aquifer



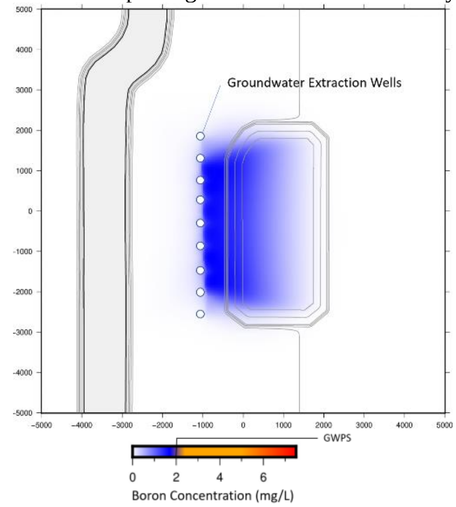
Case 1: Compliance achieved 180 years after CIP with soil cap and MNA



Case 2: Compliance achieved 120 years after CBR and MNA



Case 3: Compliance achieved 80 years after CIP with geomembrane cap and groundwater containment system



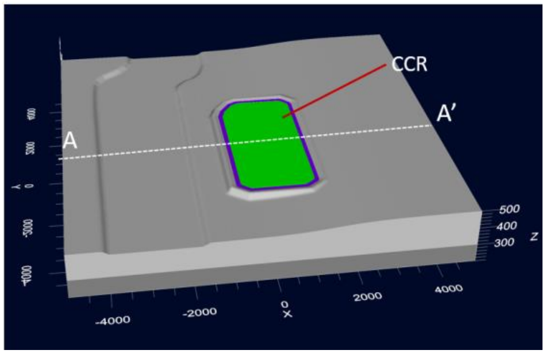
In the **Site 1** model, natural groundwater flows slowly towards the river in a thick aquifer. The pond is in operation from 1970 to 1991, then idle until the year 2020. By this time, a groundwater plume of boron has formed exceeding the proposed GWPS of 2.0 milligrams per Liter (mg/L). Three different closure scenarios are evaluated:

- Case 1: CIP (soil cap) with MNA;
- Case 2: CBR with MNA; and
- Case 3: CIP with a geomembrane cap and groundwater containment system consisting of nine groundwater extraction wells.

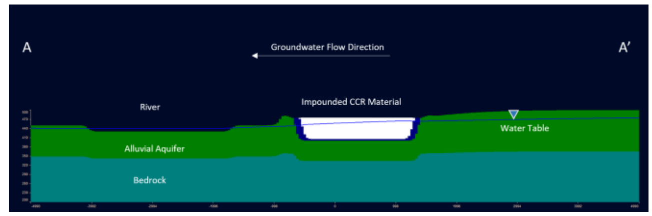
To evaluate the effect of cap type, a fourth model with MNA and geomembrane cap achieved compliance after 170 years (not shown). **All of the remedies (including both CBR and CIP) evaluated as part of this demonstration meet the threshold criteria provided above and would move forward to the comparative analysis. The comparative analysis is described below and includes as one of the sub-criteria under long- and short-term effectiveness the time until GWPS are achieved. Accordingly, time is only one factor upon which potential remedies are evaluated. When considering time, small differences in remedy timeframes (such as 10%) are often times considered equal for this sub-criteria.**

Site 2. This model simulates a CCR impoundment located on the bank of a large river with a thin alluvial aquifer with high hydraulic conductivity. Groundwater gradients are high, surface recharge is normal, and the CCR material is mostly submerged beneath the water table.

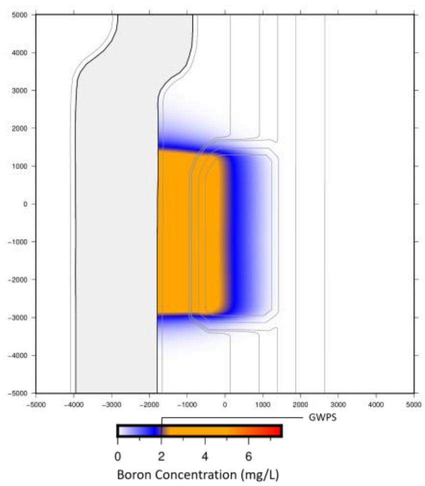
3D View of Model Area



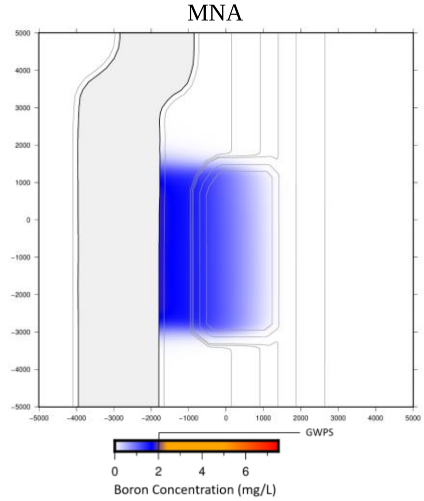
Cross Section Through Model



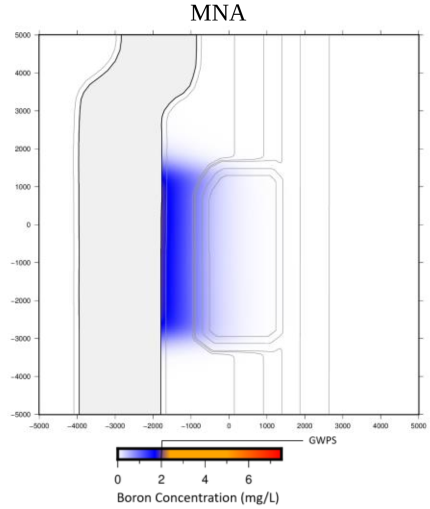
Initial Boron Concentration in Alluvial Aquifer



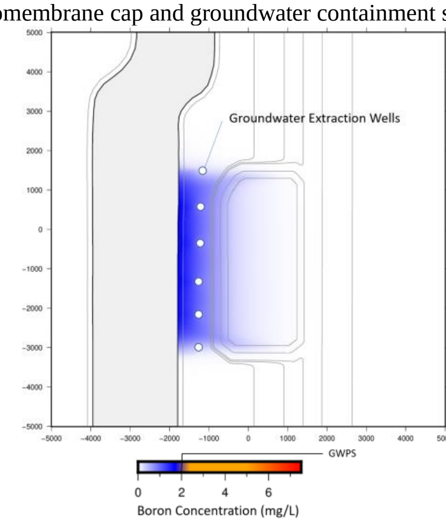
Case 1: Compliance achieved 26 years after CIP with soil cap and MNA



Case 2: Compliance achieved 14 years after CBR and MNA



Case 3: Compliance achieved 22 years after CIP with geomembrane cap and groundwater containment system



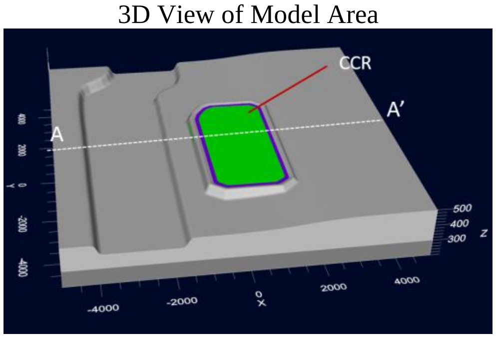
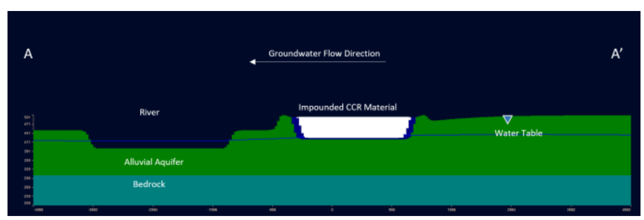
In the **Site 2** model, natural groundwater flows rapidly towards the river in the thin, high conductivity aquifer. The pond is in operation from 1970 to 1991, then idle until the year 2020. By this time, a groundwater plume of boron has formed, exceeding the GWPS of 2.0 mg/L. Three different closure scenarios are evaluated:

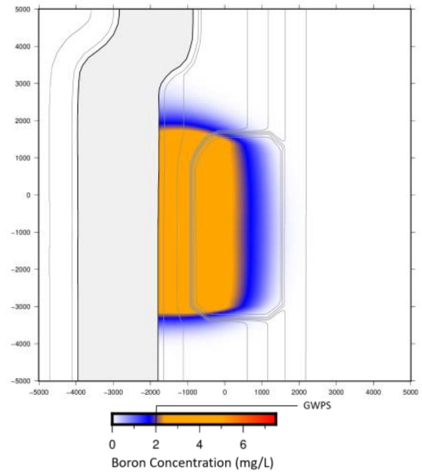
- Case 1: CIP (soil cap) with MNA;
- Case 2: CBR with MNA; and
- Case 3: CIP with a geomembrane cap and groundwater containment system consisting of six groundwater extraction wells.

In Case 1, following implementation of source control by capping, boron mass is removed through natural groundwater flow to the river and no active source controls are put into place. In Case 2, the source of additional boron is eliminated by removing the CCR material; the ground surface is returned to natural conditions and the remaining boron mass is removed by natural groundwater flow to the river. In Case 3, the CCR material is capped with a geomembrane and left in place; boron mass is removed by a groundwater extraction system and natural groundwater flow to the river.

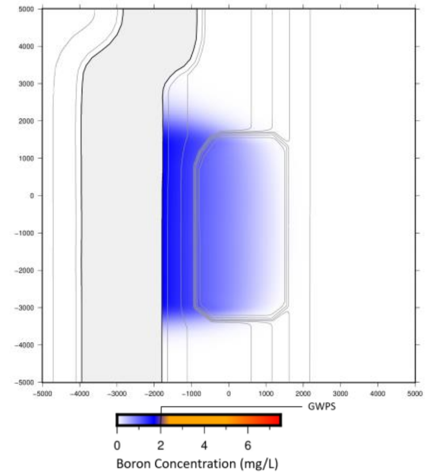
To evaluate the effect of cap type, a fourth model with MNA and geomembrane cap achieved compliance after 20 years (not shown). **All of the remedies (including both CBR and CIP) evaluated as part of this demonstration meet the threshold criteria provided above and would move forward to the comparative analysis.**

Site 3. This model simulates a CCR impoundment located on the bank of a large river with a thick alluvial aquifer with moderate hydraulic conductivity. Groundwater gradients are moderate, surface recharge is normal, and the CCR material is above the water table.

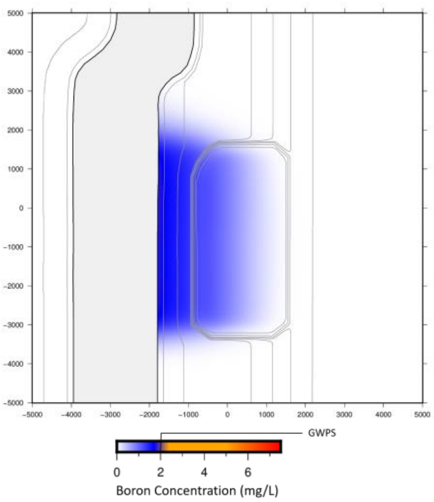
3D View of Model Area	Cross Section Through Model
	
Initial Boron Concentration in Alluvial Aquifer	Compliance achieved 40 years after CIP with soil cap and MNA

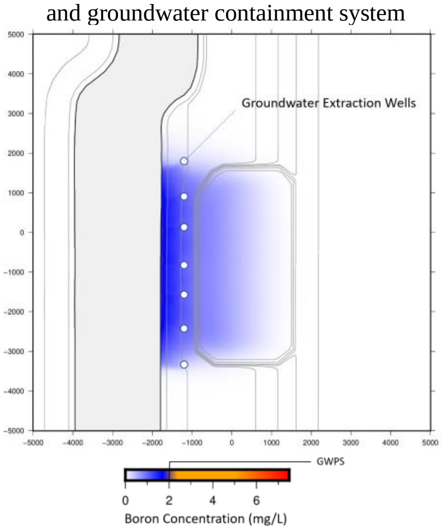


Compliance achieved 40 years after CBR and MNA



Compliance achieved 50 years after CIP with geomembrane cap and groundwater containment system





In the **Site 3** model, natural groundwater flows rapidly towards the river in the thick, high conductivity aquifer while the ash remains above the water table. The pond is in operation from 1970 to 1991, then idle until the year 2020. By this time, a groundwater plume of boron has formed, exceeding the GWPS of 2.0 mg/L. Three different closure scenarios are evaluated:

- Case 1: CIP (soil cap) with MNA;
- Case 2: CBR with MNA; and
- Case 3: CIP with a geomembrane cap and groundwater containment system consisting of seven groundwater extraction wells.

In Case 1, following implementation of source control by capping, boron mass is removed through natural groundwater flow to the river and no active source controls are put into place. In Case 2, the source of additional boron is eliminated by removing the CCR material; the ground surface is returned to natural conditions and the remaining boron mass is removed by natural groundwater flow to the river. In Case 3, the CCR material is capped with a geomembrane and left in place; boron mass is removed by a groundwater extraction system and natural groundwater flow to the river.

In the above figure, the boron plume is shown after a period of time in which the maximum concentration of the plume upgradient of the hyporheic zone (the area where groundwater discharges to the river) has fallen below the GWPS. At this point, adequate protection of human health and the environment is considered achieved. In this particular case, remedies involving capping with a geomembrane and groundwater containment (Case 3) actually delayed achieving the GWPS by limiting the dispersion of the groundwater plume. This is largely because the plume was already fully developed, and the aquifer source zone containing elevated concentrations of boron had attenuated by the time the remedy was applied. However, capping and pumping would still reduce the cumulative boron loading to the river. This is a principle that is not always apparent by basing the effectiveness of a remedy on concentrations rather than mass flux (total mass of boron flowing into the river). To evaluate the effect of cap type, a fourth model with MNA and geomembrane cap achieved compliance after 54 years (not shown). **All of the remedies (including both CBR and CIP) evaluated as part of this demonstration meet the threshold criteria provided above and would move forward to the comparative analysis.**

In each of the above sites and remedy scenarios, the proposed Rule requires the remedies that meet the threshold criteria be compared to one another using the balancing criteria:

- Long- and short-term effectiveness including evaluation of risk reduction, long-term management, time until GWPS are met, risks to the community, and potential for exposures and reliability.
- Source control including containment effectiveness and the extent of treatment is used.
- Ease or difficulty of remedy implementation including remedy construction, operational reliability, permits/approvals needed, availability of materials, equipment and specialists and capacity and location of needed treatment, storage and disposal services.
- Community concerns.

b. There are numerous available remedy classes that can, when site-specific conditions warrant, be paired with removal or a cap, including the following:

- Hydraulic Control (groundwater pumping and treatment);

- Engineered Barriers (slurry walls, sheet-pile walls, etc.);
- In-situ Treatment (using amendments such as emulsified vegetable oil to create a reducing condition); and
- MNA.

In summary, site-specific conditions should dictate selection of an appropriate closure and groundwater remedy for a surface impoundment.

2. <u>One important remedy component available for use is MNA. Active remediation may offer no long-term advantage over MNA for cleaning up groundwater.</u>

The natural attenuation processes that are often an integral part of groundwater cleanup consist of a variety of physical, chemical, or biological processes that, under favorable natural biogeochemical conditions (without human intervention), can reduce the mass, toxicity, mobility, volume, or concentrations in groundwater. These processes include the following (U.S. EPA, 1999):

- Physical processes: dispersion, dilution, sorption, and volatilization.
- Chemical and biological processes: Abiotic reactions (e.g., precipitation and redox reactions), as well as biological stabilization, transformation, or destruction of contaminants.
- Radioactive decay.

Natural attenuation processes are typically occurring at all sites, but to varying degrees of effectiveness depending on the types and concentrations of contaminants present and the physical, chemical, and biological characteristics of the soil and groundwater. Where conditions are favorable, natural attenuation processes may reduce contaminant mass or concentration at sufficiently rapid rates to be integrated into a site's soil or groundwater remedy (U.S. EPA 1999).

The scientific understanding of natural attenuation processes continues to evolve since they have been in use over the past two decades. National Research Council (NRC 2000), United States Geological Survey (Bekins et al. 2001), Interstate Technology & Regulatory Council (ITRC 2010), and U.S. EPA (2015) have performed critical review, conducted research, or provided technical guidance on the topic of natural attenuation as a tool for contaminant site management and cleanup.

Since the beginning of EPA's MNA initiative, it has been emphasized that MNA is not a "presumptive" or "default" remedy – it is an option that should be evaluated with other applicable remedies. EPA has never viewed MNA to be a "no action," "walk-away," or "do-nothing" approach, but rather considered it to be an alternative means of achieving remediation objectives (U.S. EPA 1999, ITRC 2010, U.S. EPA 2015).

Use of Monitored Natural Attenuation for Groundwater Remediation

NRC (2014) published a report, describing their technical review of various remedial options for site cleanup and their assessment of future technical, economic, and institutional challenges in the nation's groundwater remediation efforts. MNA is one of the remedial options reviewed for their effectiveness and uses. As reported in *Superfund Remedy Report Fifteen Edition* (U.S. EPA, 2017), MNA has been selected as part of the overall groundwater remedies in approximate 20% - 40% of decision documents (or National Priority List sites annually) since 2000, signifying the importance of MNA as a tool for contaminated site restoration (Figure 1). For the cases where a source remedy has been specified in the decision documents, the off-site disposal option (excavation and disposal at an off-site facility) has generally been selected at a frequency between 25% and 50% over nearly three decades (Figure 2).

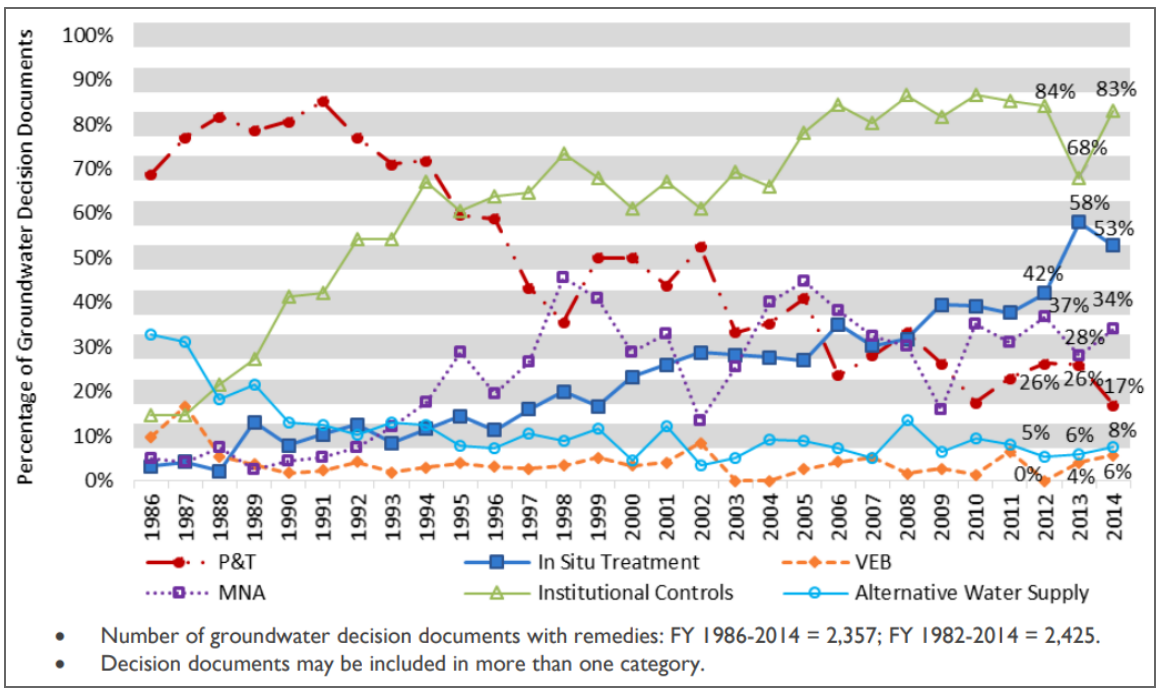


Figure 1: Selection trends for decision documents with groundwater remedies (FY 1986-2014); adopted from *Superfund Remedy Report Fifteen Edition* (U.S. EPA, 2017).

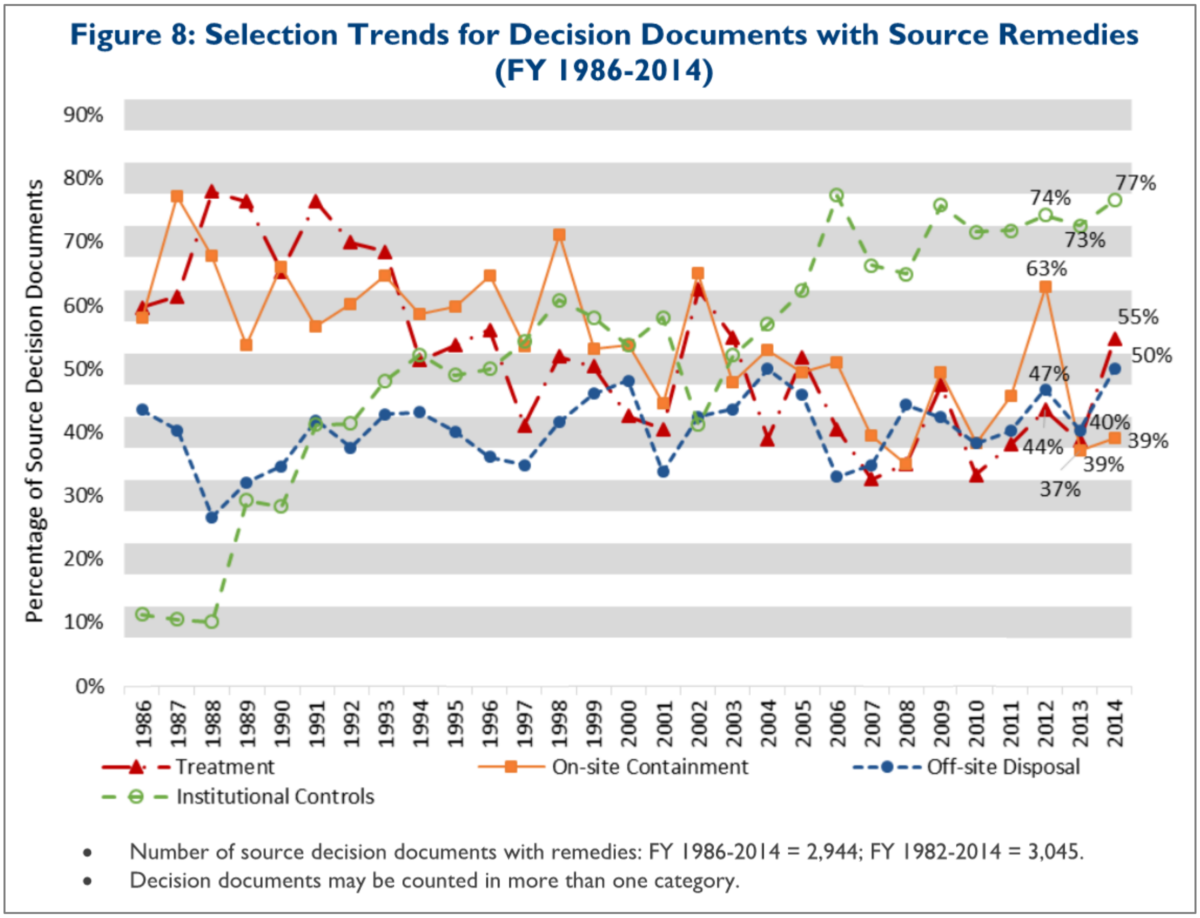


Figure 2: Selection trends for decision documents with source remedies (annotated) (FY 1986-2014). The off-site disposal option includes excavation and disposal at an off-site facility. The on-site containment option includes the use of caps, liners, covers, and landfilling on site; adopted from *Superfund Remedy Report Fifteen Edition* (U.S. EPA, 2017).

In summary, MNA has been adopted by the U.S. EPA as a long-term site management tool for Superfund sites for over two decades. Many states have established a regulatory framework of incorporating MNA as a remedy for various types of sites, including metal impacted sites

Natural Attenuation Processes for CCR Constituents – Chemical Attenuation Processes

Electric Power Research Institute (EPRI) published a technical report that provides technical information, analysis, and cost estimates related to the applicability of MNA at CCR facilities (EPRI, 2015). This report describes how to use EPA's four tier MNA evaluation protocol (developed specifically for facilities with inorganic constituents in groundwater; U.S. EPA 2007) to determine whether natural attenuation is occurring and how it will help meet remediation objectives in the future. A summary of potential chemical attenuation mechanisms associated with various CCR constituents are also documented in the report. These include adsorption, precipitation, and co-precipitation, as summarized below:

- Adsorption: Under certain geochemical conditions, adsorption may occur to allow sufficient attenuation of some CCR constituents before reaching a receptor. Adsorption to iron and manganese oxides and oxyhydroxides have been found to be a potentially important attenuation mechanism for arsenic, cadmium, chromium, cobalt, copper, lead, nickel, radium, selenium, and zinc (EPPI, 2015). Under anaerobic conditions, several CCR constituents, such as arsenic and chromium, may also be attenuated through adsorption to sulfide mineral surfaces.
- Precipitation: Under certain geochemical conditions, CCR constituents may react with other soluble constituents in groundwater to form mineral precipitates. For example, copper precipitation in the form of cooper carbonates, sulfides, and/or phosphates may occur when groundwater pH is above 6; under sulfide-genic conditions, chromium and arsenic may also form sulfide precipitates.
- Coprecipitation: This geochemical process involves the substitution of a trace element for a major element during precipitation. For example, under sulfide-genic conditions, arsenic and chromium may be incorporated into structures of various types of primary sulfide mineral precipitation (e.g., pyrite) or, under oxic conditions, they may be incorporated into structures of iron and manganese oxide or oxyhydroxide minerals.

EPA has also conducted a technical evaluation of metal attenuation processes at mining sites (U.S. EPA, 2007). Arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), uranium (U), and nickel (Ni) were the focus of this evaluation. Key attenuation processes for these metals are sorption and precipitation in strong anaerobic environments. Their work concluded in the following:

- At nearly all mining sites, natural processes are contributing to varying degrees and, in some cases, may contribute significantly to site remedial goals. Biogeochemical processes can be particularly important for natural attenuation of some metal and metalloid contaminants, under specific environmental conditions.

- Effective management of these sites over long periods of time requires complex organization of site characterization, technology selection and utilization, and long-term monitoring. Given that cleanup expectations at many mining sites are long-term, it may be appropriate to include an examination of natural attenuation processes and the role that such processes play in removing, repartitioning, or otherwise affecting the fate of contaminants in the environment.

Natural Attenuation Processes for CCR Constituents – Physical Attenuation Processes

The extent of COC impacts will depend on the assimilation capacity of the impacted aquifer (Chapelle and Bradley 1998). Dispersion and dilution are solute transport processes that result in mixing between impacted and unimpacted groundwater (Cirpka and Kitanidis 2002, Rolle and Kitanidis 2014). The extent of dispersion and dilution is a function of aquifer heterogeneity of hydraulic properties, molecular diffusion, and transport time scale. The mechanism of dilution and dispersion can result in concentration decrease along a transport pathway. It has been well known that aquifer permeability heterogeneity can also result in sequestration of COCs into fine-grained (i.e., low permeability) zones through matrix diffusion (Seyedabbasi et al. 2012). For an aquifer system containing a significant faction of fine-grained aquifer solids, the transport of a COC may be considerably retarded and the mass discharge rate to a downgradient receptor can decrease significantly through the matrix diffusion process (Einarson et al. 2013). It has also been found that the fine-grained zones often are biogeochemically active and may become a sink of many COCs (ESTCP 2015). In addition, the adsorption process described above can result in partitioning of COCs from the aqueous phase to unimpacted aquifer solids, thereby also attenuating COC concentrations in groundwater.

a) Active remediation is not always most favorable with respect to the remedy selection criteria described earlier. Recall that the remedy scenarios provided above include the active remedy component of groundwater pumping and treatment. The remedy scenario met the threshold criteria, thereby qualifying for the comparative analysis to the other remedies of CBR with MNA and CIP with MNA, neither of which include an active groundwater remedy component. By way of example, applying the balancing criteria of the active pumping and treating remedy to the other remedy alternatives described above could yield the following results:

- The pumping and treatment option may rank less favorable for long- and short-term effectiveness because it often requires higher levels of long-term management, increases the potential for exposures and has reliability concerns; therefore, this remedy option may be less favorable than the other options considered.

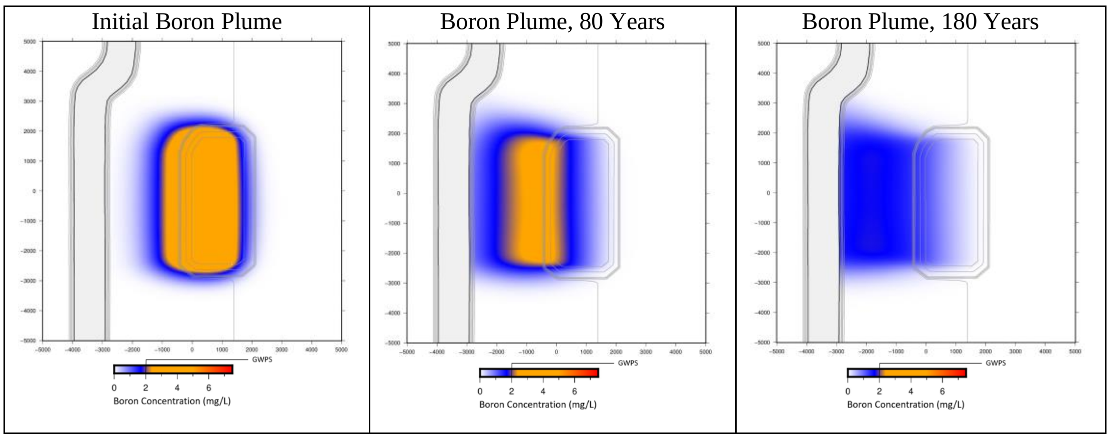
- The pumping and treatment option may rank the most favorable for source control.

- The pumping and treatment option may rank less favorable for ease or difficulty of remedy implementation because of added components required for remedy construction, operational reliability and permits/approvals needed.

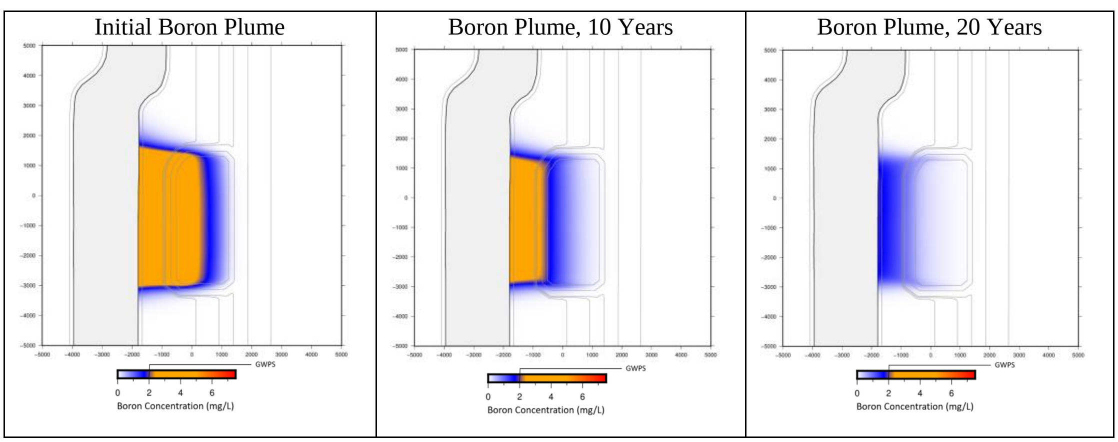
In summary, an important remedy component available for use is MNA. Active remediation may offer no long-term advantage over MNA for cleaning up groundwater, especially when the groundwater contamination does not present an unacceptable risk to human health or the environment. MNA is not a "do nothing" remedy.

3. <u>Removal is not always necessary when CCR material is below the groundwater table or situated within a floodplain.</u>

   a. The results of groundwater modeling of boron over time with CCR below the water table for a CIP remedy scenario are shown below and indicate that GWPS are met over time for CIP remedy options[1] under two hydrogeologic settings.



Site 1 Model (lower permeability aquifer material with ash submerged below the water table for CIP), CIP with geomembrane cap. For lower permeability sites, the CIP with MNA and CBR with MNA take considerable time to meet the GWPS.



Site 2 Model (higher permeability aquifer material with ash (below the water table)), CIP with geomembrane cap. For higher permeability sites, the CIP with MNA and CBR with MNA remedy alternatives take considerably less time to meet the GWPS than the lower permeability setting.

[1] For time frames for removal options see Opinion 9, Table 2.

b. This analysis is verified by the groundwater monitoring results over time from the Hennepin site located along the Illinois River where two sets of impoundment systems were taken out of service.

Hennepin West, Pond No. 1 and Pond No. 3

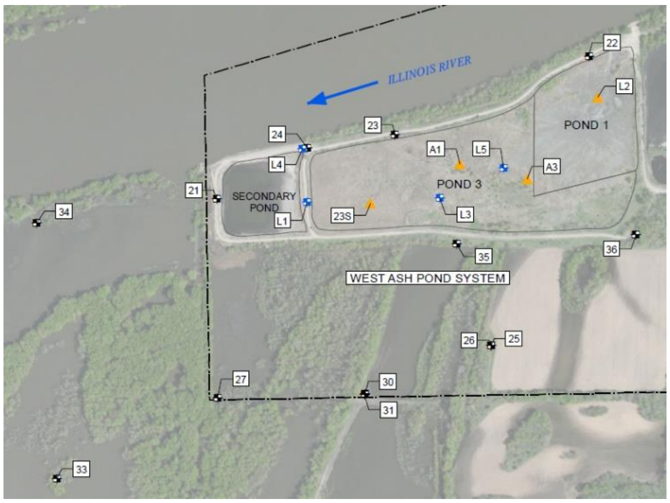


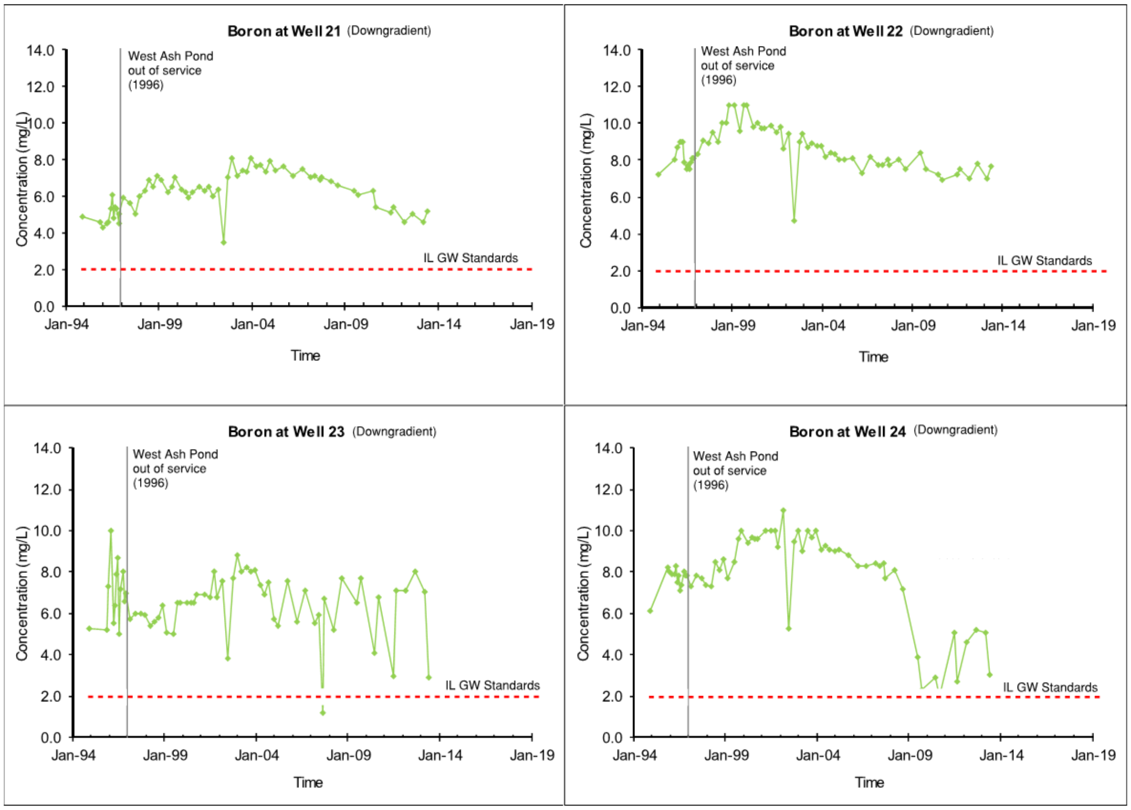
Figure adopted from Closure Alternatives Evaluation West Ash Pond System (Natural Resource Technology (NRT), (24 July 2014). Background information adopted from Closure and Post-Closure Plan Old West Ash Pond Old West Polishing Pond (Geosyntec, 20 December 2017) and Groundwater Management Zone, Application Revision (NRT 18 May 2018).

Background

Pond No. 1 (unlined) received bottom ash and slag from 1952 to 1996. Pond No. 3 (unlined), which is contiguous with and has no vertical separation of CCR materials from Pond No. 1, received mixed coal ash from 1952 to 1996.
Pond No. 1 and Pond No. 3 were taken out of service in 1996 and were not capped. The closure plan for Pond No. 1 and Pond No. 3 was approved in June 2018, involved installation of an alternative soil and geosynthetic cover, and is anticipated to be completed in November 2020. The CCR within Pond No. 1 is not typically saturated. The CCR within the eastern portions of Pond No. 3 may be seasonally saturated. The western portion of Pond No. 3 is typically saturated to depths ranging from about 6 to 11 feet. Groundwater sampling was initiated in 1983, with consistent data collection beginning in 1996.

COCs

Arsenic and boron had exceedances over proposed GWPS's. Of the exceedences, only boron consistently exceeded the proposed standard of 2.0 mg/L. The concentration of boron over time for wells downgradient of Pond No. 1 and Pond No. 3 is shown below:



Graphs adopted and annotated from Closure Alternatives Evaluation West Ash Pond System (NRT, 24 July 2014).

As can be seen from the data plots, several wells have clear decreasing trends of observed boron concentrations even though the cap has yet to be installed. These data clearly show the significance of taking a surface impoundment out of service, which removes the hydraulic head, the driving force for source constituents to enter the groundwater system. These declining boron concentrations are consistent with modeling performed for the site, as well as modeling performed in support of my opinion provided herein. Although the GWPS for boron has not been met as of this date, both the trend data and supporting models indicate that the boron GWPS will be met in the future.

Hennepin East, Pond No. 2 and Pond No. 4

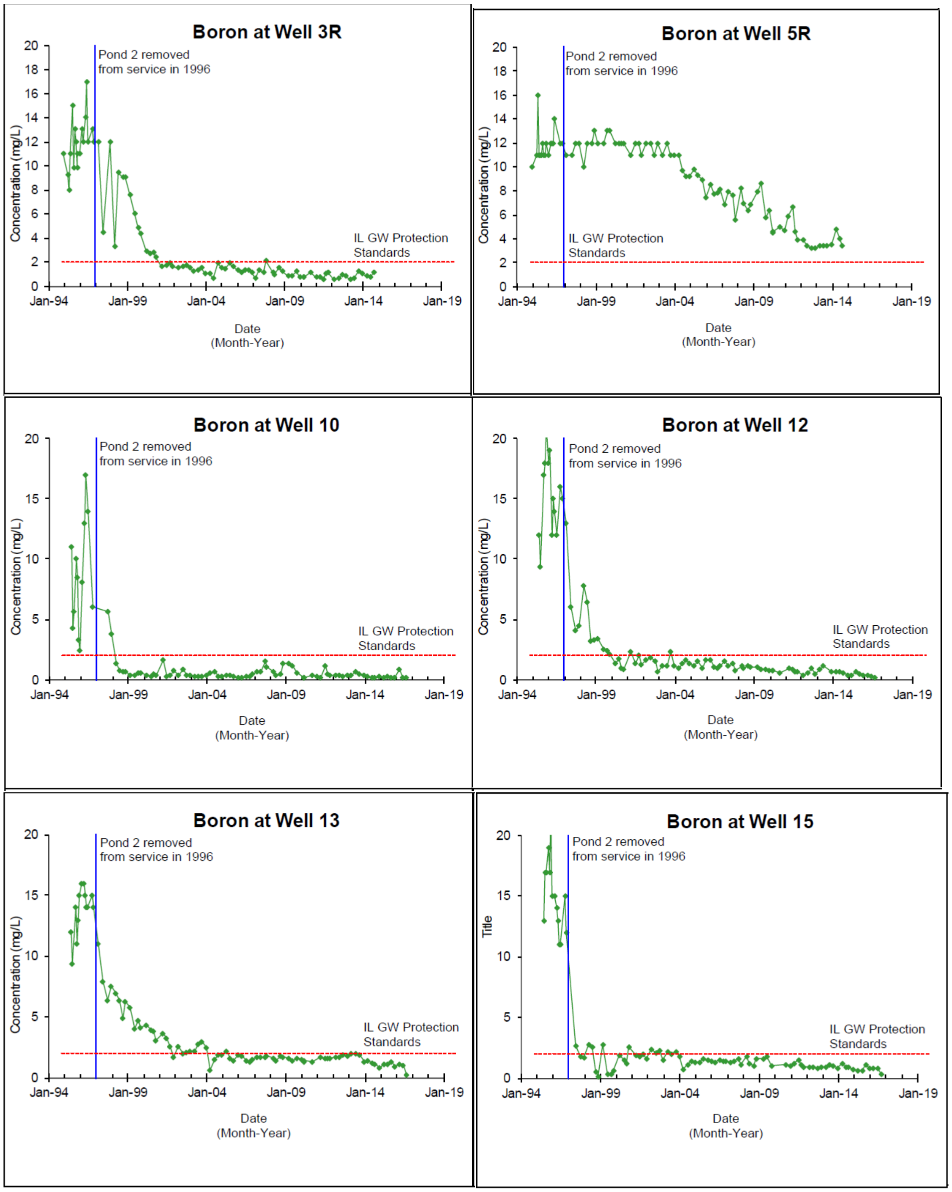
Figure adopted from the Groundwater Management Zone Application Revised Hennepin East Ash Pond No. 2 and Pond No. 4 (Ramboll, January 2020). Background information adopted from the Closure Plan Addendum (O'Brien and Gere (OBG), 25 October 2018).

Background

Pond No. 2 (unlined) received fly ash, bottom ash, and other non-CCR waste streams, including coal pile runoff, from 1958 to 1996. The pond was dewatered after being taken out of service. Pond No. 4 (an unlined former sand and gravel quarry) received ash from 1978 to 1984. Closure of Pond 2 and Pond 4 is anticipated to be completed in November 2020 and includes, in part, regrading the CCR within the ponds to achieve acceptable grades for closure and constructing a cover system. No additional dewatering beyond that which has occurred naturally is anticipated in order to complete closure. The final cover for the ponds will have a compacted soil barrier layer that is a minimum of 24 inches of earthen material with a maximum permeability of 1×10^{-7} cm/sec and a vegetative layer that is a minimum of 6 inches of earthen material capable of sustaining native plant growth. The CCR within Pond No. 2 and Pond No. 4 is typically not saturated. Ash in limited areas at the base of Pond No. 2 may be saturated (below the water table in the adjacent aquifer) during higher flood stage events of the Illinois River. The base of ash is not in contact with groundwater (i.e., non-intersecting conditions) under normal flow conditions. Groundwater sampling was initiated in 1993.

COCs

Boron had exceedances over the proposed GWPS. The concentration of boron over time for wells downgradient of Pond No. 2 and Pond No. 4 is shown below:



Graphs adopted and annotated from the Closure Plan Addendum (OBG, 25 October 2018).

The wells demonstrate a decreasing trend over time with multiple wells falling below the proposed GWPS for boron after the pond has been removed from service and prior to a cap being installed. This includes the fact that some CCR at the base of the impoundment (Pond No. 2) may be periodically saturated during some flood events. Once a cap is installed and consistent with our modeling, wells at the site should meet the GWPS indicating that removal is not necessarily warranted.

c. Site-specific assessments are needed to determine whether ash below the water table/intermittent intersecting groundwater warrants removal or additional remedial measures other than a cover system based on a number of factors including:

i. Groundwater contact with CCR materials is intermittent, of limited areal extent, or most of the groundwater moves around, not through, the CCR materials; accordingly, under these site-specific circumstances, groundwater contact or flow through the ash is minimal.

When a CCR surface impoundment is located on high permeability alluvium, which is often the case at sites in Illinois, and the hydraulic gradients are also relatively high, the vast majority of groundwater flow is through the alluvium and not through the CCR material. Groundwater flow models were developed to calculate this relationship and are summarized below:

Scenario	Recharge (inches/year)	Flow Through CCR (cfs)	Flow Around CCR (cfs)
Pre-closure	30	0.00015	1.78
Soil Cap	0.876	0.0015	1.97
Geomembrane Cap	0.438	0.0016	1.97

Table 1. Mass balance calculation for CCR material, **Site 2** Model.

In each of the cases provided above, less than 1% of the total groundwater flow is through the CCR material. Under these site conditions, the relative contribution of water flowing through the ash is quite small and the contribution of CCR constituents would be commensurately small. These factors, along with others, would need to be considered when evaluating potential remedies.

ii. The GWPS can be met when ash is below the water table. As demonstrated above, both groundwater flow modeling conducted as part of this opinion and results from the Hennepin West Pond No. 1 and Pond 3 (saturated ash of limited areal extent) and Hennepin Ash Pond No. 2 (intermittently saturated ash) indicate that GWPS's can be met when ash is below the water table.

d. Flooding/rising and receding groundwater associated with flood events does not create an unacceptable risk and may not contribute to exceedences of GWPS's. The analyses required by 845.650 and 845.710 will determine what remedial measures are necessary to ensure protection of human health and the environment. The discussion on Hennepin East, provided above, is a prime example of such a condition where CIP with MNA has been determined to be appropriate even when CCR material is periodically wetted during certain flood events.

In summary, modeling and existing site-specific groundwater monitoring data indicate that removal of CCR material that is below the groundwater table is not always necessary. In addition, site-specific assessments should be conducted to determine whether ash below the water table/intermittent intersecting groundwater warrants removal or additional remedial measures other than a cover system. Lastly, flooding/rising and receding groundwater associated with flood events does not necessarily create unacceptable risks.

4. Removal will not always result in achieving the groundwater protection standards earlier.

   a. Time to complete removal

      Often times, and particularly for large ash ponds, the time to complete removal can be lengthy and on the order of decades. That is especially true when there is inadequate disposal space in an existing on-site disposal facility (landfill) and the removal time would be dictated in part by daily disposal limits set by off-site landfill permits or the development of new on-site disposal capacity, if even feasible. These limitations, as well as the potential seasonal controls to construct the removal, can make a large-scale removal time lengthy.

      Depending on site-specific conditions, the time to achieve a GWPS for removal can be lengthier than CIP.

   b. Geochemical conditions when a surface impoundment is open and undergoing a removal action for an extended period of time can, in fact, mobilize some constituents and, therefore, their transport becomes more significant. A prime example of such a condition is the creation of aerobic conditions that could cause selenium to stay in soluble form. When closure by capping is undertaken, the aquifer could revert to anaerobic conditions causing selenium to precipitate.

   In summary, modeling indicates that removal of CCR material does not always result in achieving groundwater protection standards sooner than other remedies.

5. CIP of surface impoundments coupled with MNA or groundwater extraction has been effective at controlling and mitigating groundwater contamination in Illinois.

   Groundwater data demonstrating the effectiveness of CIP is shown for the ash ponds located at the Havana, Hutsonville, and Venice power stations:

Havana, South Ash Impoundment

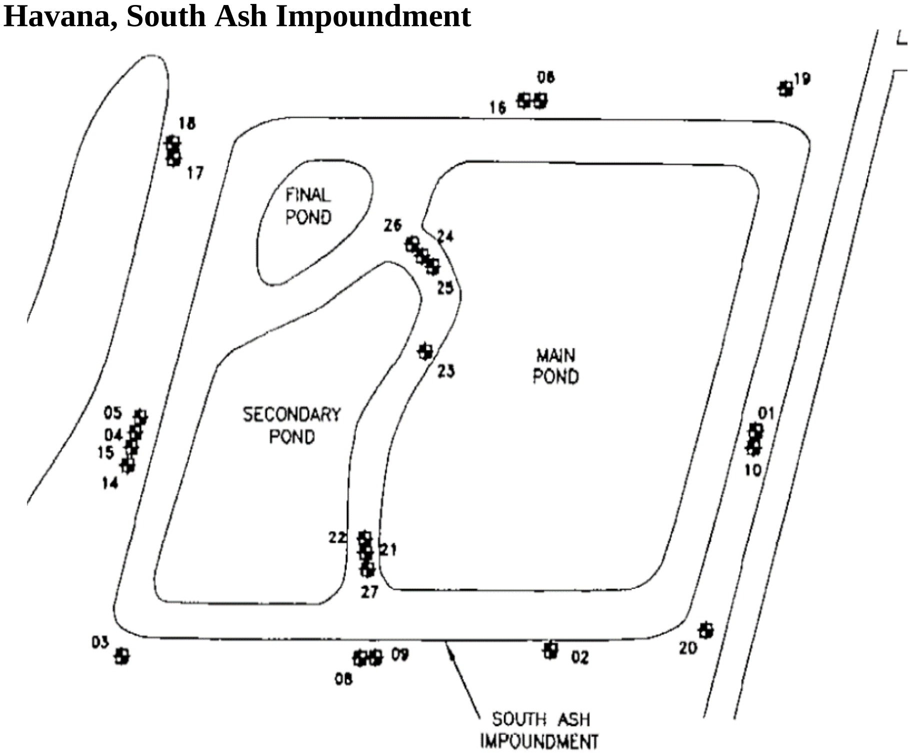


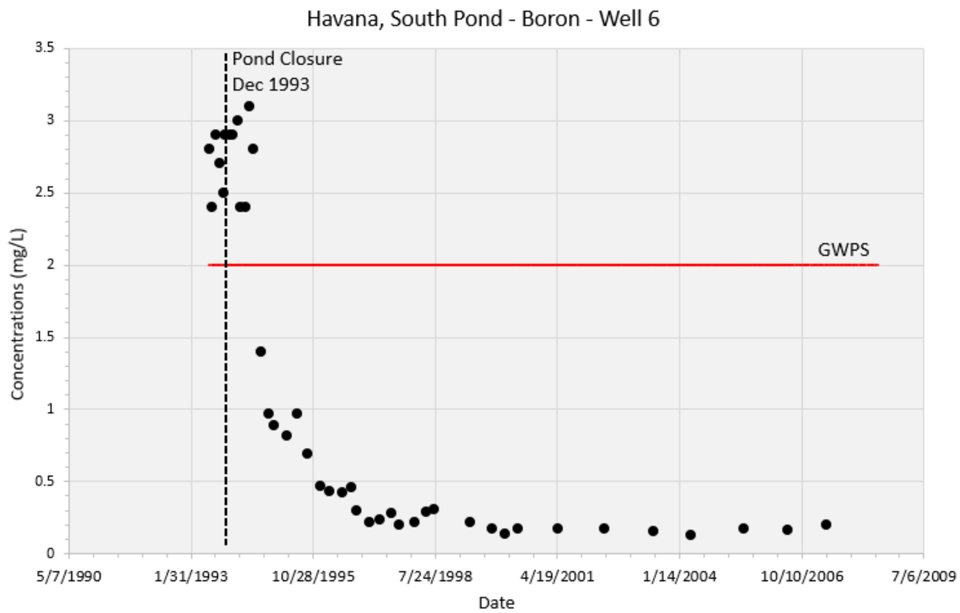
Figure and background information adopted from the 2008 Closure Work Plan Annual Report (NRT, September 2008).

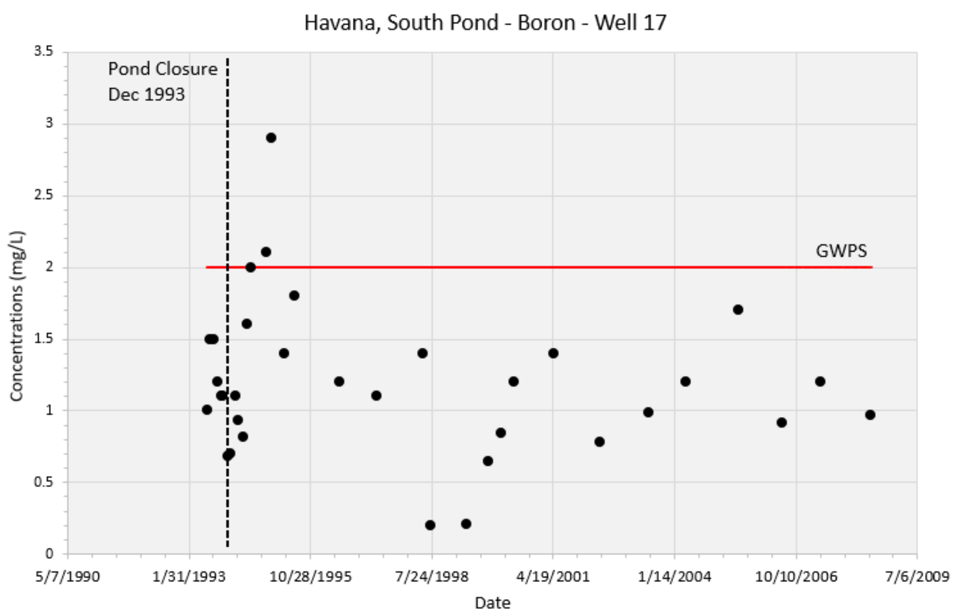
Background

The South Ash Impoundment was taken out of service in 1993. Prior to closure, materials in the secondary and tertiary ponds were placed in the South Main Pond. The South Pond (main pond) was closed in 1994 by placing a 3-foot thick cover of locally available soil material and vegetation. The site is adjacent to the Illinois River. Groundwater sampling has occurred from 1993 to at least 2008.

COCs

Boron had exceedances over prior and the currently proposed GWPS of 2.0 mg/L. The concentration of boron over time in wells downgradient of the South Ash Impoundment indicates that pond closure using a soil cap/cover has been effective at meeting the GWPS for boron.


Havana, South Pond - Boron - Well 6
Pond Closure
Dec 1993
GWPS
Concentrations (mg/L)
Date
0
0.5
1
1.5
2
2.5
3
3.5
5/7/1990
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009


Havana, South Pond - Boron - Well 17
Pond Closure
Dec 1993
GWPS
Concentrations (mg/L)
Date
0
0.5
1
1.5
2
2.5
3
3.5
5/7/1990
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009

Hutsonville, Pond D

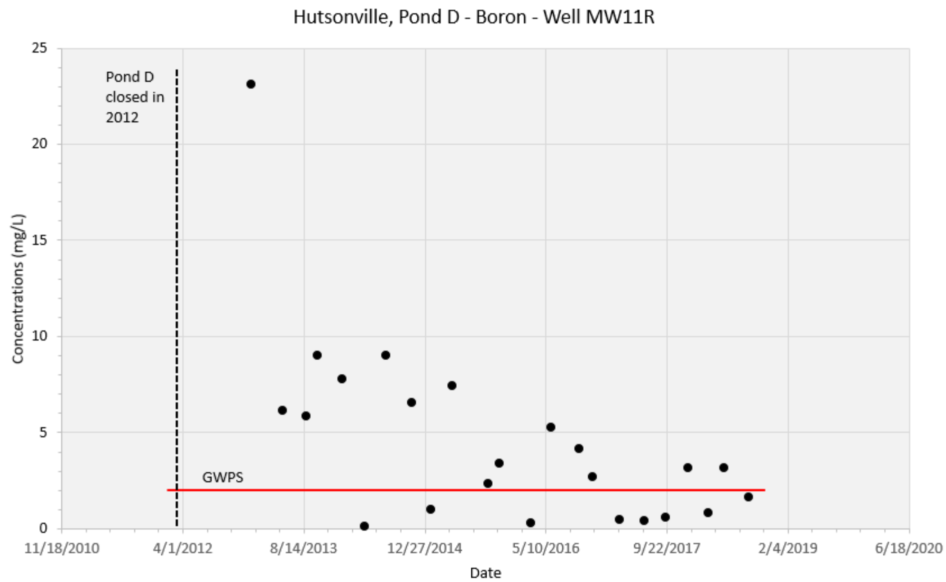
Figure and background information adopted from the 2019 Annual Report Ash Pond D (Ramboll, 28 January 2020).

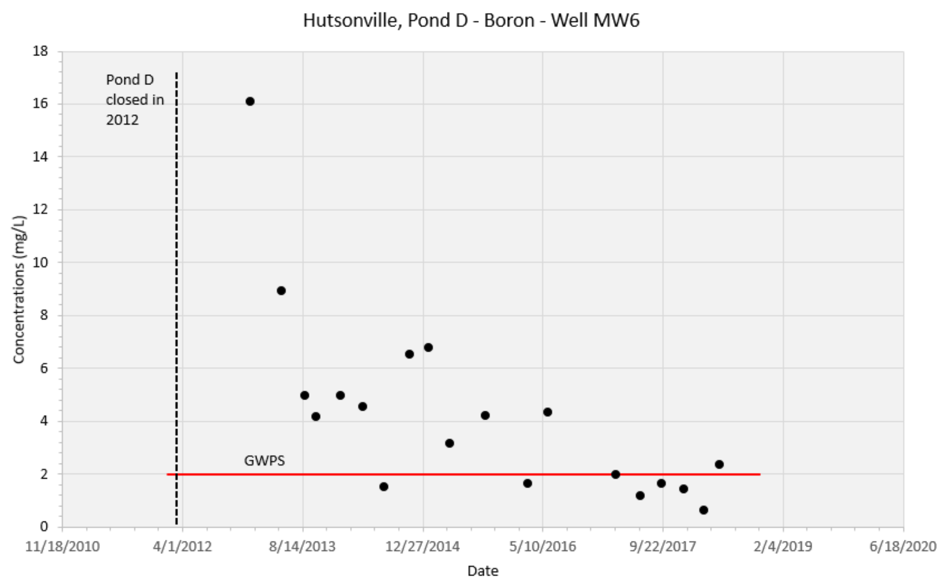
Background

Pond D (unlined) received fly and bottom ash solids from 1968 until 2000 and was closed in 2012. Closure activities included CCR subgrade grading, CCR subgrade compaction, placement of 40-mil high density polyethylene (HDPE), placement of a three-foot thick vegetative soil layer, planting vegetation, construction of surface water control structures, and construction of a groundwater collection (trench) system. Some CCR is below the water table. Pond D is adjacent to the Wabash River. Groundwater monitoring started in 1984. The groundwater collection system along the south property boundary to prevent off-site migration became operational in April 2015.

COCs

Antimony, arsenic, boron, chromium, cobalt, lead, mercury, and thallium had exceedances over proposed GWPS's. Of the exceedences, only boron consistently exceeded the proposed standard. The boron trends over time are provided below.





As shown in the above graphs, boron continues to trend downward over time, indicating the effectiveness of CIP where there is groundwater intersecting an impoundment.

Venice, Ponds 2 and 3

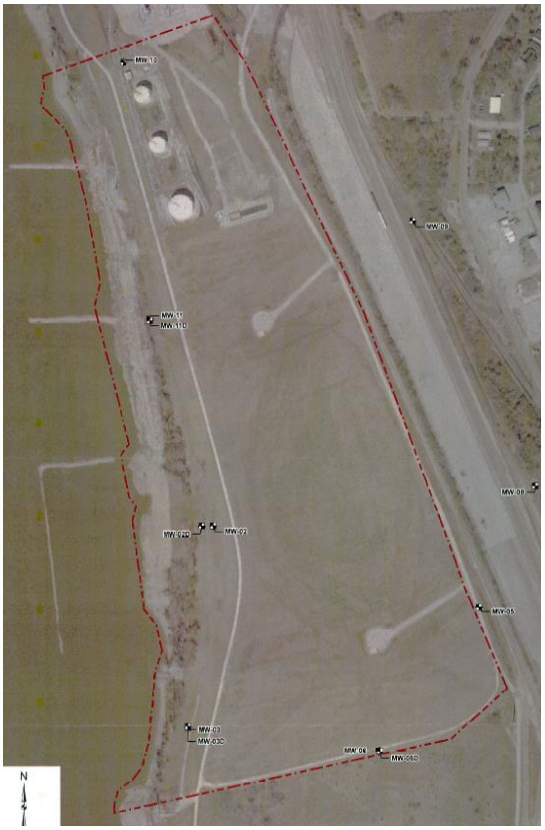


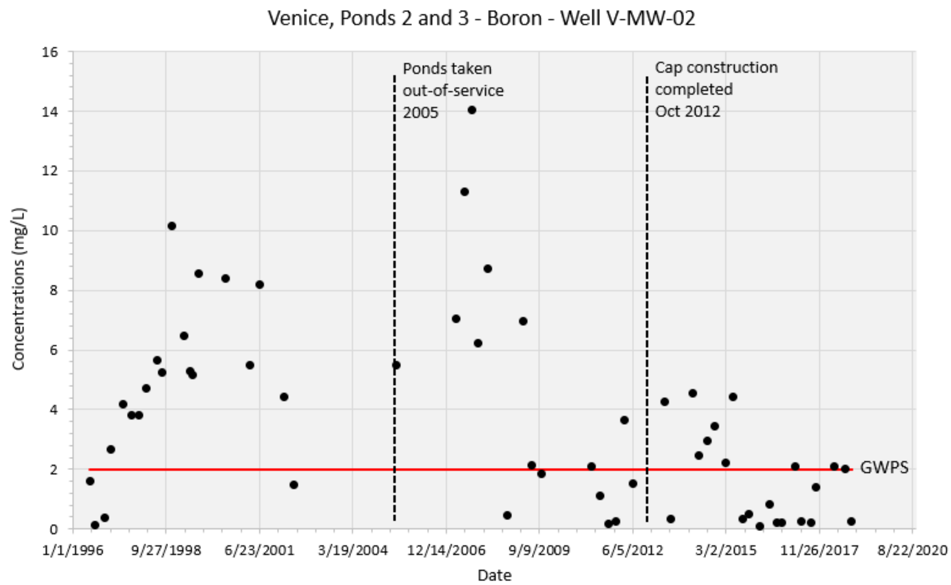
Figure adopted and annotated from the 2018 Annual Report Ash Ponds 2 and 3 (OBG, 26 March 2019). Background information from the Closure Plan Ash Ponds 2 and 3 (NRT, 4 February 2011), the Construction Quality Assurance Plan and Closure Report Ash Ponds 2 and 3 (Aquaterra, November 2012), and the 2018 Annual Report Ash Ponds 2 and 3 (OBG, 26 March 2019).

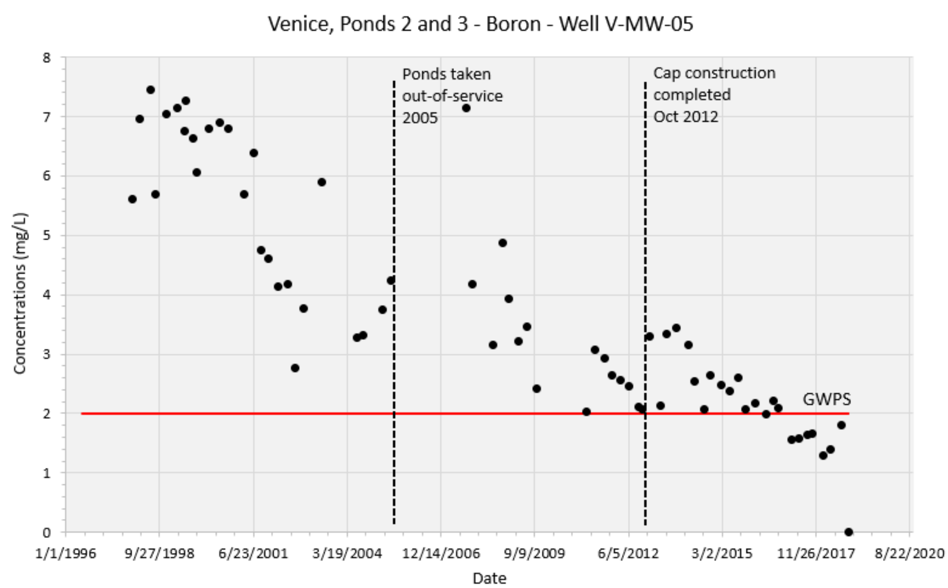
Background

Pond 2 and Pond 3 were constructed of native earthen material, are both unlined, received CCR from the 1950s until 1999, and received stormwater and process water from 1999 to 2005. Pond 2 and Pond 3 were closed in October 2012. Closure of Ponds 2 and 3 included CCR grading in each pond to provide a firm subgrade for the geomembrane cap to be installed on top of the coal ash grading layer, followed by installation of the 40-mil linear low density polyethylene (LLDPE) geomembrane, and installation of a double-sided geocomposite comprised of a HDPE geonet laminated between geotextile layers on top of the geomembrane. Closure was completed by placement of a 3-foot thick protective cover layer consisting of 2.5 feet of soil and 6 inches of topsoil on top of each pond, which was subsequently seeded for native grass vegetation. Groundwater at this site is in contact with CCR during high water stages of the adjacent Mississippi River. Groundwater monitoring began in 1996.

COCs

Antimony, arsenic, boron, chromium, cobalt, and lead had exceedances over the proposed GWPS's. Of the exceedences, only boron consistently exceeded the proposed standard, the trends over time of which are provided below.





In summary, review of existing site-specific groundwater monitoring data from sites in Illinois indicates that surface impoundment CIP coupled with MNA or an extraction system has been effective at controlling and mitigating groundwater contamination.

HALEY ALDRICH

6. The purpose of Part 845 is to perform CCR surface impoundment specific evaluations and determine whether a CCR surface impoundment is impacting groundwater, then address those impacts through closure and groundwater corrective measures. Part 845, correctly and consistent with the federal CCR Rule, assigns background concentrations to the impoundment of interest.

    a. Part 845 correctly requires an Owner or operator to measure background concentrations specific to each surface impoundment. The concept of "unimpacted background" may be valid for site-wide evaluations that would be undertaken under a different regulatory authority (Part 620 for example), but not for the unit specific surface impoundment evaluations required under the proposed rule. Accordingly, groundwater monitoring systems should be designed to determine if the unit leaks using wells specifically upgradient of the unit.

7. Part 845.650(b)'s requirement to perform quarterly groundwater monitoring should allow for monitoring frequency adjustments over the post-closure care period depending on site-specific conditions.

    Such conditions could include a demonstration that there is limited and predictable variability in groundwater quality over time, a condition that is often encountered in groundwater flow systems characterized by relatively low flow velocities. Suggested changes to this section of the proposed rule is as follows:

    > Any owner or operator conducting quarterly monitoring pursuant to Part 845.650(b)(1) may reduce the quarterly sampling to semi-annual sampling during the post-closure care period when:
    >
    > a. No monitored constituent is detectable in downgradient wells for at least four consecutive quarters;
    >
    > b. No monitored chemical constituent has a concentration that differs to a statistically significant degree from the concentration detected in upgradient wells for four consecutive quarters;
    >
    > c. After a minimum of five years with a demonstration that semi-annual monitoring does not reduce the statistical power for determination of a statistically significant result at a 90 percent confidence level for each monitored parameter.

8. The frequency of groundwater level monitoring (845.650(b)(2)) does not need to be undertaken more frequently than the sampling of the analytes listed in Section 845.640. The relationship between the groundwater and surface water should be established as part of the hydrogeologic site characterization (845.620). This would include obtaining groundwater and surface water elevation measurements during characterization activities.

The frequency of groundwater level monitoring should be based on site-specific conditions and may vary over the duration of groundwater monitoring. The frequency of groundwater level monitoring (845.650(b)(2)) does not need to be undertaken more frequently than the sampling of the analytes listed in Section 845.640. Consistent with groundwater quality sampling and analysis, the frequency of groundwater level monitoring should be based on site-specific conditions and may vary over the duration of groundwater monitoring. Importantly, groundwater levels are part of the hydrogeologic information used to understand groundwater quality results; therefore, groundwater levels should be collected at the same frequency as groundwater sampling and analysis.

9. Statistical methods consistent with the Unified Guidance Document should be used to determine an exceedance of a GWPS.

A single exceedance or a "confirmed" exceedance should not trigger corrective action – a statistically significant level above a GWPS should be used to ensure appropriate confidence that corrective action is warranted. The Unified Guidance notes that an "initial exceedance may be due to a laboratory error or other anomaly that has caused the observation to be an outlier." If the result is not in error, it may "represent a portion of the background population that has heretofore not been sampled."

Depending on the nature of the GWPS and comparison, two or more samples may be required to provide some statistical confidence of an exceedance. Statistically based approaches can be designed that incorporate formal retesting programs which is different than simple verification testing as proposed by IEPA.

In addition, the use of a singular confirmed detection greater than a GWPS to trigger corrective action does not consider the fact that the more comparisons conducted the more it "increases the accumulative risk of making a false positive mistake."[2] This is known statistically as the multiple comparison problem. The Unified Guidance notes that "as the number of tests increases, the false positive rate associated with the testing network as a whole (i.e., across all well-constituent pairs) can be surprisingly high."

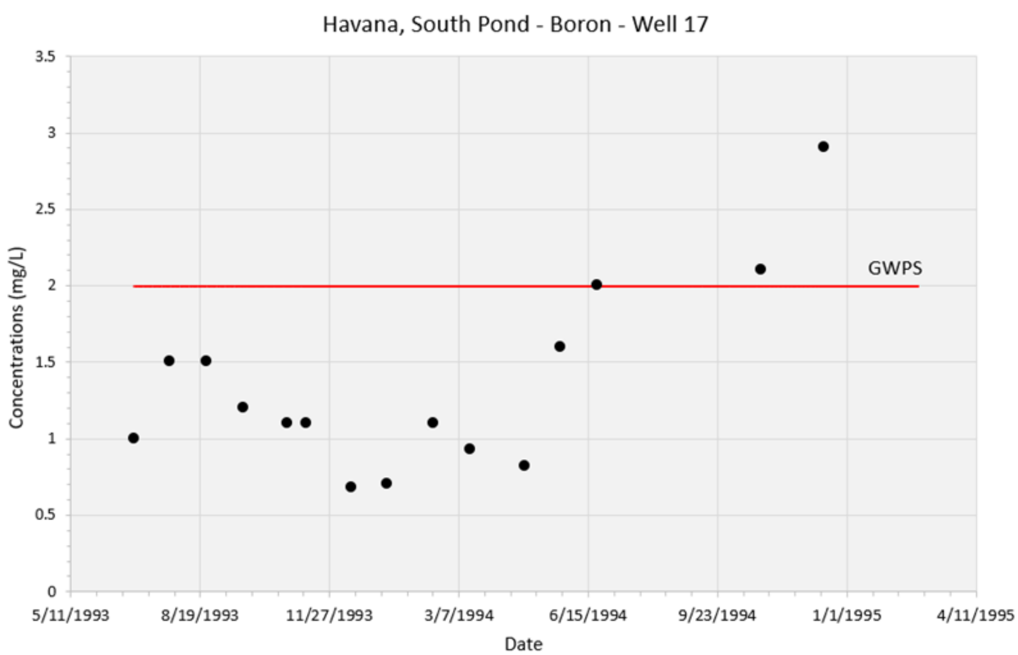
A goal of detection monitoring should include to "avoid false positive decision errors, evaluations where one or more wells are falsely declared to be contaminated". A false declaration would result in unnecessary corrective actions. Therefore, the monitoring design should include statistical analysis with consideration of potential false positives. The potential problem is compounded by, as proposed by IEPA, the merger of the detection monitoring and assessment monitoring programs. This increases the number of constituents and therefore the number of comparisons making the probability of a false positive greater.

[2] Unified Guidance Page 6-2.

Consistent with the Federal rule, decisions relative to the GWPS should require that the constituent is "detected at statistically significant levels above the groundwater protection standard."[3] The following example illustrates how using a singular confirmed detection comparison to GWPS without statistical evaluation would incorrectly trigger corrective actions under the proposed rule.

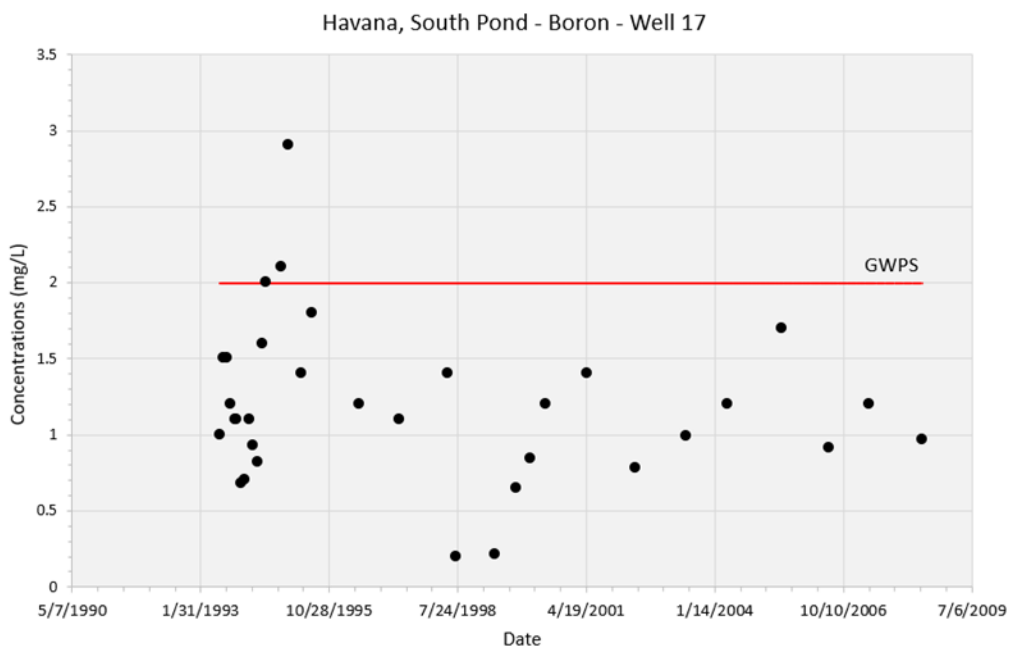
The boron sample concentrations shown in the following graph are from the Havana South Pond Well 17. One year of sampling was completed from June 1993 through May 1993. These concentrations are less than the proposed GWPS of 2 mg/L. These results were followed by a June 1994 sampling event with a concentration equal to but not greater than the proposed GWPS (2 mg/L). The next two sample concentrations were greater than the GWPS (2.1 and 2.9 mg/L in October and December 1994, respectively). Under this example, direct comparison to the GWPS at Well 17 would have triggered corrective action under the proposed rule after the "confirmed detection" from the December 1994 sampling event.

However, the results (June 1993 through December 1994) can be statistically compared to the GWPS to provide confidence as to whether the concentrations at Well 17 are an exceedance of the GWPS. Based on standard confidence limits of the mean, the boron concentration at Well 17 through December 1994 is not at statistically significant levels above the groundwater protection standard. Therefore, the decision to conduct corrective actions would be premature based on these results.



[3] § 257.95(g).

The statistical conclusion that concentrations were not an exceedance of the GWPS was subsequently demonstrated by continued sampling. The sample concentrations from 14 years of additional sampling completed after December 1994 (see below graph) were all individually and statistically less than the GWPS. Thus, the use of statistical comparisons the GWPS can minimize the potential for false positives resulting in unnecessary corrective actions.



10. <u>The timeframes to remedy groundwater, regardless of the remedies being evaluated, is most often long, spanning decades; therefore, it is inappropriate to require corrective measures and post closure care to be completed within 30 prescribed years.</u>

The estimated length of time to complete corrective measures and post closure care for several site settings/hydrogeologic conditions utilizing a range of closure and corrective measures options was determined using groundwater flow models, the results of which are provided below:

	CIP with Soil Cap and MNA (Case 1)	**CIP with Geomembrane Cap and MNA**	**CBR and MNA (Case 2)**	**Geomembrane Cap and Groundwater Containment System (Case 3)**
Site 1	180	170	120	80
Site 2	26	20	14	22
Site 3	40	54	40	50

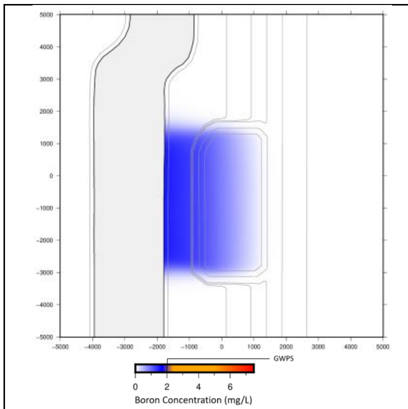
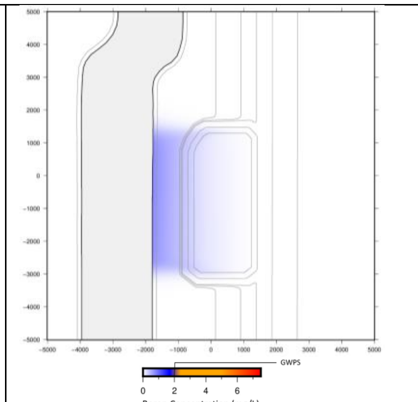
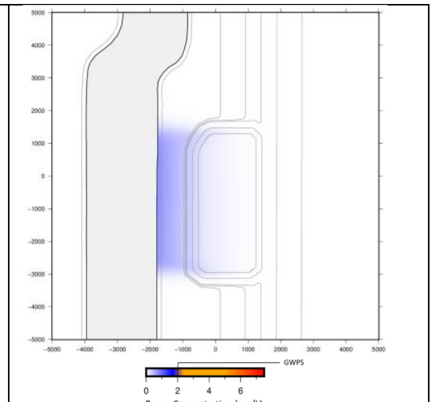
Table 2. Years to closure for each model scenario and remedy tested.

As shown in the model simulations, many of the remedies (including CIP or CBR as a remedy component) extend well beyond 30 years. These results are consistent with groundwater remedies, in general, whereby cleanup processes are often slow and have been ongoing for decades.

11. Appropriate cap and cover configuration including cap permeability and thickness is dependent on site-specific conditions.

These conditions include existing groundwater quality, underlying hydrogeologic conditions, and the nature of the source material. As demonstrated in the groundwater simulations below, cap permeability and thickness may have little effect on groundwater quality.

Results from the **Site 2** model for boron concentrations 30 years after closure for three capping scenarios are shown below. Boron concentrations less that than the GWPS of 2 mg/l, shown in blue below, are achieved utilizing each capping scenario.

		
Soil Cap (1 x 10^{-5} cm/sec)	Soil (Clay) Cap (1 x 10^{-7} cm/sec)	Geomembrane (< 1 x 10^{-7} cm/sec)

Part 845.750, Closure with a Final Cover System, proposes to specify minimum requirements for cap and cover elements including a minimum three feet thick compacted earth low permeability layer (845.750(c)(1)(A) covered by a three feet thick final protective layer (845.750(c)(2)(B). In addition, 845.750(c)(1)(B) specifies the use of a geomembrane in place of the low-permeability earth layer and specifies that it be also covered by a three-feet final protective layer (845.750(c)(2)(B). In his testimony regarding the above, Bonaparte indicates that the compacted earth low-permeability layer does not need to be 36 inches thick and can instead be constructed to an 18-inch thickness. In addition, Bonaparte testifies that the geomembrane does not need to be overlain by 36 inches of a final protection layer and can instead be suitably constructed using an 18-inch final protection layer.

The primary purpose of a cap and cover system is to limit infiltration through the system to be protective of groundwater. **Based on my experience, the changes that Bonaparte suggests as acceptable and described above will not have an effect on the amount of**

percolation/infiltration when compared to the Part 845 prescribed cap and cover system. This conclusion is confirmed by an analysis of infiltration of cap and cover systems for the configurations as specified in Part 845.750 and the Bonaparte alternatives using the Hydrologic Evaluation of Landfill Performance (HELP) Model developed for the EPA by the U.S. Army Corps of Engineers, an industry standard to evaluate cover system performance. The HELP model considers combinations of factors including vegetation, cover soils, low permeability barrier soils, geomembrane liners, and lateral drainage layers. The model calculates estimates of runoff, evapotranspiration, drainage, and liner percolation utilizing local climate data. To evaluate the proposed regulatory final cover system, HELP model evaluations were completed to compare the estimated infiltration through both 18-inch and 36-inch compacted soil layers. The results showing percolation through the compacted soil layer for these scenarios are provided below:

Model Run	Layer Description	Average Annual Percolation (In./Yr.)	% Percolation Prevented
Scenario CSL-1	36-in. Protective Soil Layer 36-In. Compacted Soil Layer	2.35	92.8%
Scenario CSL-2	36-in. Protective Soil Layer 18-In. Compacted Soil Layer	3.44	89.4%

Notes:
1. The protective soil cover layer assumed a loam soil with hydraulic conductivity of 3.7x10-4 cm/s, 1% slopes, and good vegetation growth.
2. The barrier soil layer was assumed to consist of a clay soil with a hydraulic conductivity of 1.0x10-7 cm/s.
3. The geonet lateral drainage layer was assumed to consist of a 200-mil geonet.
4. Climate data is based on Chicago, Illinois and an estimated annual precipitation of 32.6 inches. Analyses were completed for East St. Louis, Illinois for comparison of another location in the state of Illinois, and results were comparable.

As shown above, reducing the thickness of the low-permeability compacted earth layer from 36 inches to 18 inches will have little to no effect on percolation/infiltration and it will have little to no effect on groundwater quality and the time to meet the GWPS.

To evaluate the difference between a 36-inch protection layer and an 18-inch protective layer over a geomembrane, we conducted additional HELP model runs on this cap and cover configuration. The results of the modeling with respect to percolation/infiltration are as follows:

Model Run	Layer Description	Percolation (In./Yr.)	% Percolation Prevented
Scenario GM-1	36-in. Protective Soil Layer	4.84	85.2%
	HDPE Geomembrane		
Scenario GM-2	18-in. Protective Soil Layer	2.56	92.1%
	HDPE Geomembrane		

Notes:
1. The protective soil cover layer assumed a loam soil with hydraulic conductivity of 3.7x10-4 cm/s, 1% slopes, and good vegetation growth. A review of other soil types still shows that 18-inch layer has a lower percolation.
2. The barrier layer is an HPDE geomembrane with an assumed 3 installation defects and 3 pinholes per acre.
3. Models assumed a material below the geomembrane exhibiting a permeability matching or greater than that of the cover soil to develop a conservative result. If the permeability of the material below the geomembrane was lower than the cover soil, the expected percolation would be less than the results provided in this table.
4. Climate data is based on Chicago, Illinois and an estimated annual precipitation of 32.6 inches. Analyses were completed for East St. Louis, Illinois for comparison of another location in the state of Illinois, and results were comparable.

The HELP model analysis for an 18-inch thick protective cover layer instead of a 36-inch cover layer actually reduces percolation/infiltration through a geomembrane liner. Regardless of the soil type used to construct the protective cover layer, the HELP model simulates better results for 18-inch protective soil layer than a 36-inch protective soil layer due to an increase of surface runoff instead of storage in the thicker soil, a lower driving head in the thinner soil column, and by maintaining water within the soil column in the zone where improved evapotranspiration will exist. **With respect to percolation/infiltration and impact to groundwater, the HELP actually predicts better performance using the 18-inch protective layer cover.**

12. <u>The proposed Part 845 does not provide sufficient time to complete a CCPA.</u>

The proposed Part 845 does not provide sufficient time to complete a Closure Construction Permit Application (CCPA) particularly for those impoundments identified under prioritization Categories 1 through 4 for which Part 845 proposes a CCPA must be submitted no later than 1 January 2022. Specifically, key tasks including the Closure Alternatives Analysis (CAA), selecting a closure method, and preparing closure construction permit design plans will drive the schedule well past the 1 January 2022 date. These cited tasks are interdependent and for the most part cannot be completed in parallel. A Gantt Chart (Appendix C) has been developed to visually demonstrate the CCPA timeline using "typical or representative timeframes" at a typical CCR impoundment closure site. Although we reference a typical site in our assessment of the

CCPA production timeline, it is important to note that the actual project CCPA timelines will be in large part dictated by site-specific conditions including complex/challenging subsurface conditions; supplemental permitting; existing operational/facility infrastructure; management of non-CCR waters; and large acreage impoundments or complex impoundment configurations.

a. The required CCPA activities in Part 845 are extensive and cannot be completed by 1 January 2022.

There are a considerable list of work elements and or deliverables identified in Part 845 that must be completed as part of the CCPA; tasks that effectively lead up to the selection of a closure method, and those that follow the selection of a closure method. For this discussion and organizational purposes, the required list of CCPA elements can be divided into two respective groupings identified as Closure Method Preselection (PRE-CM) and Closure Method Post Selection (POST-CM).

Closure Method Pre-Selection (PRE-CM) tasks:

i. Establish the closure prioritization category for each impoundment per 845.220(d)(1).

ii. Perform a closure alternatives analysis (CAA) per 845.710(b) including the following major elements:
   - The CAA must examine for each alternative:
     - The long- and short-term effectiveness and protectiveness per Section 845.710(b)(1);
     - The effectiveness of the closure method in controlling future releases per Section 845.710(b)(2);
     - The ease or difficulty of implementing a potential closure method per Section 845.710(b)(3); and
     - The degree to which the concerns of the residents living within communities where the CCR will be handled, transported, and disposed are addressed by the closure method per Section 845.710(b)(4).
   - The CAA must analyze complete removal of the CCR (CBR) as one closure alternative in the closure alternatives analysis and include any other closure method in the alternatives analysis per Section 845.710(c);
   - For CBR, identify whether capacity exists in an existing on-site landfill, and, if not, whether constructing an onsite landfill is possible per Section 845.710(c);
   - Prepare a class 4 closure alternative cost estimate per Section 845.710(d)(1); and

- Prepare a groundwater contaminant transport model and calculations showing how each closure alternative will achieve compliance with the applicable groundwater protection standards per Sections 845.710(d)(2) thru 845.710(d)(4).
  - This task is a key driver of the CCPA submittal timeline in that it must be completed before the CAA can be finalized and will be completed in conjunction with the evaluation of groundwater corrective measures as part of the same CCPA submittal (per 845.660(e)) which is a lengthy process.

iii. Owner must hold pre-application public meetings per Section 845.240 and 845.710(e) and in preparation:
- Post documentation relied upon in making tentative construction permit application on public website 14 days prior to the public meetings; and
- Prepare an outline of the decision-making process for the CCPA, including the corrective action alternatives and the closure alternatives considered to be presented at public meeting.

iv. Following the public meetings, the Owner must select a closure method per Section 845.710(f) necessitating compilation, review and evaluation of information discussed/received at the public meetings and, revision (as necessary) and finalization of the CAA prior to selection.

Closure Method Post-Selection (POST-CM) tasks:

i. Prepare a Final Closure Plan per Section 845.720(b).

ii. Prepare closure construction permit design plans and supporting documents:
- Prepare permit-level design drawings and specifications fully describing the design, nature, function, and interrelationship of each individual component of the facility per Section 845.220(a)(6);
- Prepare a narrative report describing the closure project including figures, maps and appendices containing related design documents to support requirements of Section 845.220(a)(2) thru 845.220(a)(5);
- Prepare a Stormwater Pollution Prevention Plan and associated stormwater management design & erosion control calculations per Sections 845.740(c)(4)(E) and 845.750(d)(4)(B);
- Proposed Closure Schedule per Section 845.220(a)(6);
- Post-Closure Care Plan per Section 845.780(d); and
- Closure and Post-Closure Cost Estimate per section 845.930(a)(1).

As illustrated in the attached figure, key tasks including the CAA, selecting a closure method, and preparing closure construction permit design plans will drive the schedule well past the 1 January 2022 date.

b. Many of the required CCPA activities/deliverables in Part 845 must be completed in series and cannot be completed in parallel.

Many of the CCPA submittal elements are dependent on the outcome, results or conclusions drawn from other work items and, as a result, cannot be completed in parallel. Completion of dependent activities must therefore, either be delayed, expedited by completing tasks more quickly or expedited by completing tasks at risk in parallel if the CCPA submittal schedule is to be shortened. Examples of dependent activities include,

i. The CAA can be initiated but cannot be completed until the on-site landfill evaluation and groundwater contaminant transport modeling is completed. These tasks are key drivers of the CCPA submittal timeline and will be completed in conjunction with the evaluation of groundwater corrective measures as part of the same CCPA submittal (per 845.660(e)) which is a lengthy process.

ii. The public meetings and associated posting of documentation relied upon in making the tentative construction permit application 14 days prior cannot be completed until the CAA is completed.

iii. A closure method cannot be selected until after the public meeting and related evaluation of information received at the public meeting is completed.

iv. The closure plan cannot be finalized until the closure method is selected.

v. The closure construction permit design plans and supporting documents cannot be prepared until the closure method is selected.

The schedule provided on the attached Gantt chart accounts for the schedule dependencies described above and indicate the following:

- Timeframes for completing all CCPA submittal elements may reasonably be expected to take twice the time (20 months) than currently allocated in the proposed Part 845 schedule (9 months for this effort) if impoundments are classified as prioritization category 1 to 4;
- Timeframe just to complete the Pre-CM tasks is likely to require the full 9 months (or more) allotted in Part 845 for the entire CPAA

submittal associated with prioritization category 1 to 4 impoundments; and

- The typical timeframe to complete the Post-CM tasks and submit all CCPA documentation would likely require an additional 11 months or more.

c. The CCPA timeline provided herein includes necessary assumptions that shorten the schedule for CCPA preparation and submittal process

The Gantt chart CCPA submittal timeline includes conservative assumptions that shorten the CCPA submittal process. If the following assumptions were not made, the timeline to complete the CCPA process would be even greater:

i. Establishment of closure prioritization category (per 845.220(d)(1)) will be completed in parallel with GW contaminant transport modeling. This task is a key driver of the CCPA submittal timeline since, in the case when more than one impoundment must be closed at a particular facility, it must be completed to establish Agency submittal priority.

ii. Operating Permit Application (OPA) work elements specific to the groundwater monitoring program have been completed or can be completed in parallel with that of the CCPA and will be approved as submitted. The OPA is required to be submitted by 30 September 2021 per 845.230(d)(1):
   - Hydrogeologic site characterization meeting requirements of Section 845.620;
   - Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630;
   - A groundwater sampling and analysis program as required by Section 845.640; and
   - Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well as required by Section 845.650(b).

iii. In addition, although not specifically cited in the 845 regulation as part of the CCPA package, supplemental geotechnical investigations, testing and analysis will not be required for both the CIP and CBR closure methods. CBR designs.

13. <u>The proposed Part 845 does not account for site-specific conditions in the development of the CCPA.</u>

The required durations to complete the CCPA tasks are dictated by site-specific conditions which can add additional burden to the project schedule and would ensure that the CCPA could not be completed by 1 January 2022. Although we reference a typical site in our

Gantt Chart defining the CCPA production timeline, it is important to note that the actual project CCPA timelines will be in large part dictated by site-specific conditions. Many factors and site-specific conditions can influence and prolong the time required to prepare the CCPA submittal. The following is a list of some potential factors to be considered:

- Complex/challenging subsurface conditions;
- Supplemental permitting;
- Existing operational/facility infrastructure;
- Management of non-CCR waters;
- Large acreage impoundments or complex impoundment configurations; and
- Number, spatial proximity and magnitude of groundwater protection standard exceedances.

These site-specific conditions and their associated challenges will add to the amount of engineering assessment and design required to complete required work elements.

Closing

If you have any questions or concerns, please contact me at 216.706.1313 or by email at dhagen@haleyaldrich.com.

Sincerely yours,
HALEY & ALDRICH, INC.

David J. Hagen
Principal Consultant

Attachments:

Appendix A
Appendix B
Appendix C

Electronic Filing: Received, Clerk's Office 08/27/2020

Appendix A

HALEY ALDRICH

DAVID J. HAGEN

Principal Consultant

EDUCATION

M.S., Geology, Oklahoma State University, 1986
B.S., Biology, Baldwin-Wallace College, 1981

PROFESSIONAL REGISTRATIONS

DNAPLs in Fractured Geologic Media: Behavior, Monitoring and Remediation, University Consortium Solvents in Groundwater Research Program, November 1997
Groundwater Issues and the Ohio Voluntary Action Program, Ohio Environmental Protection Agency, June 1998
The Voluntary Action Program Process, Ohio Environmental Protection Agency, April 1997
Brownfield Redevelopment, International Business Communications, July 1996
Theoretical and Practical Considerations of Flow in Fractured Rocks, Seminar Series with Shlomo P. Neuman

Since joining Haley & Aldrich in 1986, Mr. Hagen has participated in a variety of projects involving environmental regulations, including the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); Resource Conservation and Recovery Act (RCRA); state solid waste laws; petroleum and hazardous substance underground storage tank (UST) regulations; Toxic Substances Control Act (TSCA); the Clean Water Act (CWA); and the Clean Air Act (CAA). His experience includes directly applying the technical aspects of these laws with Federal and State regulatory agencies as well as in private transactions involving environmental matters. He has solved problems in a wide range of environmental conditions at sites contaminated with petroleum hydrocarbons, chlorinated solvents, phthalates, coal tar, metals and polychlorinated biphenyls (PCBs).

Mr. Hagen has designed, installed, and monitored groundwater at numerous CCR, industrial waste, and municipal solid waste landfills and RCRA land-based units utilizing the same framework provided in the CCR rules Sections 257.90 through 257.98. As part of his experience, he has provided expert support for a case involving groundwater impacts and corrective action for a power plant located in the Northwestern United States and for a second plant with a release from a CCR management unit in the Southwestern United States. He has testified as an expert on detection monitoring, site and groundwater assessment, and financial assurance for metals associated with a CCR, industrial waste, and municipal solid waste landfill. He is a skilled facilitator and highly sought out for his exceptional planning and strategic thinking skills and CM/CA RCRA and CERCLA type projects. He is currently working on over a dozen CCR management units subject to the CCR Rule.

Mr. Hagen has specific education, training, and technical expertise as a hydrogeologist and worked in a variety of hydrogeologic settings, including buried valley aquifers, fractured bedrock aquifers including KARST, and low-permeability geologic settings. He has been the technical leader of many of these projects, directing teams of experts in groundwater and solute transport modeling, groundwater remediation, and risk assessment.

His specific project experience and responsibilities include overall management of investigation programs, feasibility studies, design, construction, and operations, maintenance, and monitoring to comply with environmental regulations (CWA, CAA, RCRA, CERCLA, TSCA, solid waste and USTs), including brownfield investigations and redevelopment. He has conducted RCRA Corrective Actions at over 15 facilities throughout the U.S. and been involved in several sites on the CERCLA National Priority List (NPL). Mr. Hagen is often called upon to aid clients with negotiations of consent orders and represent clients in negotiations of alleged violations or other matters of alleged non-compliance.

RELEVANT PROJECT EXPERIENCE

CERCLA

Tremont City Landfill Barrel Fill Operable Unit consisted of approximately 50,000 buried drums of industrial waste located over a thick glacial till and outwash sequence near the Mad River Aquifer in Springfield, Ohio. Services included negotiating an Administrative Order on Consent and the associated scope of work for the project, and completing the RI and FS.

On the state CERCLA level, Mr. Hagen led a diverse project team to undertake a FS through issuance of a Record of Decision for a contaminated land and river site on the Hudson River in New York. The site was contaminated with high levels of PCBs that required both on-land excavation and river dredging with associated restoration to allow future development.

Mr. Hagen also led a team of environmental professionals on an emergency removal action associated with indoor air contamination at a residential neighborhood in Dayton, Ohio. Services included negotiating an order, implementing indoor air sampling and analysis, installing indoor air mitigation systems, and installing source area remediation systems. The project is nearing completion with associated discharge of the order and shut-down of remediation systems.

In addition to the above, Mr. Hagen has represented clients in commenting on proposed NPL listings and an associated legal challenge of one of the listings. Services included scoring using the HRS with back-up documentation supporting the revised score.

RCRA

Mr. Hagen has led project teams in conducting RCRA Corrective Action, RCRA Hazardous Waste Management Unit Closures (both greater-than and less-than 90 day units), compliance audits, enforcement action representation, and permitting.

Representative examples of Mr. Hagen's project experience in RCRA Corrective Action includes:

At the GM Linden, New Jersey facility, the EPA Region 2 and the New Jersey Department of Environmental Protection (NJDEP) combined RCRA Corrective Action and Industrial Site Recovery Act with significant soil and groundwater contamination by chlorinated solvents, metals, PCBs, and petroleum constituents. Services included preparing a Current Conditions Report, RCRA Facility Investigation (RFI), conducting interim remedial measures (IM) soil excavation and disposal, risk assessment, and property transaction services representing the seller.

At the former GM Harrison Facility in Dayton, Ohio, this EPA Region 5 RCRA Corrective Action consisted of a CCR, RFI, IM, and risk assessment for contaminated soil and groundwater with petroleum product (light non-aqueous phase liquid), PCBs, and chlorinated solvents in a glacial outwash aquifer near a municipal well field.

At the GM Assembly Facility in Lordstown, Ohio, the EPA Region 5 RCRA Corrective Action consisted of a CCR, RFI, IM, Corrective Measures Study (CMS), and remedy implementation consisting of long-term monitoring and land use restrictions.

At the Delphi Vandalia, Ohio Facility the EPA Region 5 RCRA Corrective Action consisted of a CCR, RFI, IM, CMS, and remedy implementation (Corrective Measures Implementation) consisting of groundwater migration control in a bedrock aquifer.

Representative examples of Mr. Hagen's RCRA Closure experience include:

The GM Defiance, Ohio Hazardous Waste Landfill project involved an in-place closure of a former foundry waste disposal area by construction of a RCRA landfill cap and leachate collection system. Services included closure negotiation, preapring a RCRA Closure Plan, Closure Certification Report, and subsequent long-term groundwater monitoring and maintenance.

A project for a confidential client in Mogadore, Ohio included closure of three hazardous waste storage areas for a former refractory brick recycling facility. Services to date have included closure negotiation, preparing a RCRA Closure Plan, and closure implementation.

A project involving hazardous waste underground storage tanks in Dayton, Ohio, included simultaneous closure of several hazardous waste USTs with closure of a petroleum UST under the Ohio Bureau of Underground Storage Tank Regulations (BUSTR), as well as closure negotiation, preparing a RCRA Closure Plan and BUSTR documentation, and closure implementation and certification.

At a former hazardous waste storage area in Parma, Ohio, the project involved closure of a former soil storage area under RCRA in compliance with a Consent Order. Services included negotiating the order, preparing the Closure Plan, implementing closure per the approved plan, and a certification report.

Representative examples of RCRA compliance activities include:

Represented a client in Pennsylvania in their interactions with U.S. environmental enforcement personnel in connection with potential violations of RCRA regarding recycling. Our work, along with legal counsel, resulted in discontinuation of the investigation by the authorities.

Currently serving as RCRA technical expert and agency liaison for a confidential client for a potential enforcement action related to numerous notices of violation resulting from an inspection by the Ohio EPA.

Solid Waste

Mr. Hagen has been involved in numerous solid waste matter primarily related to landfill siting, closure, and post-closure care. He has worked on solid waste matter in numerous states, with most of his experience in Ohio and New York. Notably, Mr. Hagen was involved in the siting of the Monroe County, New York landfill as a hydrogeoglogic expert, the closure of an industrial landfill in Rochester, New York, and the closure of a municipal solid waste landfill in Cleveland, Ohio.

He is familiar with landfill construction requirements; post-closure care, including groundwater monitoring; and establishing post-closure care financial assurance, all in compliance with applicable state regulations. In addition to the above, Mr. Hagen has served as an expert witness related to landfill siting requirements associated with setbacks from surface water bodies and groundwater aquifers, as well as establishing financial assurance for a landfill in Ohio. As noted above, Mr. Hagen was also the lead for closure and post-closure care of a hazardous waste (RCRA) landfill in Ohio.

TSCA

Mr. Hagen has been involved in several environmental matters related to TSCA, particularly the technical application to PCBs. He has undertaken numerous projects that required a determination of the applicability of TSCA to historic PCB spills. In addition, he has undertaken several PCB remediation projects using the self-implementing portion of the Megarule. Mr. Hagen has also applied TSCA to PCBs related to building demolition and equipment salvage projects where a determination of the applicability of the PCB product exemption was critical. Mr. Hagen commonly works with clients to determine waste disposal options for PCB contaminated materials to allow for compliant and cost-effective disposal alternatives. His services on TSCA projects include compliance consultation, developing sampling and analysis plans, cleanup implementation, and reporting.

Underground Storage Tanks

Mr. Hagen has undertaken UST closure, assessment, and remediation, primarily under state regulatory programs. His primary work on USTs has involved petroleum and hazardous substance USTs at large manufacturing facilities that stored a variety of products such as oils, gasoline, and various solvents. His work has resulted in several No Further Action determinations by regulators. Specific projects include the closure of two underground USTs at a former manufacturing facility in Northeast Ohio, closure of two Stoddard solvent USTs at a former manufacturing facility in Dayton, Ohio, closure and remediation of numerous USTs at a manufacturing facility in Vandalia, Ohio, removal and closure of numerous petroleum USTs at a manufacturing facility in Lordstown, Ohio, and closure of a UST utilizing a monitored natural attenuation approach in Sandusky, Ohio. All of the above projects resulted in issuance of No Further Action letters by regulators. Many of the above examples involved UST closures in the context of both RCRA Corrective Action and UST regulations.

Securities and Exchange Commission Compliance

Mr. Hagen has successfully assisted numerous clients in their compliance with SEC requirements by estimating contingent environmental liabilities. These projects involve developing standard estimating approaches consistent with accounting requirements for our client's portfolio of sites. Estimates have been developed using a variety of approaches, including most probable, expected value, and range of values using probabilistic statistics.

Examples of his work on SEC compliance related projects include the following:

For a confidential client, Mr. Hagen developed a standard approach, including formulation of unit costs, for major investigation and remedy components at 36 compressor stations contaminated by PCBs. Cost estimating was undertaken using event tree analysis resulting in reserve bookings on the portfolio expected value. In addition, the client reported the range of potential costs using the results of probabilistic analysis. The estimates were subsequently verified based on an audit by a major accounting firm.

For a confidential client, Mr. Hagen developed a standard approach, including formulation of unit costs, for major investigation and remedy components at 70 former manufactured gas plant sites. Led an estimating team consisting of six client environmental professionals and six environmental consulting firms to complete the work in five weeks. Cost estimating was undertaken using event tree analysis resulting in reserve bookings on the portfolio expected value. In addition, the client reported the range of potential costs using the results of probabilistic analysis. The estimates were subsequently verified based on an audit by a major accounting firm.

For a confidential client, Mr. Hagen estimated contingent environmental liabilities for approximately 35 current and former manufacturing sites located across the U.S. Individual sites ranged upward to over two million square feet of building footprint and over 100 acres. Many operations dated to the early 1900's and all sites included heavy machining operations involving significant oil and solvent use. In instances where site data were incomplete, led data gathering efforts to reduce the uncertainty in the estimates. The results of our work included booking the most probable contingent liability. The estimates were also used to aid with bankruptcy proceedings associated with the client.

Transaction Related Services

Mr. Hagen has assisted a wide variety of clients during property and business transactions. These projects most often include conducting Phase I, Phase II, and subsequent environmental investigations, as well as compliance reviews and building assessments related to demolition, decommissioning, or mothballing. Over the course of his career, the number of projects of this nature led by Mr. Hagen is well over 1000. In addition to the traditional transaction services described above, he has represented debtors involved in bankruptcy and in establishing environmental trusts. Specifically, Mr. Hagen has represented Motors Liquidation (former General Motors), Delphi, and Chrysler as these entities established environmental trusts as part of their emergence. In all of the transaction services noted above, Mr. Hagen has applied his experience and knowledge in the valuation of environmental liabilities to represent his client's interests in the transaction.

Expert Witness on Environmental Matters

Mr. Hagen has served as a testifying expert on several cases involving environmental matters. A sampling of his work is as follows:

State of Ohio v. Mercomp, et al.: Testimony included hydrogeology, monitoring well installation and the effects of turbidity on water quality analysis and financial assurance for a solid waste landfill located in Northeast Ohio.

Moraine Properties, LLC v. Ethyl Corporation: Testimony on PCB contamination related to the former operations of a paper mill in southwest Ohio. Specifically opined on the applicability of TSCA at a former disposal area, in former wastewater lagoons, and remediation approaches and costs related to the same.

A.M. Todd v. AEG Photoconductor and Hologic: Prepared an expert report related to Phase I, Phase II, and subsequent remediation of sub-slab vapors and the applicability of the Ohio Voluntary Action Program cost recovery.

Remedial Design and Construction

Project officer for numerous remedial design and remedial construction projects. Design activities include preparing conceptual, preliminary, pre-final, and final design packages; preparing design specifications, remedial design cost estimates, construction schedules, and contractor bid packages; and evaluating bids and contractor selection. Design projects have included remediation of a 60-acre former oil refinery by capping with geomembrane and installing a groundwater collection trench, design of a vacuum-enhanced extraction system for DNAPL recovery, and design a vacuum extraction and groundwater migration control system at an active manufacturing facility. The latter project included design of a vacuum extraction system over a 2-acre area that consisted of installing 90 extraction wells, 180 air injection wells, capping of the site with a Bentomat cover, and installing a vacuum system capable of producing approximately 2000 scfm air flow. Extracted air was treated with an activated carbon that included conditioning of the air stream to control temperature and humidity. Each of the above projects incorporated construction management services, including field engineering, review of as-built drawings, review and approval of change orders, quality assurance testing/engineering, and inspecting completed construction.

Construction-related Environmental Projects

Project manager for numerous construction-related environmental projects, including remediation of chlorinated solvent contamination beneath existing structures/buildings using innovative technologies such as dual-phase vacuum extraction. Completed the remediation of hydrocarbon-contaminated soils using innovative field testing and excavation methods to site remediation prior to a process change-over at an automotive facility. Conducted a detailed characterization of a State Superfund site that was undergoing building expansion. The site characterization delineated the nature and extent of contamination, provided estimates of soil volumes for disposal, and determined proper disposal methods.

Landfill-related Projects

Project manager and project hydrogeologist for hydrogeologic studies performed to support State landfill permitting. Project duties included developing site hydrogeologic investigation work plans, installing monitoring wells, developing groundwater monitoring networks, evaluating hydrogeologic and groundwater quality conditions, designing detection and assessment monitoring systems, statistical analysis of groundwater quality data for detection and assessment monitoring, financial assurance cost estimating, and assistance with permit applications.

Water Supply Projects

Project hydrogeologist and manager for numerous groundwater supply and development projects ranging from small-scale irrigation supplies to a 3-MGD groundwater supply development in a fractured limestone aquifer. Responsibilities included local and regional hydrogeologic assessments, groundwater flow modeling, well installations (large diameter wells, deep installations, and open-rock holes), well design and bid specification preparation, contracting, aquifer/pump testing, aquifer test analysis, capture zone delineation, and report preparation. Projects have been conducted in varied hydrogeologic settings, including fractured limestones, sandstones and shale's, glacial outwash, and alluvial fan deposits.

Miscellaneous

Project Remedial Investigations/Feasibility Studies (RI/FS). Project manager for RI/FS to delineate soil, groundwater, and light non-aqueous phase liquids (LNAPL)/dense non-aqueous phase liquids (DNAPL) contamination in a variety of hydrogeologic/geologic settings in numerous states. Scope of work on projects generally includes preparing Quality Assurance Project Plans, work plans, sampling, and analysis plans; negotiating with State/Federal regulatory agencies; implementing subsurface testing programs, including installing monitoring wells with innovations such as telescoped casings to isolate contaminant zones and drilling of angled borings to evaluate vertical geologic structures; performing hydraulic testing, including water pressure and slug testing; geophysical investigations; and implementing soil and groundwater quality sampling programs. The projects often involve a multi-disciplinary approach, including risk assessment, environmental assessment, and engineering feasibility studies. Projects have been undertaken in U.S. Environmental Protection Agency (EPA) Regions 2, 5, 4, and 9, as well as under State jurisdiction in New Jersey, New York, Indiana, Michigan, Ohio, Kentucky, and California.

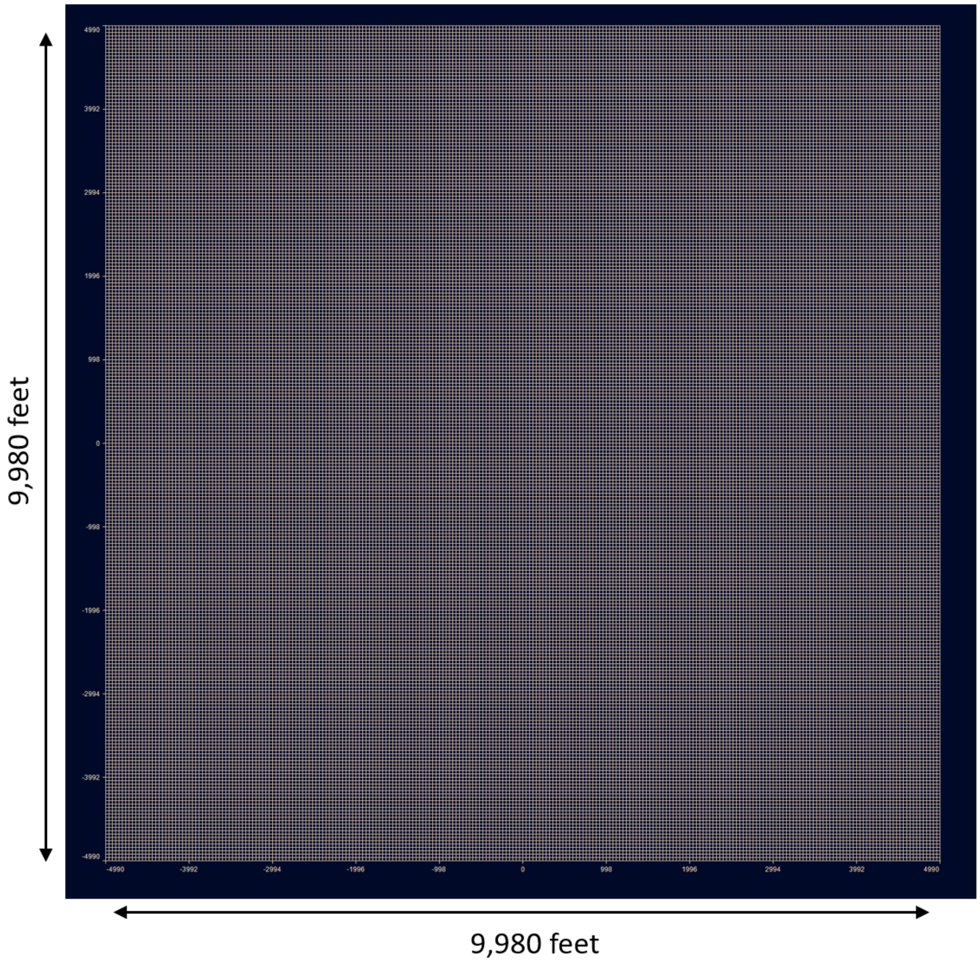
Multi-investigation Environmental Program. Program director for investigation and remediation work undertaken at a 5-sq-mi industrial facility. Scope of work includes strategic planning development; technical guidance in conjunction with a peer review team; program development, including preparing work plans; field investigations and report preparation; negotiations with applicable regulatory agencies; and implementing interim remedial measures. The project work consists of characterization and remediation of DNAPL in a fractured bedrock system.

General Motors Corporation, Manufacturing Facilities. Project manager for Phase I, Phase II, Phase III, and compliance audits performed to support the sale of six manufacturing facilities in Michigan, Ohio, and New York. Scope of work included Phase I, II and III investigations, compliance audits, and support of property transaction negotiations between General Motors and prospective buyers. Responsible for preparing and implementing sampling and analysis plans, Phase I investigations, compliance audits, and Phase II investigations. The Phase II investigations consisted of soil boring and monitoring well installation, sampling and analyses of impacted media, and data quality assurance/quality control at large (greater than 1 million-sq-ft) facilities.

Appendix B

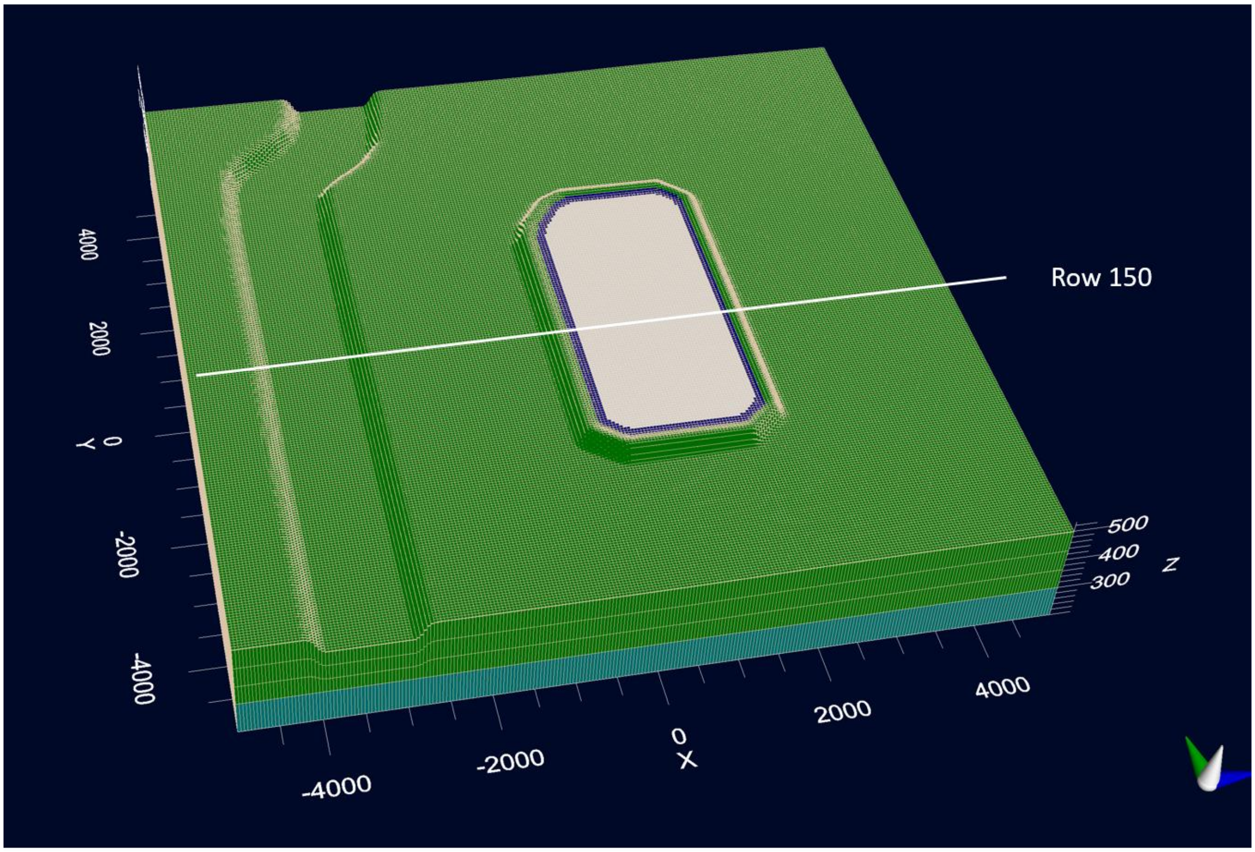
Three groundwater basemodels were constructed to represent fate and transport in groundwater during and after operation of a CCR impoundment, and to compare the effectiveness of subsequent remedies. The flow calculations are performed using MODFLOW-NWT (Niswonger 2011); transport calculations are made using MT3D-USGS (Bedekar et al., 2016).

All models are constructed using an evenly spaced finite difference grid with 250 rows and 250 columns, with individual cells approximately 40 feet x 40 feet.

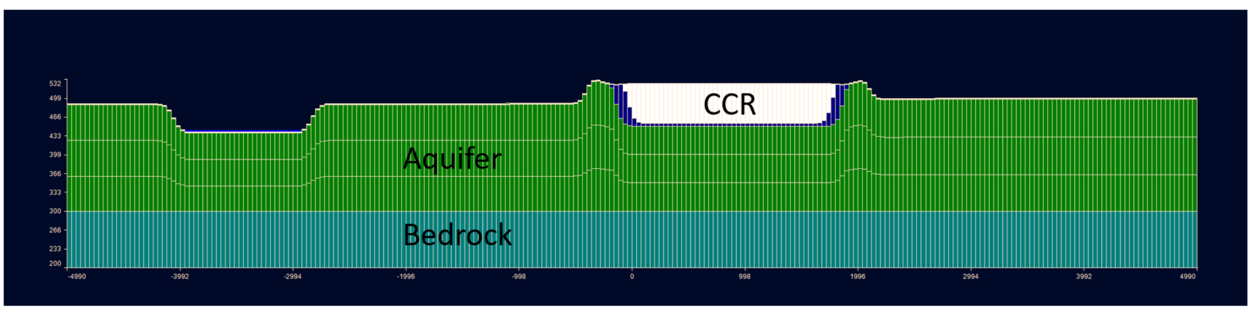


The model grid in map view.

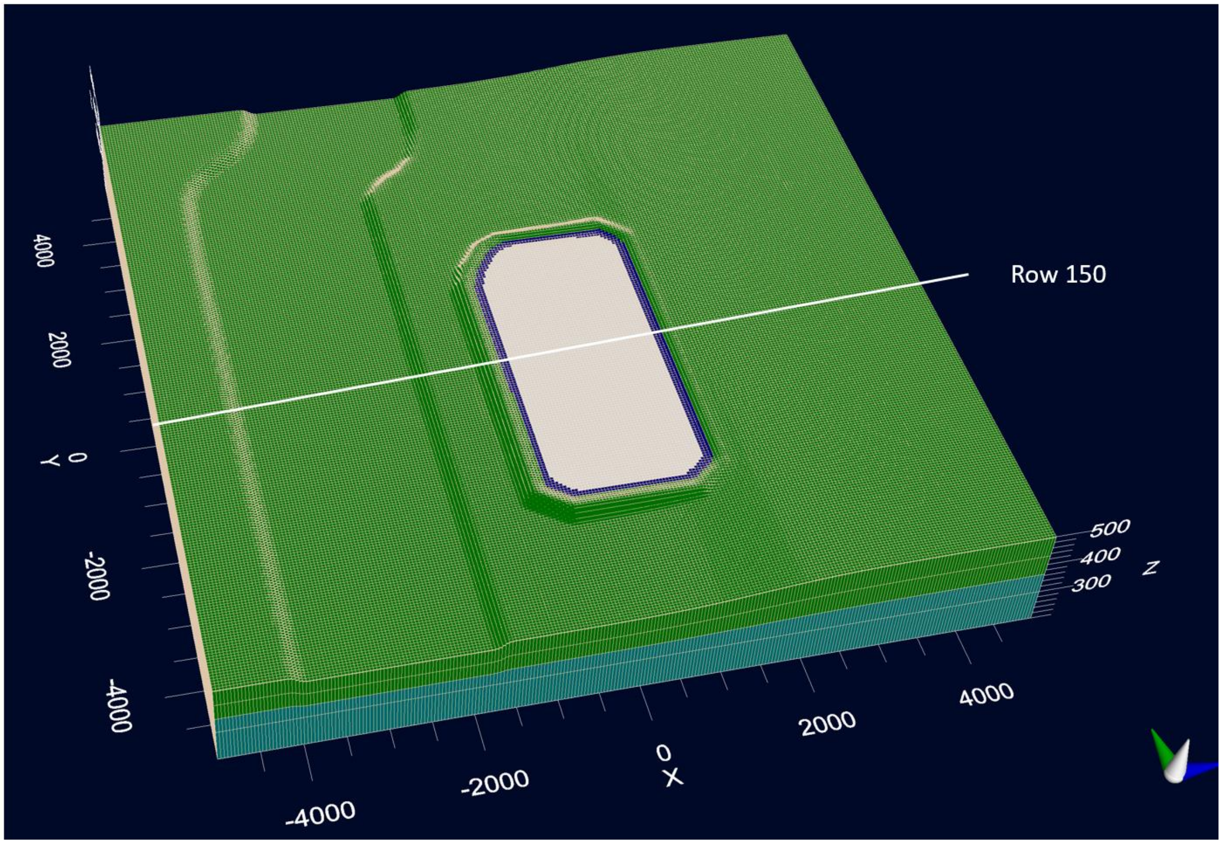
The models are divided vertically into 6 layers. The bottom layer (layer 6) is assigned a constant thickness. Layers 3,4 and 5 are evenly spaced between layer 6 and layer 2. Layers 1 and 2 have a variable thickness. Property zones are used to represent the alluvial aquifer, bedrock, and CCR material (an additional property zone representing a pond liner is shown, but not used in these calculations). Outside of the CCR areas, Layers 1 and 2 have a minimum thickness of 1 foot and are assigned to the alluvial aquifer. All model results shown in the report are concentrations from Layer 4.



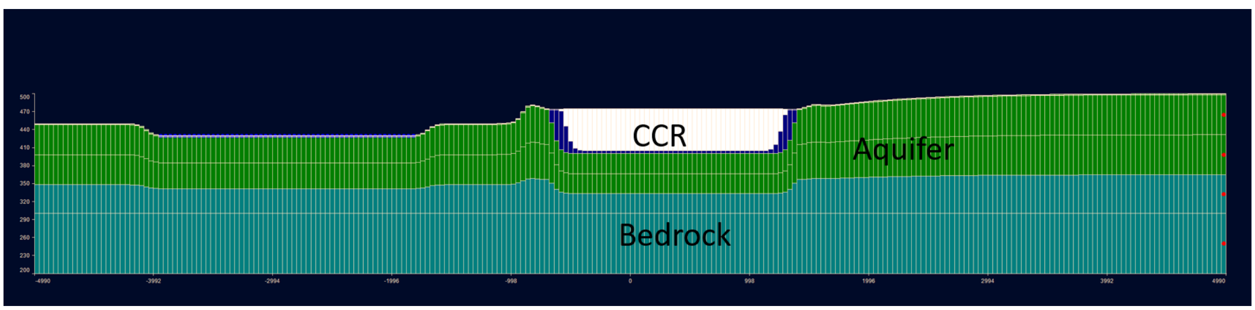
Grid in 3D perspective for the Site 1 Model



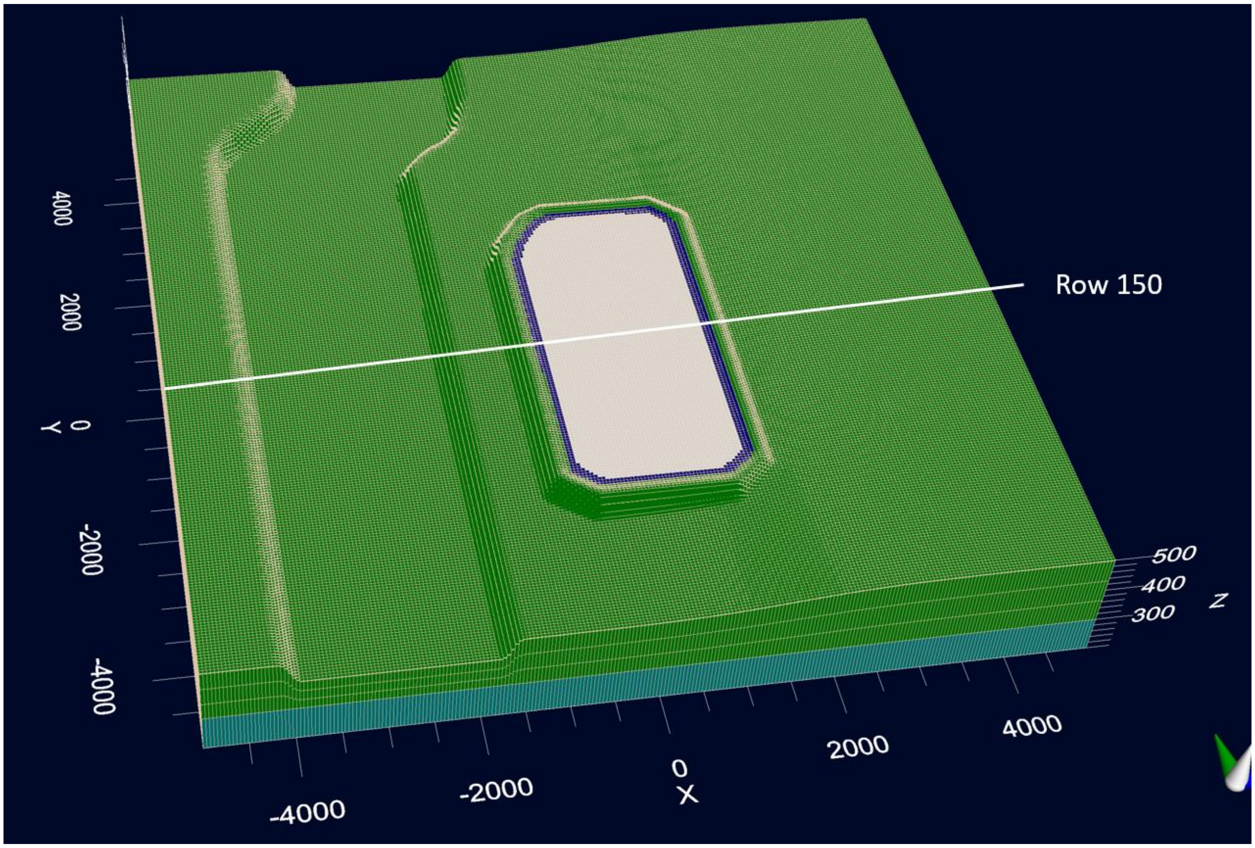
Grid and property zones in cross section view for Row 150 of the Site 1 Model.



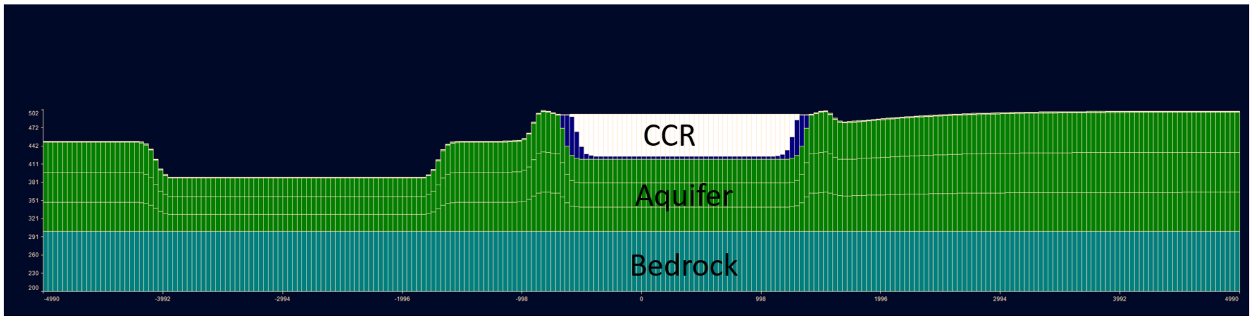
Grid in 3D perspective for the Site 2 Model



Grid and property zone in cross section view for the Site 2 Model (Row 150).



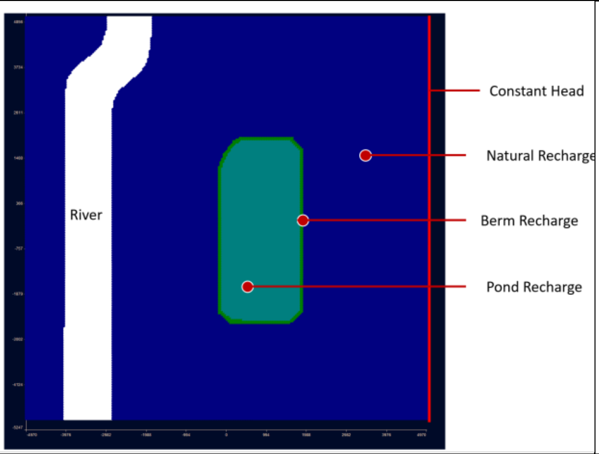
Grid in 3D perspective for the Site 3 Model



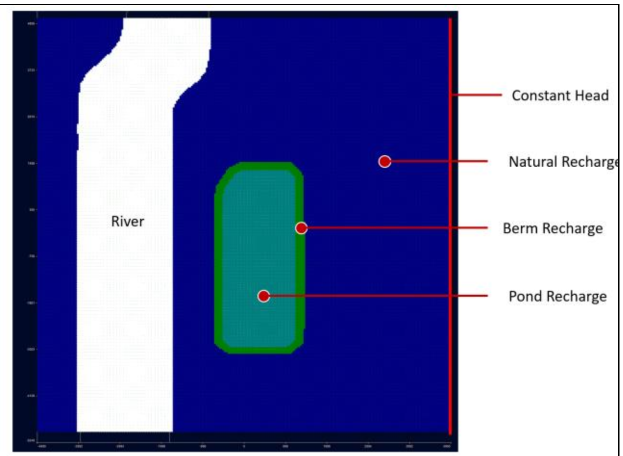
Grid and property zones in cross section view for the Site 3 Model (Row 150).

Reactive transport is used to model contaminant migration in MT3D-USGS. A linear isotherm sorption/desorption model is applied. When the impoundment is active, water is recharged through the CCR property zone with a boron concentration of 10 mg/L (EPRI, 2006). This allows the CCR material to saturate with boron. After the pond is taken out of service, the CCR material is recharged with fresh water and the boron leaches from the CCR material by equilibrium desorption. This conserves the total mass of boron in the system. When simulating removal, the sorbed mass of boron in the CCR is set to zero, effectively modeling recharge through a clean backfill.

River, recharge, and constant head boundary conditions are used in all models. The constant head boundary condition is applied to all cells at the upgradient edge. Recharge is not specified where the river boundary condition is applied.



Boundary Conditions for the Site 1 Model



Boundary Conditions for Site 2 and Site 3 Models

MT3D-USGS requires the cells to be nominally wet for sorption/desorption reactions. In the Site 3 model, the Layer 1 and Layer 2 cells in the Berm and Pond recharge footprints are also assigned a zero horizontal net flux to compensate. This represents the lack of lateral flow through CCR situated above the water table.

Fly ash from combustion of coal is made up primarily of silt-sized spherules of vitrified glass. Bottom ash may be even coarser. Because of the relatively uniform shape and size grading, measured hydraulic conductivity is in the high range of what would be expected from soils with similar grain size. Here a value of 0.1 feet/day (3.8e-5 cm/sec) is used; this is the mean value from a worldwide compilation of 172 published fly ash measurements (Bachus et al., 2019).

Model Specific Parameters:

	Site 1	Site 2	Site 3
Aquifer Kv (ft/day)	10	50	20
Aquifer Kh (ft/day)	1	5	2
Natural Recharge (inches/year)	2	14	14
Pond operating recharge (inches/year)	60	175	100
Pond out of service recharge (inches/year)	30	30	30
River Stage (feet above sea level)	460	440	415
Constant Head (feet above sea level)	480	475	435

Other Parameters:

Aquifer Porosity	0.35
Aquifer Bulk Density	1700 kg/m^3
CCR Porosity	0.40
CCR Hydraulic Conductivity	0.1 ft/day
CCR Bulk Density	1600 kg/m^3
Kd Boron, CCR	1.0 L/Kg
Kd Boron, Aquifer	0.1 L/Kg
Riverbed Conductance	1.0e6 ft^2/day
Berm Recharge =	0.1 ft/year

Recharge rates for capped scenarios are typical values from a confidential compilation of HELP model results from other CCR closure projects in the US Midwest.

Typical Cap Recharge Values
Soil Cap (K = 1e-5 cm/s) …… 0.0032 ft/day
Soil Cap (K = 1e-7 cm/s) …… 0.0002 ft/day
Geomembrane ……………….. 0.0001 ft/day

References

Bachus, R.C., M. Terzariol, C. Pasten, S.H. Chong, S.Dai, M.S. Cha, S. Kim, J. Jang, E. Papadopoulis, S. Roshankhan, L. Lei, A. Garcia, J. Park, A. Sivaram, F. Santamarina, X. Ren and J.C. Santamarina (2019) Characterization and Engineering Properties of Dry and Ponded Class-F Fly Ash. Journal of Geotechnical and Geoenvironmental Engineering, 145 (3)

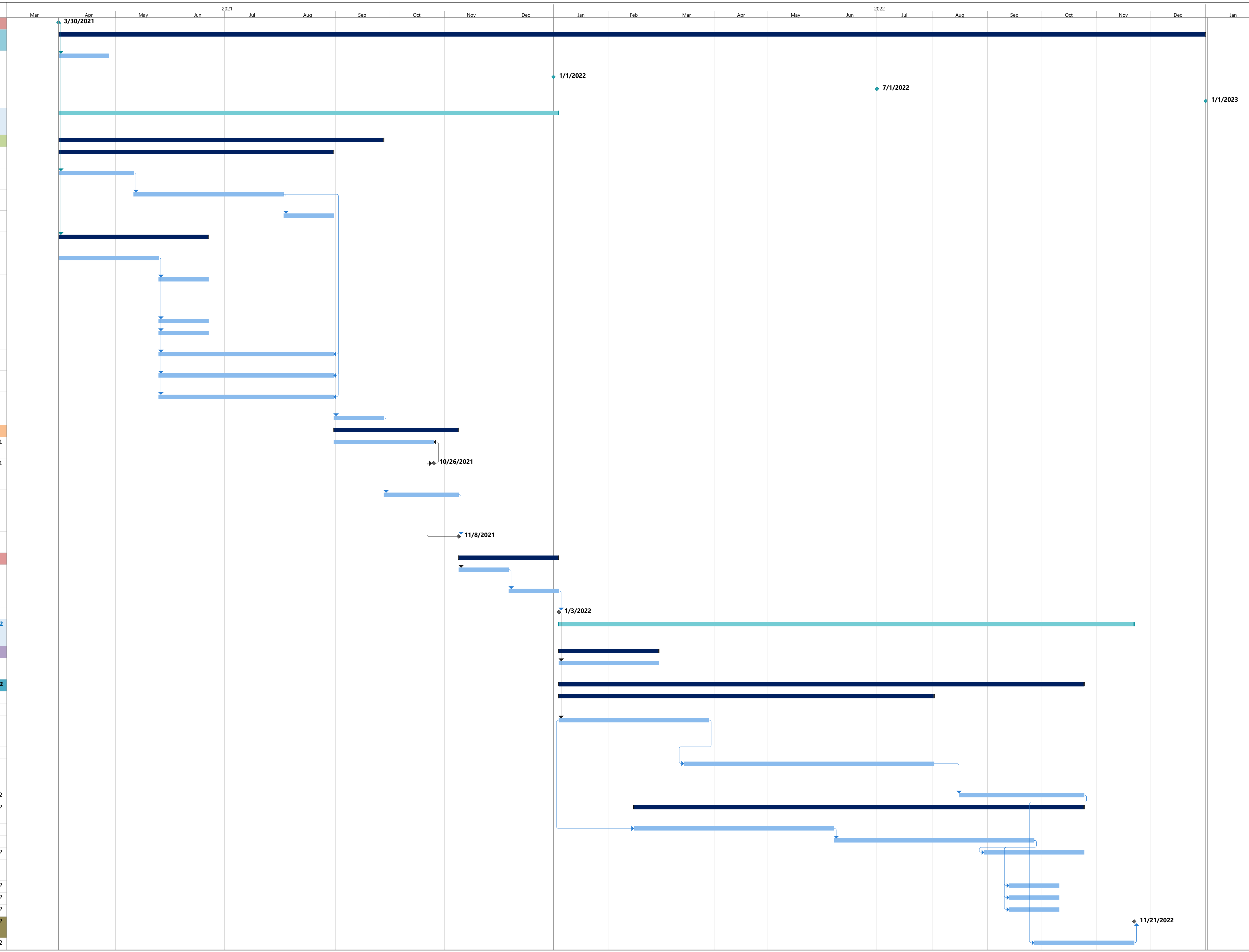
Bedekar, V., E. Morway, C. Langevin, M. Tonkin (2016) MT3D-USGS Version 1: A U.S. Geological Survey Release of MT3DMS Updated with New Expanded Transport Capabilities for Use with MODFLOW. United States Geological Survey Groundwater Resources Program, Techniques and Methods 6-A53

Niswonger, R. (2011) MODFLOW-NWT, A Newton Formulation for MODFLOW-2005. United States Geological Survey Groundwater Resources Program, Techniques and Methods 6-A37

Appendix C

ILLINOIS PART 845 DRAFT STANDARDS FOR THE DISPOSAL OF COAL COMBUSTION RESIDUALS IN SURFACE IMPOUNDMENTS

ID	No.	Description	Part 845 Draft Rule Reference	Estimated Duration	Start	Finish
1	**1**	**Effective Date of Rule (Proposed)**	not specified	0 days	3/30/2021	3/30/2021
2	**2**	**Closure Construction Permit Application (CCPA)**	**845.700(h)**	**459 days**	**3/30/2021**	**1/1/2023**
3		Establish Closure Prioritization Category	845.220(d)(1); 845.700(g)(1)	1 mon	3/30/2021	4/26/2021
4	2.1	Prioritization Category 1-4	845.220(h)(1)	0 days	1/1/2022	1/1/2022
5	2.2	Prioritization Category 5	845.220(h)(2)	0 days	7/1/2022	7/1/2022
6	2.3	Prioritization Category 6 & 7	845.220(h)(3)	0 days	1/1/2023	1/1/2023
7		**CLOSURE METHOD PRE-SELECTION (PRE-CM)**		**200 days**	**3/30/2021**	**1/3/2022**
8	**3**	**Perform a Closure Alternatives Analysis (CAA)**	**845.710(b)**	**130 days**	**3/30/2021**	**9/27/2021**
9	**3.1**	Consideration of Closure by Removal (CBR), Closure in Place (CIP), and/or Hybrid Closure	845.710(c)	110 days	3/30/2021	8/30/2021
10	3.11	For CBR, Identify whether capacity exists in existing on-site landfill, or	845.710(c)	1.5 mons	3/30/2021	5/10/2021
11	3.12	For CBR, Determine whether on-site landfill can be constructed	845.710(c)	3 mons	5/11/2021	8/2/2021
12	3.2	Prepare Class 4 closure alternative cost estimate under AACE	845.710(d)(1)	1 mon	8/3/2021	8/30/2021
13	**3.3**	**Prepare GW Contaminant Transport Modeling and Report**	**845.220(d)(3); 845.710(d)(2)**	**60 days**	**3/30/2021**	**6/21/2021**
14	3.31	Groundwater Contaminant Transport Model	845.220(d)(3); 845.710(d)(2)	2 mons	3/30/2021	5/24/2021
15	3.32	Include description of Fate and Transport Contaminants, modeling results and calculations showing how closurewill achieve compliance	845.220(d)(3(A) & .710(d)(3)	1 mon	5/25/2021	6/21/2021
16	3.33	Assess impacts to waters in the state	845.710(d)(4)	1 mon	5/25/2021	6/21/2021
17	3.34	Capture zone modeling, if applicable	845.220(d)(3(D)	1 mon	5/25/2021	6/21/2021
18	3.4	Examine the long and short term effectiveness and protectiveness of the method	845.710(b)(1)	3.5 mons	5/25/2021	8/30/2021
19	3.5	Examine the effectiveness in controlling future releases	845.710(b)(2)	3.5 mons	5/25/2021	8/30/2021
20	3.6	Examine the ease or difficulty of implementing the closure method	845.710(b)(3)	3.5 mons	5/25/2021	8/30/2021
21	3.7	Compile CAA Deliverable Package	not specified	1 mon	8/31/2021	9/27/2021
22	**4**	**Public Meetings to discuss results of the CAA**	**845.710(f)**	**50 days**	**8/31/2021**	**11/8/2021**
23	4.1	Select Venue & circulate public notice of proposed construction project	845.240(b)	2 mons	8/31/2021	10/26/2021
24	4.2	Post documentation relied upon in making tentative const. permit application on public website 14 days prior to meeting	845.240(e)	0 days	10/26/2021	10/26/2021
25	4.3	At Public Meeting, prepare/present outline of decision making process for const. permit application including corrective action and closure alternatives considered	845.240(f)	1.5 mons	9/28/2021	11/8/2021
26	4.4	Hold two (2) public meetings at least 30 days prior to submitting CCPA	845.240(a) & 710(f)	0 days	11/8/2021	11/8/2021
27	**5**	**Select a Closure Method**	**845.710(f)**	**40 days**	**11/9/2021**	**1/3/2022**
28	5.1	Compile, review and evaluate information received at public meetings	not specified	1 mon	11/9/2021	12/6/2021
29	5.2	Revise CAA as appropriate based upon public meeting input	not specified	1 mon	12/7/2021	1/3/2022
30	5.3	Select a Closure Method	845.240(f)	0 days	1/3/2022	1/3/2022
31		**CLOSURE METHOD POST-SELECTION (POST-CM)**		**230 days**	**1/4/2022**	**11/21/2022**
32	**6**	**Prepare a Final Closure Plan**		**40 days**	**1/4/2022**	**2/28/2022**
33	6.1	Prepare Final Closure Plan (FCP) utilizing Preliminary Written Closure Plan (PCP)	845.720(a)(1) & 845.720(b)	2 mons	1/4/2022	2/28/2022
34	**7**	**Prepare Closure Construction Permit Plans**		**210 days**	**1/4/2022**	**10/24/2022**
35	7.1	Design & Construction Plans	845.220(a)(1)	150 days	1/4/2022	8/1/2022
36	7.11	Overall Site Topographic Survey	.220(a)(1)(F)			
37	7.12	Geotechnical Analysis & Design	.220(a)(1)(D), (E) & (F) & .220(a)(6) & 750(d)(4)(B)	3 mons	1/4/2022	3/28/2022
38	7.13	Operation & Maintenance Specifications	.220(a)(1)(J)			
39	7.14	Stormwater Management/SWPPP Design & Calculations	.220(a)(1)(C), (H) & (I) & .220(a)(6) & .740(c)(4)(E)	5 mons	3/15/2022	8/1/2022
40	7.2	Proposed Report Narrative & Maps	.220(a)(2) thru (5)	2.5 mons	8/16/2022	10/24/2022
41	7.3	Plans & Specifications	845.220(a)(1)(F) & .220(a)(6)	180 days	2/15/2022	10/24/2022
42	7.31	30% Design Plans	not specified	4 mons	2/15/2022	6/6/2022
43	7.32	60% Design Plans	not specified	4 mons	6/7/2022	9/26/2022
44	7.33	Specifications	845.220(a)(6)	2 mons	8/30/2022	10/24/2022
45	7.4	Groundwater Monitoring Program/Geological and Hydrogeological Report	.220(a)(7)			
46	7.5	Proposed Closure Schedule	.220(d)(4)	1 mon	9/13/2022	10/10/2022
47	7.6	Prepare Post-Closure Care Plan	845.220(d)(5) & 84	1 mon	9/13/2022	10/10/2022
48	7.7	Cost Estimate	845.930(a)(1)	1 mon	9/13/2022	10/10/2022
49	**8**	**Submit Closure Construction Permit Application to Agency**	845.730	0 days	11/21/2022	11/21/2022
50	8.1	Compile all CCPA Submittal Documents		2 mons	9/27/2022	11/21/2022



Project: 2020 0624 IL Part 845 S
Date: 6/24/2020

Task · Split · Milestone · Summary · Project Summary · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · External Tasks · External Milestone · Deadline · Critical · Critical Split · Progress · Manual Progress

Testimony 5:

Andrew Bittner

Pre-filed Testimony of Andrew Bittner, P.E. Regarding Proposed Illinois Administrative Code Title 35, Subtitle G, Chapter I, Subchapter j, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments

Prepared by

Andrew B. Bittner, M.Eng., P.E.

Prepared for
Schiff Hardin LLP
233 South Wacker Drive, Suite 7100
Chicago, IL 60606

August 27, 2020

GRADIENT
www.gradientcorp.com
One Beacon Street, 17th Floor
Boston, MA 02108
617-395-5000

Table of Contents

Page

1 Introduction 1
- 1.1 Scope and Objectives 1
- 1.2 Report Structure 1
- 1.3 Qualifications and Compensation 1

2 Background 3
- 2.1 Relevant Coal Ash Regulations 3

3 Part 845.710 adequately ensures the protection of human health and the environment. 5
- 3.1 The Part 845 closure alternatives analysis requirements are consistent with federal regulations and will ensure the protection of human health and the environment. 6
- 3.2 The performance standards in Part 845.710 are capable of evaluating closures at all SIs. 9
- 3.3 Worker safety and cost are two important closure alternatives analysis metrics that should be explicitly identified in Part 845.710. 12
  - 3.3.1 Worker Safety 12
  - 3.3.2 Cost 12

4 Closure by removal is not always more protective than closure in place. 15
- 4.1 US EPA considers that both closure in place and closure by removal can be equally protective if implemented properly. 15
- 4.2 Closure in place may be as protective, and in some instances, more protective, of groundwater than closure by removal at some sites. 16
  - 4.2.1 Modeling Details 17
  - 4.2.2 Modeling Results 20
- 4.3 The short-term adverse impacts of closure by removal must be considered. 22

5 Background groundwater monitoring requirements should be specific to each SI and groundwater monitoring should be limited to CCR-related constituents. 24
- 5.1 Background concentrations should be evaluated specific to each SI. 24
- 5.2 Groundwater monitoring analytes should be representative of CCRs. 25

6 Consolidating CCRs does not create unacceptable risks. 27
- 6.1 CCR consolidation does not alter or affect the ability to achieve closure performance criteria. 27
- 6.2 On-site consolidation can effectively reduce the CCR footprint at a site. 28

6.3 On-site consolidation of CCRs does not increase the time required to achieve GWPSs for a capped SI. 29
6.3.1 On-site consolidation of CCRs does not affect post-closure hydraulic flux to the aquifer. 30
6.3.2 Post-closure leachate concentrations are not affected by the presence of consolidated CCRs. 30
6.3.3 Consolidation of CCRs does not impact the time it takes to achieve GWPSs. 31

7 No timeframe limits should be prescribed for completing groundwater corrective action. 32

References 35

Appendix A *Curriculum Vitae* of Andrew B. Bittner, M.Eng., P.E.

List of Tables

Table 3.1 Comparison of Performance Standards

Table 4.1 Example Site-specific Factors Influencing When Closure in Place Is as Protective or More Protective of Groundwater Quality than Closure by Removal

Table 4.2 Cap Construction and Ash Excavation Times

Table 4.3 Soil-Water Partition Coefficients and Retardation Coefficients

Table 4.4 30-Year TWA Arsenic Concentrations at Downgradient Monitoring Well

Table 5.1 Groundwater Monitoring Analytes

Table 7.1 Factors that May Affect the Duration of Groundwater Corrective Action

List of Figures

Figure 4.1 Intersecting Groundwater Conditions Model Cross-section

Figure 4.2 Non-intersecting Groundwater Conditions Model Cross-section

Figure 4.3 Breakthrough Curves for a 25-acre SI with Non-intersecting Groundwater Conditions

Figure 4.4 Breakthrough Curves for a 200-acre SI with Intersecting Groundwater Conditions

Figure 5.1 Conceptual Model of SI-specific Background Concentration Determinations

Figure 6.1a Closure-in-Place for CCR Surface Impoundment Using Soil Fill

Figure 6.1b Closure-in-Place for CCR Surface Impoundment Using Consolidated CCRs

Abbreviations

As(III)	Arsenic(III)
As(V)	Arsenic(V)
CBR	Closure by Removal
CCR	Coal Combustion Residual
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Closure in Place
cm/s	Centimeters Per Second
FGD	Flue Gas Desulfurization
GWPS	Groundwater Protection Standard
HELP	Hydrologic Evaluation of Landfill Performance
IEPA	Illinois Environmental Protection Agency
NO_x	Nitrogen Oxide
NPDES	National Pollutant Discharge Elimination System
PM	Particulate Matter
RCRA	Resource Conservation and Recovery Act
SI	Surface Impoundment
SO_x	Sulfur Oxide
TI	Technical Impracticability
US EPA	United States Environmental Protection Agency
WIIN	Water Infrastructure Improvements for the Nation

1 Introduction

1.1 Scope and Objectives

I have been retained, as an employee of Gradient, by Schiff Hardin on behalf of Dynegy Midwest Generation, LLC; Kincaid Generation, LLC; Illinois Power Resources Generating Company; Illinois Power Generating Company; and Electric Energy Inc. to provide opinions related to the Illinois Environmental Protection Agency (IEPA) Proposed Part 845 Rulemaking of the Illinois Administrative Code (Title 35, Subtitle G, Chapter I, Subchapter j). The proposed rule ("Part 845") sets standards and requirements pertaining to the design, construction, operation, groundwater monitoring, corrective action, closure, and post-closure care of coal combustion residual (CCR) surface impoundments (SIs). In particular, my opinions are focused on certain proposed requirements in Part 845 relating to "Groundwater Monitoring and Corrective Action" (Subpart F) and "Closure and Post-Closure Care" (Subpart G).

The opinions presented in this pre-filed testimony are based on the information that I have reviewed and cited as of the date the testimony was submitted as well as my education and experience. I reserve the right to modify my opinions based on additional information.

1.2 Report Structure

I have structured this document as follows:

- Section 1 contains introductory material;
- Section 2 provides a brief background on coal ash and a summary of relevant federal and state regulations pertaining to coal ash;
- Section 3 provides a discussion of the proposed performance standards required for the evaluation of potential CCR SI closure alternatives (Part 845.710);
- Section 4 provides a detailed analysis demonstrating that closure by removal (CBR) is not always more protective of groundwater than closure in place (CIP);
- Section 5 presents a discussion of background concentrations and groundwater monitoring events;
- Section 6 presents a discussion of the on-site consolidation of CCRs during CIP; and
- Section 7 presents a discussion of the imposition of time limits by which all groundwater corrective action must be completed.

1.3 Qualifications and Compensation

I am a Principal at Gradient, an environmental consulting firm located in Boston, Massachusetts, and a licensed professional engineer. With approximately 22 years of professional experience, I have consulted and testified regarding a variety of projects related to the fate and transport of constituents in the environment, hydrogeology, groundwater and surface water modeling, site characterization, and remediation system design. I have a master's degree in environmental engineering from the Massachusetts

Institute of Technology and bachelor's degrees in environmental engineering and physics from the University of Michigan. A copy of my *curriculum vitae* is provided in Appendix A.

I have published and presented on a variety of topics, including groundwater and surface water fate and transport modeling of coal ash constituents, assessments of former coal-fired power plants, mass flux and mass discharge of constituents in groundwater, remedial system optimization, and the impact of environmental regulations in the United States and abroad. As a consultant during the past 22 years, I have applied my knowledge of fate and transport processes to address a range of complex challenges in the electric power, oil and gas, chemical manufacturing, pharmaceutical, mining, agrichemical, and waste disposal sectors. In particular, for the electric power industry, my experience includes projects involving regulatory comment, closure assessments, fate and transport modeling, and risk assessment. Moreover, I have worked on and been involved with projects at approximately 60 CCR SIs.

2 Background

Coal ash, in the form of fly ash and bottom ash, is the residual generated when coal is dried, pulverized, and burned in a boiler. Bottom ash is the portion of this residual that collects at the bottom of the boiler. Fly ash is the portion that is light enough to float upwards and is often collected by an air pollution control device. Bottom ash particles are angular and porous while fly ash particles are small and spherical. Some boilers also generate boiler slag, molten bottom ash that turns angular and glassy when cooled. Coal-fired power plants may also generate flue gas desulfurization (FGD) material (synthetic gypsum), a specific CCR produced in an air pollution control system designed to remove sulfur dioxide from flue gases (ARTBA, 2015).

There are two primary types of coal ash management at coal-fired power plants: wet storage of CCRs in SIs and dry storage in landfills. During wet storage, which is the subject of the Part 845 regulations, coal ash is mixed with water at the power plant and sluiced/conveyed to an ash basin. Ash basins are a key component of a plant's wastewater treatment system. In an ash basin, coal ash settles and accumulates at the bottom of the basin under the influence of gravity. The remaining decanted water overlying the settled coal ash will often be permitted (under an approved National Pollutant Discharge Elimination System [NPDES] permit) to discharge to a nearby surface water body *via* an overflow spillway or pipe outfall.

Coal ash contains the same inorganic elements as the original coal from which it was derived. Mineral oxides (*e.g.*, of iron, calcium, silicon, or aluminum) comprise up to 99% of coal ash. Coal ash may also contain trace amounts (<1%) of a wide range of metals, including arsenic, cadmium, chromium, mercury, and selenium. While the concentrations of individual constituents may vary, CCRs are generally comprised of a similar suite of constituents.

2.1 Relevant Coal Ash Regulations

Regulations governing the disposal and cleanup of solid wastes have a long history in the US. The Resource Conservation and Recovery Act (RCRA), which was enacted in 1976, provides a national framework for managing solid and hazardous wastes. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, aka Superfund), which was enacted in 1980, provides a national framework for responding to releases or threatened releases of contaminants. In April 2015, the United States Environmental Protection Agency (US EPA) published its Final Rule covering the disposal of CCRs from electric utilities (US EPA, 2015). Based on this rule, CCRs are regulated as a solid waste under Subtitle D of RCRA. As part of the rule, US EPA developed national minimum criteria for new and existing CCR landfills and SIs. Among other things, the rule established groundwater monitoring, corrective action, and closure requirements at CCR disposal facilities. In addition, in December 2016, the Water Infrastructure Improvements for the Nation (WIIN) Act was passed (US Congress, 2016). The WIIN Act created a process by which states can create a permit program or other system for the regulation of CCR storage units within their state as long as the program is at least as protective as the requirements contained in the Federal CCR Rule.

On August 21, 2018, the District of Columbia (DC) Circuit Court vacated portions of the Federal CCR Rule (US Court of Appeals, District of Columbia Circuit, 2018), prompting US EPA to propose two updates:

- Part A of the holistic approach to closure changes the classification of soil- or clay-lined SIs from "lined" to "unlined" and requires all unlined CCR SIs, and SIs that fail the aquifer location restriction, to stop receiving CCRs and initiate closure or retrofit by April 11, 2021. The Final Rule for Part A was submitted by US EPA for publication in the Federal Register on July 29, 2020 (US EPA, 2020a); and
- Part B of the holistic approach to closure establishes a process by which owners or operators of "unlined" SIs may prepare and submit an alternative liner demonstration and proposes a process by which CCRs may continue to be placed in an SI to support closure and cap construction if performed under an approved closure plan. The proposed rule for Part B was published by US EPA on March 3, 2020 (US EPA, 2020b); the Part B rule has not yet been finalized.

Subsequent to these federal regulations, in March 2020, IEPA published a draft of Part 845, proposed rules to regulate the disposal of CCRs in SIs in Illinois (IEPA, 2020). Part 845 "establishes criteria for the purpose of determining which CCR surface impoundments do not pose a reasonable probability of adverse effects on health or the environment" (IEPA, 2020, Part 845.100). Part 845 includes regulations and standards relating to permitting, location restrictions, design and operating criteria, groundwater monitoring and corrective action, closure and post-closure care, record-keeping, and financial assurance. It is noteworthy that while the Federal Rule pertains to CCRs disposed both in SIs and landfills, Part 845 only regulates CCRs disposed in SIs. Additionally, Part 845 only prescribes standards and requirements relating to groundwater quality associated with an SI, not the entire property on which an SI may be located; groundwater quality at these other portions of a property will continue to be regulated under Part 620 of the Illinois Administrative Code (IEPA, 2013).

Part 845 Subpart F (845.600 through 845.680) addresses groundwater monitoring and corrective action, while Subpart G (845.700 through 845.780) addresses closure and post-closure care. Subpart F establishes a rigorous groundwater monitoring program, requiring double the sampling frequency of the Federal CCR Rule (IEPA, 2020, Part 845.650; US EPA, 2014, p. 21485). If an exceedance of a groundwater protection standard (GWPS) is confirmed in groundwater and attributed to a release from an SI, corrective action is required (IEPA, 2020, Part 845.660-845.680). Subpart G outlines a process for evaluating closure alternatives for an SI that includes an analysis of how each closure alternative meets specified performance standards (IEPA, 2020, Part 845.710). These performance standards are consistent with existing federal and state regulations and allow for site-specific flexibility while ensuring the protection of human health and the environment.

3 Part 845.710 adequately ensures the protection of human health and the environment.

Part 845.710 details the process for evaluating alternatives when closing a CCR SI (IEPA, 2020, Part 845.710). In general, CCR SIs can be closed "either by leaving the CCR in place and installing a final cover system [CIP] or through removal of the CCR and decontamination of the CCR unit [CBR]" (US EPA, 2015, p. 21305; see also IEPA, 2020, Part 845.710(a)). Other closure alternatives may combine elements of CBR and CIP by consolidating ash in order to reduce the footprint and then capping the SI, or may supplement the two general approaches by incorporating other source control measures, such as construction of a barrier wall. Selecting an appropriate site-specific closure plan involves a careful analysis of the available alternatives, consistent with decades of corrective action alternatives assessment methods for cleanups under RCRA.[1] Selection of a closure alternative must be supported by a closure alternatives analysis (IEPA, 2020, Part 845.710(a)-(c)), which evaluates how each closure alternative will meet performance standards, including each alternative's long- and short-term effectiveness and protectiveness, the relative difficulty of implementation, and the degree to which the concerns of nearby residents are addressed. Part 845 is appropriately flexible, yet robust: by specifying protective performance standards, Part 845 allows site owners or operators to tailor their closure approach to the unique conditions of their site (*e.g.*, intersection with the groundwater table[2] or location within a floodplain), while ensuring that the selected closure alternative is effective and adequately protects human health and the environment.

Unlike the Federal CCR Rule, which allows owners and operators to select a closure alternative that meets the minimum performance standards without comparing the performance of closure alternatives, the closure alternatives analysis required in Part 845.710 requires owners and operators to compare how each alternative meets key protectiveness factors, which are consistent with the factors that have been used in RCRA and CERCLA evaluations (discussed in Section 3.1) for decades and have been determined by US EPA to be protective of human health and the environment. The factors listed in Part 845.710 are sufficient to assess and assure that potential closures are protective; no threshold criteria requiring a specific closure alternative for certain SIs, *e.g.*, those with intersecting groundwater conditions or those located in a floodplain, are necessary (Section 3.2). Finally, while worker safety and cost are implicitly included in the Part 845.710 performance criteria, they should be explicitly enumerated in Part 845.710(b) (see Section 3.3).

[1] "EPA agrees that the RBCA [risk-based corrective action] process, using recognized and generally accepted good engineering practices such as the ASTM Eco–RBCA process, can be a useful tool to evaluate whether waste removal is appropriate at the site" (US EPA, 2015, p. 21412).

[2] When SIs are constructed below the natural groundwater elevation, such that groundwater has the potential to flow into its footprint, the SI is described as having "intersecting groundwater conditions." When SIs are constructed above the natural groundwater elevation, such that a discrete unsaturated zone is present between the bottom of the SI and the natural groundwater elevation, the SI is described as having "non-intersecting groundwater conditions" (EPRI, 2016).

3.1 The Part 845 closure alternatives analysis requirements are consistent with federal regulations and will ensure the protection of human health and the environment.

The proposed Illinois regulations set performance standards that must be evaluated in a closure alternatives analysis at CCR SIs:

1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:

   A) Magnitude of reduction of existing risks;

   B) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;

   C) The type and degree of long-term management required, including monitoring, operation, and maintenance;

   D) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;

   E) Time until groundwater protection standards in Section 845.600 are achieved;

   F) The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment or changes in groundwater flow;

   G) The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and

   H) Potential need for replacement of the remedy.

2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

   A) The extent to which containment practices will reduce further releases; and

   B) The extent to which treatment technologies may be used.

3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:

   A) Degree of difficulty associated with constructing the technology;

   B) Expected operational reliability of the technologies;

   C) Need to coordinate with and obtain necessary approvals and permits from other agencies;

   D) Availability of necessary equipment and specialists; and

   E) Available capacity and location of needed treatment, storage, and disposal services.

4) The degree to which community concerns are addressed by a potential remedy(s). (IEPA, 2020, Part 845.710(b)(1)-(4))

These performance standards for a closure alternatives analysis closely parallel existing requirements in longstanding environmental regulations, including RCRA Part 258 Subpart E, CERCLA (a.k.a. Superfund), and the Federal CCR Rule, that were designed to protect human health and the environment (*e.g.*, "the standards must account for and be protective of all sites, including those that are highly vulnerable" [US EPA, 2014, p. 21311]). Many of these federal requirements have been used by US EPA for decades to evaluate whether waste disposal facility closures and corrective actions are protective. Table 3.1 compares the performance standards in Part 845.710 with existing federal regulations that address how to select a plan to remedy the presence of contaminants in the environment. The performance standards listed in Part 845.710 are similar to, and in many cases identical to, the performance standards contained in existing federal regulations. This demonstrates that the performance standards in Part 845.710 are also sufficient to protect human health and the environment.

The closure alternatives evaluated against the rigorous Part 845.710 criteria should be practical, viable alternatives. Such an approach is consistent with the approach outlined in existing federal regulations for remedy selection under CERCLA: "[a] detailed analysis shall be conducted on the limited number of alternatives that represent viable approaches to remedial action after evaluation in the screening stage" (US EPA, 2003, 40 CFR 300.430(e)(9)(i)). Screening evaluations streamline the alternatives analysis by reducing the large number of possible alternatives to a reasonable number of viable alternatives. Specifying the evaluation of alternatives that are theoretical, but may not be viable, as in Part 845.710(c) (requiring the evaluation of "whether constructing an onsite landfill is possible") (IEPA, 2020) should not be a requirement of the closure alternatives analysis.

Table 3.1 Comparison of Performance Standards

Part 845.710 – Closure Alternatives for CCR SIs	RCRA Part 258 Subpart E – Selection of Remedy for Municipal Solid Waste Landfills (40 CFR 258.57)	CERCLA – Selection of Remedy (40 CFR 300.430(e)(9)(iii))	Federal CCR Rule (RCRA Part 257 Subpart D) – Selection of Remedy (40 CFR 257.97)
Long- and short-term effectiveness and protectiveness (845.710(b)(1))	Long- and short-term effectiveness and protectiveness (258.57(c)(1))	Overall protection of human health and the environment (300.430(e)(9)(iii)(A))	Long- and short-term effectiveness and protectiveness (257.97(c)(1))
Magnitude of risk reduction (845.710(b)(1)(A)	Magnitude of risk reduction (258.57(c)(1)(i))	Reduction of toxicity, mobility, or volume (300.430(e)(9)(iii)(D))	Magnitude of risk reduction (257.97(c)(1)(i))
Magnitude of residual risk from CCR releases (845.710(b)(1)(B)	Magnitude of residual risks from releases (258.57(c)(1)(ii))	Magnitude of residual risk remaining (300.430(e)(9)(iii)(C)(1))	Magnitude of residual risk from CCR releases (257.97(c)(1)(ii))
Long-term O&M (845.710(b)(1)(C)	Long-term O&M (258.57(c)(1)(iii))	Annual and net present value of O&M costs (300.430(e)(9)(iii)(G)(2-3))	Long-term O&M (257.97(c)(1)(iii))
Short-term risks to community or environment during implementation (845.710(b)(1)(D)	Short-term risks to community or environment during implementation (258.57(c)(1)(iv))	Short-term risks to community or environment during implementation (300.430(e)(9)(iii)(E)(1-3))	Short-term risks to community or environment during implementation (257.97(c)(1)(iv))
Time until closure, post-closure, and groundwater monitoring complete (845.710(b)(1)(E)	Time until full protection achieved (258.57(c)(1)(v))	Time until protection is achieved (300.430(e)(9)(iii)(E)(4))	Time until full protection achieved (257.97(c)(1)(v))
Magnitude of residual risk from exposure to remaining wastes (845.710(b)(1)(F)	Potential for exposure to remaining wastes (258.57(c)(1)(vi))	Type and quantity of residuals that will remain (300.430(e)(9)(iii)(D)(5))	Magnitude of residual risk from exposure to remaining wastes (257.97(c)(1)(vi))
Long-term reliability of controls (845.710(b)(1)(G)	Long-term reliability of controls (258.57(c)(1)(vii))	Long-term reliability of controls (300.430(e)(9)(iii)(C)(2))	Long-term reliability of controls (257.97(c)(1)(vii))
Potential need for future corrective action (845.710(b)(1)(H)	Potential need for remedy replacement (258.57(c)(1)(viii))	Potential need for remedy replacement (300.430(e)(9)(iii)(C)(2))	Potential need for remedy replacement (257.97(c)(1)(viii))
Effectiveness of controlling future releases (845.710(b)(2))	Effectiveness of controlling future releases (258.57(c)(2))	Degree to which residuals remain hazardous, accounting for mobility (300.430(e)(9)(iii)(C)(1))	Effectiveness of controlling future releases (257.97(c)(2))
Implementability (845.710(b)(3))	Implementability (258.57(c)(3))	Implementability (300.430(e)(9)(iii)(F))	Implementability (257.97(c)(3))
Community acceptance (845.710(b)(4))	Community acceptance 258.57(c)(5)	Community acceptance (300.430(e)(9)(iii)(I))	Community acceptance (257.97(c)(4))

Notes:
Performance standards sources:
RCRA: 40 CFR Part 258 Subpart E (US EPA, 2019a).
CERCLA: 40 CFR Part 300 (US EPA, 2003).
Federal CCR Rule: 40 CFR Part 257 Subpart D (US EPA, 2015).
Part 845.710: IEPA Proposed Rule (IEPA, 2020).

In addition to the performance standards listed in Table 3.1, Part 845 contains further requirements for assessing the potential impacts of each closure alternative to groundwater and surface water (IEPA, 2020, Part 845.710(d)), including that the closure alternatives analysis should:

2) contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards;

3) include a description of the fate and transport of contaminants with the closure alternative over time including consideration of seasonal variations; and

4) assess impacts to waters in the state. (IEPA, 2020, Part 845.710(d)(2)-(4))

The supplemental requirements will ensure that closure alternatives are evaluated against the performance standards in a manner that rigorously focuses on water quality. CCR SI owners and operators will be required to thoroughly evaluate and assess potentially unique issues that may affect groundwater and surface water at each site, and meet a higher burden of proof to show protectiveness than required in the Federal CCR Rule, which is designed to be protective. The performance standards and evaluation requirements in Part 845.710 are sufficient to ensure that any selected closure alternative will be protective of human health and the environment.

3.2 The performance standards in Part 845.710 are capable of evaluating closures at all SIs.

The proposed closure alternative assessments (Part 845.710) present a structure for evaluating risks to human health and the environment for all SIs and for selecting appropriate closure alternatives for all SIs, including SIs with intersecting groundwater conditions, SIs located in floodplains, and SIs that may fail other location criteria, such as distance of separation between the bottom of the SI and the uppermost aquifer (IEPA, 2020, Part 845.300-845.350,).[3] Requiring a particular closure alternative based on specific triggers (*e.g.*, intersecting groundwater conditions) is unnecessary because the performance standards in Part 845.710 are sufficient for evaluating the ability of a closure alternative to meet protectiveness requirements at all SIs.[4]

Closure alternative performance is evaluated in Part 845 based on multiple factors (see Section 3.1; IEPA, 2020, Part 845.710(b),(d)). Several examples illustrating how the Part 845.710 factors can effectively be used to evaluate protectiveness at SIs in all environmental conditions are provided below.

SIs with Intersecting Groundwater

SIs that are constructed with intersecting groundwater conditions (*i.e.*, the base of the impoundment is below the natural groundwater elevation) are often of particular concern due to the potential for CCR constituent mass to continue leaching into groundwater even after closure is completed. Despite this potential, if a closure alternatives analysis is performed properly, the criteria contained in Part 845.710 are adequate to assess, even at sites with intersecting groundwater, whether a closure alternative will meet performance metrics and, thus, be protective of human health and the environment. No triggers defaulting

[3] Location restrictions are described in Subpart C to Part 845 and describe the locations where placement of CCRs in both existing and new CCR SIs will not be permissible.

[4] Note that identical performance standards are used in Part 845.670(e) to evaluate and select a corrective action alternative. Because closure, *i.e.*, source control, is a form of corrective action, these performance standards are sufficient for evaluating and selecting both corrective action alternatives and closure alternatives.

to CBR are necessary. The following bullets illustrate how Part 845.710 criteria may be implemented at a site with intersecting groundwater.

- Part 845.710(b)(1)(B) (magnitude of residual risks in terms of the likelihood of future releases of CCRs) and Part 845.710(b)(2) (effectiveness in controlling future releases) will reflect whether the risk of future releases of CCRs at a site with intersecting groundwater are significant and whether CIP is a suitable closure alternative in such a circumstance. The use of additional source control technologies, beyond the technologies selected for closure, may also be assessed.
- Part 845.710(b)(1)(E) (time until closure and post-closure care or completion of groundwater monitoring is completed) will reflect if CCRs at a site with intersecting groundwater conditions act as a significant continuing source of constituents to groundwater.
- Part 845.710(b)(1)(F) (potential for exposure to remaining wastes) will assess whether long-term contact of CCRs with groundwater is of concern.

Note that, consistent with the Federal CCR Rule, Part 845.750 requires that, for CIP, "[f]ree liquids must be eliminated by removing liquid wastes" (IEPA, 2020, Part 845.750(b)(1); see also US EPA, 2014, 40 CFR 257.100(2)(i)). Removing liquid wastes refers to removing the ponded, free-standing, and mobile water in the SI. It does not preclude groundwater, upon completion of closure, from flowing into and out of the SI footprint, because groundwater is not a liquid waste. Liquid wastes refers to the liquids generated as part of the CCR management process contained within the boundaries of the disposal facility (*i.e.*, waters/slurry sluiced into the SI). The interaction of groundwater and CCRs does not make groundwater a liquid waste. In both Part 845.750 and the Federal CCR Rule, the requirement to eliminate free liquids is included under the "[d]rainage and stabilization of CCR surface impoundments" section of the rule (IEPA, 2020, Part 845.750(b); US EPA, 2014, 40 CFR 257.102(d)(2)), because it is intended to be a structural stability requirement, rather than a control on future releases. The requirement must be met "prior to installing the final cover system" (IEPA, 2020, Part 845.750(b); US EPA, 2014, 40 CFR 257.102(d)(2)), with no reference to ongoing inflow and outflow from an SI. Groundwater that may contact CCRs and become impacted is addressed separately as part of groundwater corrective action (IEPA, 2020, Part 845.660-845.680; US EPA, 2014, pp. 21487-21489). Thus, there is no requirement in either existing federal regulations or in Part 845 that precludes using CIP as the closure alternative for SIs with intersecting groundwater.

In addition to the performance criteria that ensure protective closure alternatives analysis and selection, Part 845 requires a thorough groundwater monitoring program (IEPA, 2020, Part 845.650(b)(1)), groundwater corrective action if exceedances of GWPSs are confirmed through assessment and detection monitoring (IEPA, 2020, Part 845.650(d)), and post-closure care (IEPA, 2020, Part 845.780). These programs will provide ongoing protection of groundwater quality.

SIs Located in Floodplains

SIs constructed in floodplains are another scenario of concern due to the potential contact of surface water and CCRs in some circumstances. Despite these potential circumstances, if a closure alternatives analysis is performed properly, the criteria contained in Part 845.710 are able to assess, even at sites located in floodplains, whether a closure alternative will meet performance metrics and, thus, be protective of human health and the environment. No triggers defaulting to CBR are necessary. The following bullets illustrate how Part 845.710 criteria may be implemented at a site located in a floodplain.

- Part 845.710(b)(1)(B) (magnitude of residual risks in terms of the likelihood of future releases of CCRs) and Part 845.710(b)(2) (effectiveness in controlling future releases) will reflect whether the risk of future releases of CCRs from the SI to floodwaters are significant, and the extent to which treatment technologies may be used to control releases.

- Part 845.710(b)(1)(F) (potential for exposure to remaining wastes) will assess whether structural hazards posed by floodwaters that may result in contact with CCRs are of concern.
- Part 845.710(b)(1)(G) (long-term reliability) and Part 845.710(b)(3)(B) (expected operational reliability) will assess whether overtopping floodwaters present a reliability risk to a particular site.

In addition to the performance criteria that ensure protective closure alternatives analysis and selection, Part 845 requires hazard potential, structural stability, and safety factor assessments at SIs (IEPA, 2020, Part 845.440-845.460). SI integrity is required to be assessed with regularly scheduled inspections and after significant storms (IEPA, 2020, Part 845.540). Regular assessments, consistent with those proposed by Rudolph Bonaparte, performed at all SIs, will reduce the susceptibility of any closure alternative to structural damage from and/or releases to floodwaters.

SIs that Fail a Location Criterion

The criteria contained in Part 845.710 are suitable performance metrics for evaluating whether closure alternatives can be protective of human health and the environment, even at sites that are required to close because they failed a location criterion (*i.e.*, Part 845.300). SIs may be required to close as a result of their locations within fault zones, seismic impact zones, and/or unstable areas; their proximity to wetlands; or their distance above the uppermost aquifer unit (IEPA, 2020, Part 845.300-845.350). No triggers defaulting to CBR at such sites are necessary. The following bullets illustrate how Part 845.710 criteria may be implemented at a site that fails a location criterion.

- Part 845.710(b)(1)(B) (magnitude of residual risks in terms of the likelihood of future releases of CCRs) and Part 845.710(b)(2) (effectiveness in controlling future releases) will reflect whether the risk of future releases of CCRs from the SI as a result of a location within fault zones, seismic impact zones, and unstable areas are significant. This performance standard will also reflect whether the risk of future releases of CCRs from the SI to wetlands or to groundwaters located within five vertical feet of the SI are significant and the extent to which treatment technologies may be used to control releases.
- Part 845.710(b)(1)(E) (time until closure and post-closure care or completion of groundwater monitoring is completed) will reflect if CCRs at a site with groundwater located within five vertical feet of the SI acts as a significant continuing source of CCR-related constituents.
- Part 845.710(b)(1)(F) (potential for exposure to remaining wastes) will assess whether structural hazards that may result in contact with CCRs are of concern. This performance standard will also reflect whether there is potential for exposure to CCRs from the SI *via* nearby wetlands.
- Part 845.710(b)(1)(G) (long-term reliability, "including an analysis of any off-site, nearby destabilizing activities" [IEPA, 2020]), in-particular, will address whether a closure alternative provides sufficient long-term reliability with respect to potential structural hazards and to nearby wetlands.
- Part 845.710(b)(3)(B) (expected operational reliability) will assess whether potential structural damage presents a reliability risk to a particular site.

In addition to the performance criteria that ensure protective closure alternatives analysis and selection, Part 845 requires hazard potential, structural stability, and safety factor assessments at SIs (IEPA, 2020, Part 845.440-845.460). SI integrity will be required to be assessed regularly (IEPA, 2020, Part 845.540).

Regular assessments, consistent with those proposed by Rudolph Bonaparte, performed at all SIs, will reduce the susceptibility of any closure alternative to damage from structural instability.

3.3 Worker safety and cost are two important closure alternatives analysis metrics that should be explicitly identified in Part 845.710.

While Part 845.710 effectively accounts for many of the important elements associated with the closure of an SI, there are additional factors, worker safety and cost, that should be explicitly identified as performance metrics for closure alternatives analyses. Both worker safety and cost are currently implicitly referenced in Part 845.710; however, to improve clarity, both of these important factors should be explicitly identified.

3.3.1 Worker Safety

Because workers that implement a selected closure alternative are part of the community, worker safety should already be included in evaluations of short-term impacts to the community in Part 845.710 (IEPA, 2020, Part 845.710(b)(1)(D)). However, due to the importance of protecting workers, an assessment of potential risks to workers associated with each closure alternative should explicitly be required in the closure alternatives analysis. Explicit requirements to assess worker safety as part of the closure alternatives evaluation process would be consistent with existing federal and state regulations. Both RCRA and the Illinois Municipal Solid Waste Landfill regulations require the consideration of worker safety as part of corrective action remedy assessment, specifying that those programs require assessments to evaluate "[s]hort-term risks that might be posed to the community, **workers**, or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and redisposal or containment" (US EPA, 2019a, 40 CFR 258.57(c)(1)(iv); IEPA, 2018, Part 811.325(c)(1)(D) [emphasis added]).

CERCLA similarly specifies worker risk as one of the key components of short-term effectiveness, stating "[t]he short-term impacts of alternatives shall be assessed considering the following: (*1*) Short-term risks that might be posed to the community during implementation of an alternative; (*2*) **Potential impacts on workers during remedial action** and the effectiveness and reliability of protective measures…" (US EPA, 2009, 40 CFR 300.430(e)(9)(iii)(E) [emphasis added]). Consistent with existing federal and state regulations and the numerous public comments, Part 845.710(b)(1)(D) should also specify worker safety as an explicit component of short-term effectiveness that must be considered during CCR SI closure alternatives analyses.

3.3.2 Cost

Cost has long been a factor in federal and state regulations used to evaluate and select appropriate corrective action and closure alternatives. Because cost is a key component of the "ease or difficulty of implementing a potential closure method" (IEPA, 2020, Part 845.710(b)(3)), it is already implicitly included as a closure alternatives analysis performance metric in Part 845.710. However, cost should be explicitly identified as a performance metric consistent with existing federal and state regulations.

Both federal and Illinois regulations evaluate cost in remedial decision-making. At the federal level, cost-effectiveness has been a factor that must be considered as part of remedy selection for decades. CERCLA requires that every remedy selected must be cost-effective and has identified cost as one of the nine evaluation criteria required to objectively assess potential remedies (US EPA, 2003, 40 CFR 300.430(e)(9)(iii)(G); US EPA, 1996).

Specifically, CERCLA states that:

> The costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated. (US EPA, 2003, 40 CFR 300.4309(e)(7)(iii))

US EPA has identified that a remedy is cost-effective if its "costs are proportional to its overall effectiveness" (US EPA, 2003, 40 CFR 300.430(f)(1)(ii)(D)) and has indicated that "large sums of money should not be spent treating low-level threat wastes" (US EPA, 1996, p. 4). Moreover, US EPA provides an example of a scenario that would not meet its cost-effectiveness standard:

> [T]he costs associated with treating a complex mixture of heterogeneous wastes without discrete hot spots (e.g., a large municipal landfill) would likely be considered excessive in comparison to the effectiveness of such treatment. As a result, a treatment alternative for such a site would likely be eliminated from consideration during the screening process. (US EPA, 1996, p. 4)

Due to the expected large costs relative to the remedy effectiveness, US EPA would expect that the alternative described in the above example would be eliminated from the list of viable alternatives.

RCRA also requires the consideration of cost during corrective measures assessments. Regulations that pertain to municipal solid waste landfills and certain non-municipal non-hazardous waste disposal facilities, which are the regulations upon which the Federal CCR Rule is based, specifically list cost as a factor that must be analyzed during assessment of corrective measures:

> The assessment shall include an analysis of the effectiveness of potential corrective measures in meeting **all** of the requirements and objectives of the remedy as described under [§258.57 or §257.27], addressing **at least** the following: (1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination; (2) The time required to begin and complete the remedy; 3) **The costs of remedy implementation**… (US EPA, 2019a, 40 CFR 258.56(c) [emphasis added], 2019b, 40 CFR 257.26(c)(1)(iv) [emphasis added])

The assessment of costs in corrective action assessments in RCRA was explained further in the preamble to the proposed municipal solid waste landfill rule. US EPA envisioned that, when approving a selected remedy, "[c]ost estimates will be very important to the State" and that "[t]he practicable capabilities of the facility, including the capability to finance and manage a corrective action program may be considered by the State in determining the duration of the clean-up. Therefore, the cost of the remedy may affect the remedy selected and the timing of the cleanup..." (US EPA, 1988a, p. 33376). In the final rule, US EPA described how cost should be included in the remedy selection process, explaining that if two potential remedies will result in the same level of protection to human health and the environment, it may be appropriate to consider cost as a determinative factor: cost "may become important in the remedy selection process when evaluating alternative remedies that will achieve the same level of protection" (US EPA, 1991, p. 51089).

At the state level, the Illinois Administrative Code also requires consideration of cost during corrective action assessments at municipal solid waste landfill units, with similar language to RCRA.

> The assessment shall include an analysis of the effectiveness of various potential corrective action measures in meeting **all** of the requirements and objectives of the remedy, as described under Section 811.325, addressing **at least** the following: 1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination; 2)The time required to begin and complete the remedy; 3) **The costs of remedy implementation**…(IEPA, 2018, Illinois Administrative Code Title 35, Part 811.324(d) [emphasis added])

These existing federal and state regulations have been designed to ensure that remedies are economically reasonable and to avoid scenarios in which a grossly more expensive remedy is selected that does not provide any meaningful risk reduction relative to other, more inexpensive remedies. To be consistent with existing regulations, and to be efficient in the allocation of resources while ensuring protectiveness, cost should be explicitly listed in the Part 845.710 criteria.

4 Closure by removal is not always more protective than closure in place.

Selecting an appropriate site-specific closure plan involves a careful analysis of the available alternatives. Neither CBR nor CIP is universally more protective of human health and the environment than the other: there are numerous site-specific and environmental factors that might make one closure alternative preferable to the other. As such, performance standards, such as those defined in Part 845.710, are the appropriate regulatory mechanism to ensure the proper evaluation and selection of CCR SI closure alternatives. Setting arbitrary criteria or triggers that require the selection of a specific closure alternative would neglect the fact that no one closure approach is always more protective than another. Site-specific evaluations, based on the criteria in Part 845.710, are necessary to determine which closure alternatives are appropriate for a given site. The remainder of this section presents a detailed discussion of the following issues:

- US EPA considers that both CIP and CBR can be equally protective if implemented properly (Section 4.1).
- At some sites, depending on the SI characteristics and the environmental setting, CIP may be more protective of groundwater quality than CBR (Section 4.2).
- CBR can have greater adverse impacts than CIP to short-term risks, such as impacts to nearby communities and worker safety; additionally, greenhouse gas, sulfur oxide (SO_x), nitrogen oxide (NO_x), and particulate matter (PM) emissions are typically much higher for CBR compared to CIP. Balancing these adverse impacts with potential beneficial impacts to groundwater quality is best achieved through the closure alternatives analysis outlined in Part 845.710 (IEPA, 2020, Part 845.710; Section 4.3).

4.1 US EPA considers that both closure in place and closure by removal can be equally protective if implemented properly.

In the Federal CCR Rule, US EPA notes, having specified CIP and CBR as the two methods by which CCR SIs may close (US EPA, 2015, p. 21305), that "both methods of closure… can be equally protective, provided they are conducted properly" (US EPA, 2015, p. 21412). Protection of human health and the environment is a threshold criterion in environmental actions, *i.e.*, all closure and cleanup activities must ensure the protection of human health and the environment in order to be eligible for selection.[5] If CIP were determined not to be protective of human health and the environment for a particular SI, it would not be eligible for selection as the closure alternative for the impoundment. Further, any selected closure alternative can be supplemented with additional source control and corrective action measures in order to be protective of human health and the environment. For example, a combination of CIP and a vertical barrier wall may be necessary to be protective of human health and the environment.

[5] See, for example, US EPA (1988, 2003, 40 CFR 300.430(f)(1)(i)(A)).

Both CIP and CBR are capable of achieving acceptable levels of protectiveness of human health and the environment. US EPA conducted a nationwide CCR risk assessment (US EPA, 2014) as part of the development of the Federal CCR Rule. The assessment evaluated differences in risks based on the assumptions that SIs were both closed *via* capping and *via* excavation. US EPA found "that releases from surface impoundments [to groundwater] drop dramatically after closure, even with waste in place" (US EPA, 2014, pp. 5-28 to 5-29) and concluded that the use of CBR as the SI closure alternative "has a negligible effect on modeled risks" compared to CIP (US EPA, 2014, p. 5-29). Thus, because both closure alternatives can be protective, threshold criteria or triggers that require a specific closure approach are inappropriate and unnecessary. The more appropriate regulatory approach, and the approach included in Part 845 (IEPA, 2020, Part 845.710), is that a site-specific evaluation of human health and environmental protectiveness should be performed for each closure scenario considered.

4.2 Closure in place may be as protective, and in some instances, more protective, of groundwater than closure by removal at some sites.

Depending on a range of site-specific and hydrogeological conditions, CIP sometimes provides an equal or a greater degree of protection to groundwater than CBR. Because of this, site-specific closure analyses are necessary to determine which closure options best meet the performance criteria outlined in Part 845.710. Because cap construction can typically be completed appreciably faster than excavation of an SI, CIP is often associated with a more rapid reduction in the flux of CCR constituents from an impoundment into the underlying groundwater. CBR, while typically taking longer to implement, can completely remove the CCRs from the immediate environment and thus eliminate the long-term primary source of constituents to groundwater. Which closure alternative is sufficiently protective of groundwater quality depends on site and environmental conditions. Table 4.1 lists examples of site-specific factors that may influence whether CIP is as protective or more protective of groundwater quality than CBR. Which closure option tends to be favorable for protection of groundwater at a site is driven by the inherent differences between the more rapid, but sometimes incomplete, elimination of the flux of constituents to groundwater achieved by CIP and the slower initial reduction, but often eventual complete elimination, of the flux of constituents to groundwater achieved by CBR.

Table 4.1 Example Site-specific Factors Influencing When Closure in Place Is as Protective or More Protective of Groundwater Quality than Closure by Removal

Site-specific Factor	Closure in Place (CIP) Generally More Protective of Groundwater Quality	Closure by Removal (CBR) Generally More Protective of Groundwater Quality
Groundwater aquifer hydraulic conductivity	CIP tends to be more protective in lower-conductivity aquifers, which have slower contaminant transport.	CBR tends to be more protective in higher-conductivity aquifers, which have more rapid contaminant transport.
Constituent of interest transport characteristics	CIP tends to be more protective for compounds that sorb more strongly to soil and are transported more slowly, *e.g.*, As(V).	CBR tends to be more protective for compounds that sorb less strongly to soil and are transported more rapidly, *e.g.*, As(III).
SI size	CIP tends to be more protective for larger impoundments, for which the time difference between constructing a cap and excavating CCRs is longer.	CBR tends to be more protective for smaller impoundments, for which the time difference between constructing a cap and excavating CCRs is shorter.

Notes:
As= Arsenic; CCR = Coal Combustion Residual; SI = Surface Impoundment.

As examples of how the factors in Table 4.1 affect concentrations of constituents in groundwater associated with an SI closed by CIP *vs*. CBR, I assessed two different hypothetical SIs in different hydrogeologic environments using groundwater contaminant transport modeling. I first considered a 25-acre/0.6 million cubic yard SI with non-intersecting groundwater conditions, and then a 200-acre/4.8 million cubic yard SI with intersecting groundwater conditions.[6] For both cases, I created numerical groundwater flow and constituent transport models using MODFLOW (Harbaugh, 2005) and MT3DMS (Zheng and Wang, 1999), both industry-standard modeling codes. I designed hypothetical square SIs with characteristics typical of many existing SIs – although not based on any single SI. Similarly, I selected closure option parameters (*e.g.* CIP cap design, construction schedules) consistent with typical values and professional engineering judgment. I then evaluated groundwater concentrations of arsenic(III) (As[III]) and arsenic(V) (As[V]) at approximately 30 ft downgradient of the edge of the containment berm, at a monitoring well screened over the top 5 ft of the aquifer thickness for the first 30 years post-closure. Arsenic is a common risk-driving constituent associated with CCR SIs and thus appropriate to use for this modeling evaluation. This type of comparative modeling evaluation is consistent with the Part 845.710(d)(2) (IEPA, 2020) requirements for groundwater contaminant transport modeling as part of the closure alternatives assessment.

4.2.1 Modeling Details

The hydraulic conductivity in the aquifer underlying the hypothetical SI was set to 5×10^{-3} centimeters per second (cm/s), representing a typical hydraulic conductivity for silty sands. I assumed an average annual precipitation of 40 inches/year, of which 20% (8 inches/year) naturally recharges groundwater. For the non-intersecting groundwater scenario, the pre-development depth to groundwater was 5 ft beneath the bottom of the SI, although there was some variation from the upgradient to downgradient edges of the SI. For the intersecting groundwater scenario, the pre-development depth to groundwater was approximately 5 ft above the bottom of the SI, although there was some variation from the upgradient to downgradient edges of the SI. Cross-sections of the intersecting and non-intersecting groundwater model setups are shown in Figures 4.1 and 4.2, respectively.

[6] When a CCR SI is constructed below the natural groundwater elevation, such that groundwater has the potential to flow into the impoundment's footprint, the impoundment is described as having "intersecting groundwater" conditions. When a CCR SI is constructed above the natural groundwater elevation, such that a discrete unsaturated zone is present between the bottom of the impoundment and the natural groundwater elevation, the impoundment is described as having "non-intersecting groundwater conditions" (EPRI, 2016).

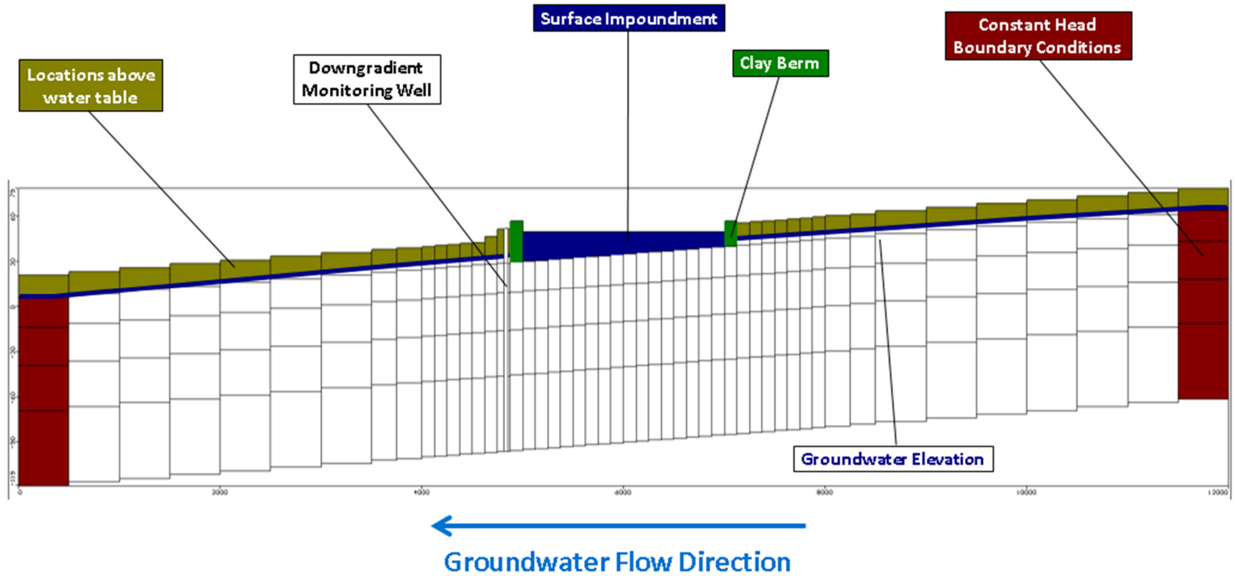


Figure 4.1 Intersecting Groundwater Conditions Model Cross-section

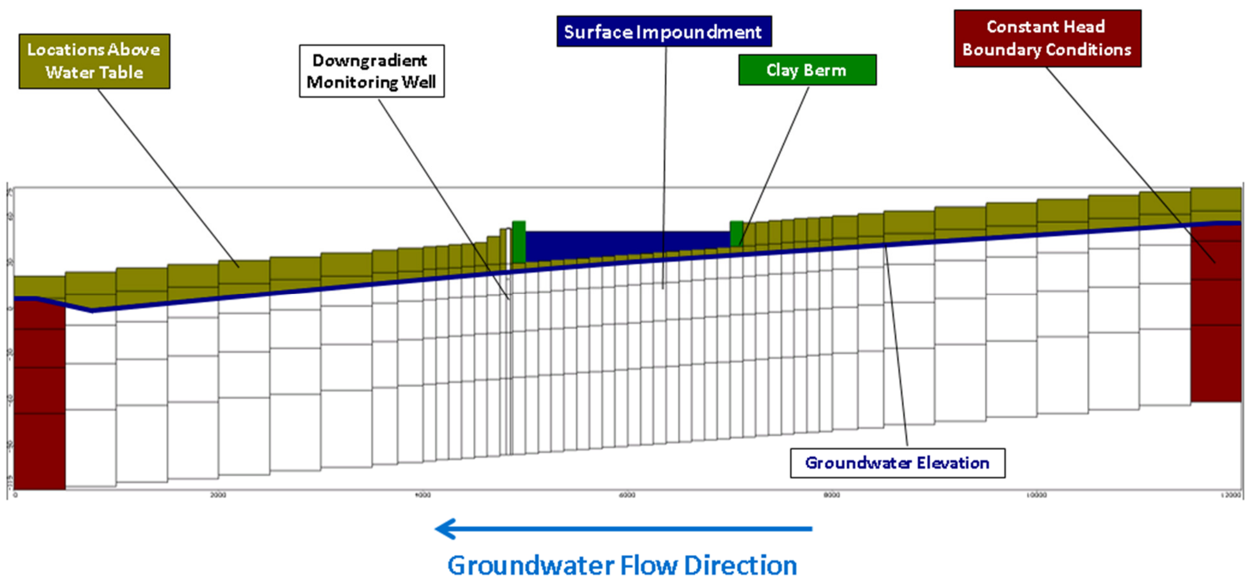


Figure 4.2 Non-intersecting Groundwater Conditions Model Cross-section

The time required to construct a cap for CIP and the time to excavate ash for CBR are dependent upon the size of the SI (Table 4.2). The duration of cap construction and of CCR excavation were calculated based on the rate of material transport to or from the hypothetical SI site, respectively. The cap construction duration, under CIP, was estimated to range from 0.3 to 2.5 years, based on the time required for 10-cubic-yard trucks working 5 days per week and making 100 roundtrips per day to transport materials for a 2-ft-thick impermeable soil cap layer to the site. The CCR excavation duration, under CBR, was estimated to range from 2.3 to 18.5 years, based on the time required for 10-cubic-yard trucks working 5 days per week and making 100 roundtrips per day to transport all the dewatered CCRs from the SI site to a new or existing lined landfill.

Table 4.2 Cap Construction and Ash Excavation Times

SI Size/CCR Volume	Duration of Cap Construction (CIP)	Duration of CCR Excavation (CBR)
25 acres (0.6 M cy)	0.3 years	2.3 years
200 acres (4.8 M cy)	2.5 years	18.5 years

Notes:
CBR = Closure by Removal; CCR = Coal Combustion Residual; CIP = Closure in Place; M cy = Million Cubic Yard; SI = Surface Impoundment.

Several different time periods were modeled to determine the post-closure concentrations of CCR constituents in groundwater, as summarized below.

- **Period of SI Operation (40 years):** Constant head boundary conditions were added within the footprint of the SI to simulate the effect of the impounded water. Constant strength source boundary conditions were applied to model cells within the SI to simulate the presence of CCR constituents in the saturated ash.
- **Period of Dewatering (1 year):** The constant head boundary conditions within the footprint of the SI were removed from the model, but all the other model parameters and boundary conditions remained consistent.
- **Closure by CIP:** Constant strength source concentrations remained in the hypothetical SI's CCR layer to simulate the effect of CCRs left in place below the constructed cap. Under intersecting groundwater conditions, residual saturated ash will contribute to the ongoing flux of CCR constituents to downgradient groundwater. The infiltration rate for the period after the engineered cap has been constructed was estimated to be 0.2 inches/year using the Hydrologic Evaluation of Landfill Performance (HELP) model (Schroeder *et al*., 1994). Constant strength recharge concentrations were used in the top model layer to simulate precipitation-induced leachate infiltrating through the CCRs into the underlying soils.
- **Closure by CBR:** Constant strength concentrations were defined to simulate the impact of CCRs in the SI, and recharge concentrations were defined to simulate precipitation-induced leachate infiltrating through the CCRs into the underlying soils during the dewatering and ash excavation periods. The constant concentration and recharge concentration boundary conditions were removed for the post-excavation period because infiltration of CCR-impacted leachate would not occur, as all the CCRs would have been removed during excavation.

During the cap construction period under CIP, which ranges from 0.3 years for the 25-acre SI to 2.5 years for the 200-acre SI, I assumed that recharge within the aerial footprint of the SI was equal to the ambient recharge rate throughout the rest of the model domain (8 inches/year). Prior to cap construction, the recharge rate may be higher than the ambient rate due to ponding of precipitation within the SI; as the cap is constructed, the recharge rate will decrease. Using the ambient recharge rate represents an averaging of these conditions.

During the CCR excavation period under CBR, precipitation falling onto the exposed ash will either infiltrate or evaporate. I assumed that recharge within the aerial footprint of the SI was equal to the ambient recharge rate throughout the rest of the model domain (8 inches/year). Similarly, after the ash excavation has been completed under CBR, I used the same ambient recharge rate throughout the aerial footprint of the former SI, because soil backfill would be expected to produce a similar recharge rate as the surrounding native soils. All CCR sources are removed in this period, however, so recharge does not add leachate mass to groundwater.

The median soil partition coefficient values based on US EPA's CCR risk assessment (US EPA, 2014) were used to determine the retardation factors for As(III) and As(V) constituent transport. The soil-water partition coefficients and the calculated retardation coefficients are presented in Table 4.3.

Table 4.3 Soil-Water Partition Coefficients and Retardation Coefficients

Constituent	Saturated Soil Partition Coefficient[a] (mL/g)	Saturated Zone Retardation Coefficient (R)
As(III)	0.87	9.0
As(V)	110	1,014

Notes:
As = Arsenic.
(a) Source: US EPA (2014).

Source concentrations for both species of arsenic were fixed at a unitless concentration of 1. Downgradient groundwater concentrations are reported as a unitless concentration ratio, C/C_o; C is the model-predicted downgradient concentration and C_o is the simulated source leachate concentration in the SI.

4.2.2 Modeling Results

Figures 4.3 and 4.4 show breakthrough curves of As(III) and As(V) concentrations for CIP and CBR for hypothetical 25-acre and 200-acre SIs, respectively. Table 4.4 summarizes the 30-year time-weighted average results at the groundwater monitoring point located downgradient of the SI. The differences in the time-weighted averages between the two closure scenarios are small (less than 10%), indicating that both CIP and CBR provide similar levels of protectiveness for groundwater. CBR provides greater levels of protectiveness regarding As(III) for the smaller (25 acre) SI. CIP, however, provides greater levels of protectiveness regarding As(III) for the larger (200 acre) SI. As shown in Figure 4.4, the more rapid decrease in mass flux following CIP results in lower arsenic concentrations in groundwater than CBR over the first 30 years after closure. For the slower-moving As(V), CIP is more protective than CBR for both SI scenarios.

Table 4.4 30-Year TWA Arsenic Concentrations at Downgradient Monitoring Well

Scenario	30-year TWA Concentration (C/C_o)			
	CIP		CBR	
	As(III)	As(V)	As(III)	As(V)
25-acre SI; Non-intersecting Groundwater Conditions	0.87	0.0068	0.81	0.0069
200-acre SI; Intersecting Groundwater Conditions	0.92	0.0025	0.94	0.0026

Notes:
C= Model-predicted Downgradient Concentration; C_o = Simulated Source Leachate Concentration in the SI; As = Arsenic; CBR = Closure by Removal; CIP = Closure in Place; SI = Surface Impoundment; TWA = Time-Weighted Average.
Shaded cells indicate which closure option for a given scenario is most protective of groundwater.

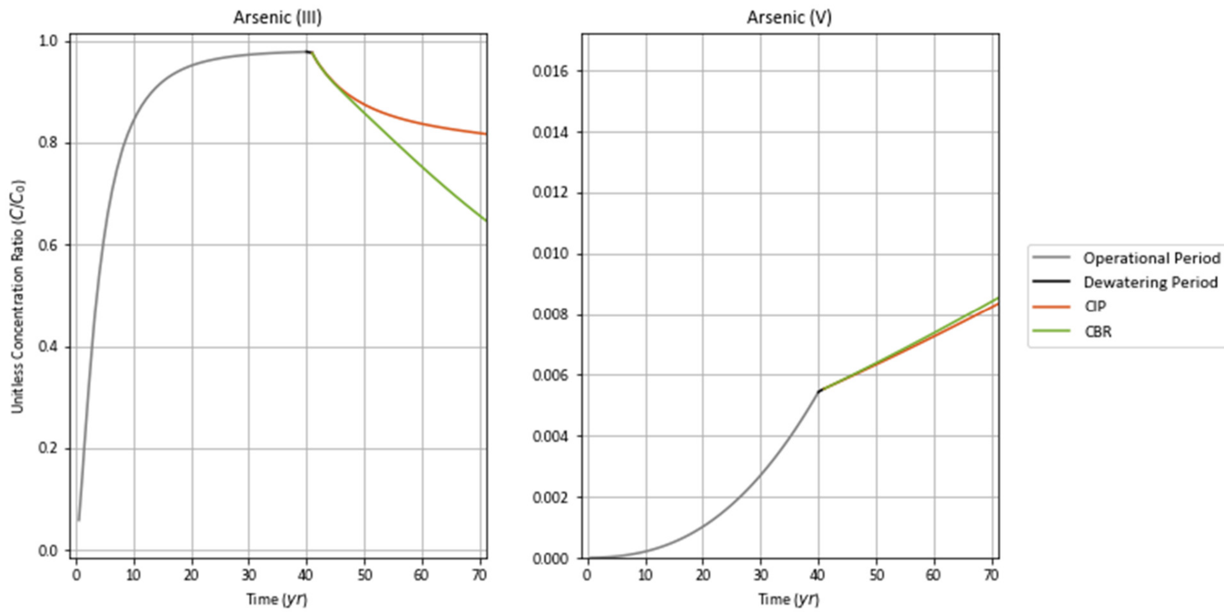


Figure 4.3 Breakthrough Curves for a 25-acre SI with Non-intersecting Groundwater Conditions

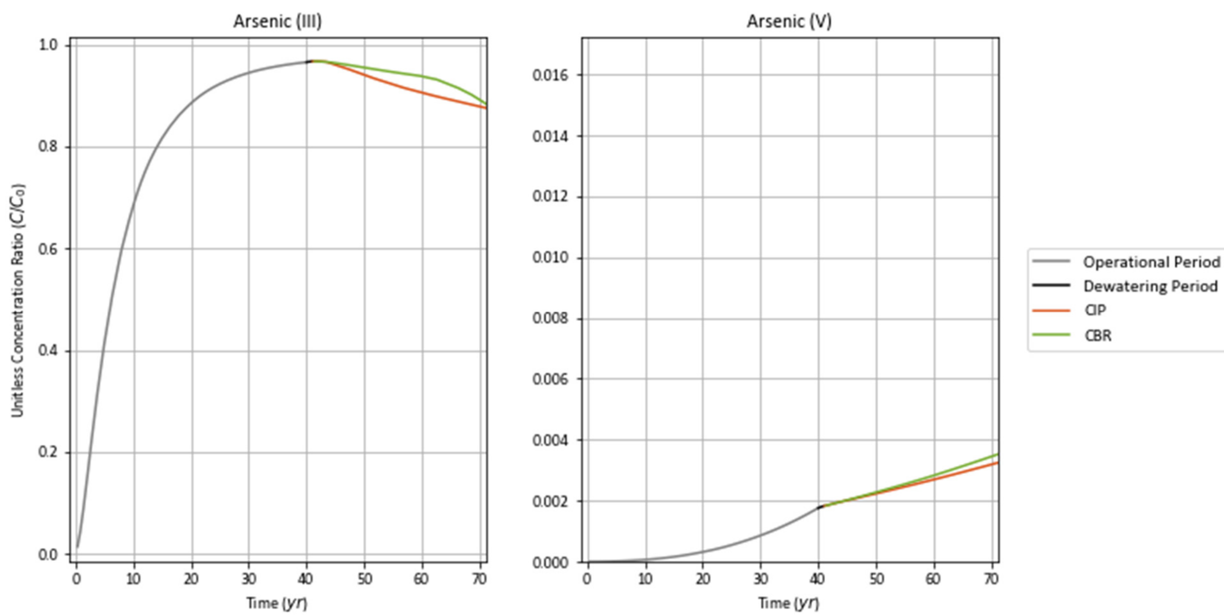


Figure 4.4 Breakthrough Curves for a 200-acre SI with Intersecting Groundwater Conditions

The modeling results show that both CIP and CBR provide significant beneficial impacts to groundwater quality demonstrated by declining groundwater concentrations of As(III) over time under both closure options and that neither of the closure options is always more beneficial with respect to downgradient groundwater quality than the other. Even for SIs with intersecting groundwater conditions, CIP can be more protective of groundwater than CBR because of the shorter time required to construct a cap as compared to the lengthier time required to excavate. These results are consistent with US EPA's position in the Federal CCR Rule that both closure options can be equally protective (US EPA, 2015), provided that they are implemented properly. Depending on the constituents of interest, the size of the SI, the time required to complete the closure alternative, and the hydrogeological conditions, CIP sometimes provides a greater degree of contaminant reduction in downgradient groundwater monitoring wells, and CBR sometimes provides a greater degree of contaminant reduction in downgradient groundwater monitoring wells. As discussed above, the degree of contaminant reduction is not the only factor for determining the degree of protectiveness that an owner or operator must consider when selecting a closure alternative in accordance with Part 845.710.

4.3 The short-term adverse impacts of closure by removal must be considered.

Part 845.710(b)(1)(D) requires the evaluation of the short-term risks posed to the community or the environment associated with each closure alternative, including threats associated with the transportation of CCRs (IEPA, 2020). Short-term risks to the community include risks borne by workers who provide services at the site, by drivers transporting construction materials or ash, by community members sharing roads with drivers, and by community members living in the vicinity of transportation routes to and from the site who may be exposed to fugitive emissions. Short-term risks to the environment include impacts from the greenhouse gas, PM, SO_x, and NO_x emissions associated with the equipment necessary to perform work at the site (EPRI, 2016, pp. 8-1, 9-1).

CBR generally has greater adverse short-term impacts than CIP, including adverse impacts to nearby communities, worker safety, and air emissions. CBR typically requires greater effort to implement than CIP. CBR requires more workers over a longer period of time, as well as more construction equipment requiring more energy and producing greater environmental emissions (*e.g.*, see EPRI, 2016, p. 8-4). While CBR can result in greater groundwater protectiveness at some sites (see Section 4.2), the potential benefits must be weighed against the greater short-term risks. The closure alternatives analysis in Part 845 (IEPA, 2020, Part 845.710a) provides a mechanism to evaluate and weigh the benefits and risks of different closure alternatives.

Both CIP and CBR (as well as any other environmental actions) produce short-term adverse impacts resulting from emissions associated with constructing and moving material as well as increased worker safety risks during performance of the work. Key factors in evaluating short-term impacts include (EPRI, 2016, pp. 8-1, 9-1):

- Injury and mortality risks to workers. Greater worker-hour requirements result in a greater risk of injury and potential mortality.
- Injury and mortality risks to the community. The more hours vehicles spend on roads in the nearby community, the greater the risk of vehicle accidents.
- Community health risks from exposure to diesel and fugitive dust emissions. Greater amounts of CCRs transported on roads in the community increase the total fugitive CCR dust emissions along those roads.
- Environmental impacts from greenhouse gas, SO_x, and NO_x emissions. Greater equipment and energy requirements result in greater emissions.

The worker and equipment requirements for an environmental action scale with the amount of materials moved at a site, because each worker or piece of equipment can handle a discrete volume of material at a time and each piece of equipment uses a discrete amount of energy per hour of work required. CBR typically requires significantly greater material movement than CIP. The primary materials necessary to implement CIP are the cap construction materials, and the material required scales with the surface area of the SI. In contrast, for CBR, all of the CCRs must be moved from the SI. Because SIs are typically deep, a larger volume of material must be moved for CBR compared to CIP. Moving a larger volume of material requires more construction equipment, resulting in more emissions, and more drivers and workers to transport the CCRs. Thus, the short-term risks to worker safety, the community, and the environment are typically much greater for CBR than for CIP.

As an example, to implement CBR at the Vermilion Power Station near Oakwood, Illinois, approximately 2.5 million cubic yards of impounded ash would require excavation and disposal (Stantec, 2017, Figure 2). Assuming that each truck can transport about 12.5 cubic yards of CCRs (*i.e.*, average of 10-cubic-yard and 15-cubic-yard truck sizes), this excavation process would require approximately 200,000 truck loads of ash to be transported from the SI to a lined landfill. Based on 60 trucks making one round trip per day between the SI and the landfill over a 5-day work-week, I have estimated that the excavation process would take approximately 13 years. If the ash were disposed at the nearby Republic Services Brickyard Disposal landfill in Batestown, Illinois, during transport, the trucks would pass more than 50 homes, a junior high school, a church, and a daycare facility. If the ash were disposed at the farther Republic Services Illinois Landfill, the route would pass through downtown Rossville, Illinois, and trucks would pass additional homes, schools, churches, and community centers. On average over a 10-hour work-day, a truck either transporting ash for disposal or returning to the SI would pass by these community receptors every 5 minutes, substantially adding to air emissions, noise pollution, and the risk of vehicle accidents.

Part 845 appropriately requires consideration of "the short-term risks that might be posed to the community or the environment during implementation of… closure, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants" as part of the analysis to select a closure alternative (IEPA, 2020, Part 845.710(b)(1)(D)). These short-term risks are balanced with other factors in Part 845.710 to determine the optimal closure alternative at each site. Applying triggers that require CBR for certain threshold criteria may result in a detrimental impact on workers and communities across the state.

5 Background groundwater monitoring requirements should be specific to each SI and groundwater monitoring should be limited to CCR-related constituents.

The purpose of Part 845 is to regulate CCR SIs (Part 845.100) by determining whether an SI is leaking and by requiring corrective measures to address potentially associated groundwater contamination. Part 845 does not address impacts from sources other than CCR SIs. Groundwater quality impacts from other sources are regulated under Part 620 of the Illinois Administrative Code (IEPA, 2013). Because of this, the groundwater monitoring, investigations, and corrective action requirements in Part 845 should all be directed toward evaluating specific SIs, rather than entire sites. Thus, background concentrations (IEPA, 2020, Part 845.630(a)) should be evaluated specific to each SI, rather than for an entire site (Section 5.1). Additionally, the groundwater monitoring constituents should be constituents that are representative of CCR leachate, as codified in Appendices III and IV of the Federal CCR Rule (US EPA, 2015), as opposed to constituents that may be representative of other, non-CCR-related releases (Section 5.2).

5.1 Background concentrations should be evaluated specific to each SI.

Background concentrations of constituents that are used to help determine whether there have been releases from a CCR SI should be evaluated specific to each SI. Because Part 845 sets standards and requirements pertaining to specific CCR SIs, it may be inappropriate to develop background concentrations for an entire site or to uniformly apply the same background concentrations at all SIs located on a particular site. Part 845.630(a) states that background groundwater quality should be established by examining "groundwater that has not been affected by leakage from a landfill containing CCR or CCR surface impoundment" (IEPA, 2020). Background concentrations of CCR-related constituents are used as the GWPSs for new CCR SIs and for CCR SIs at which the background values exceed the existing GWPSs (IEPA, 2020, Part 845.600(a)(2)). Thus, exceedances of background constituent concentrations may be the basis for initiating corrective action (IEPA, 2020, Part 845.660(a)(1)). In order to accurately assess whether releases from an SI have occurred or are occurring, background concentrations should be specific to each SI, even if the upgradient groundwater has been affected by another source.

To illustrate this concept, consider a site with multiple SIs, as configured in Figure 5.1, with one SI located upgradient of the other. In this scenario, background concentrations should be evaluated separately for each SI. If there is a release from the upgradient SI, it may impact groundwater underneath the downgradient SI, even if there were no releases from the downgradient SI. Using a single set of background concentrations for the entire site may result in both SIs requiring corrective action, even though only one of the two had a release to groundwater. In order to determine whether the downgradient SI is adversely impacting groundwater quality, the constituent concentrations immediately upgradient of that SI should be permitted for use as the background concentrations for the SI, regardless of whether that upgradient groundwater has been impacted by another source and regardless of whether the source is an upgradient CCR SI or a different source regulated under Part 620 (IEPA, 2013).

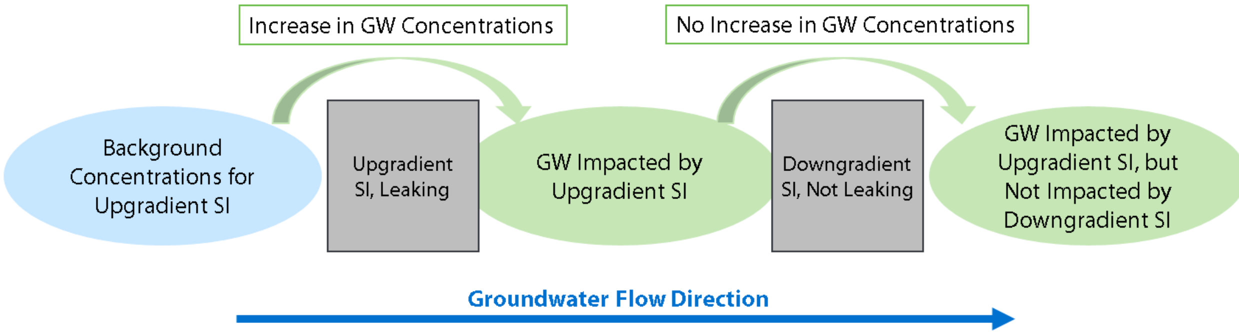


Figure 5.1 Conceptual Model of SI-specific Background Concentration Determinations

The groundwater sampling and analysis requirements in Part 845.640 provide sufficient statistical avenues to determine whether an SI is contributing to groundwater impacts even if elevated upgradient constituent concentrations are used as the background concentrations. As an example, Part 845.640(g)(6) states that any statistical method "must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data" (IEPA, 2020), which could be used to control for increasing or decreasing background concentration trends attributable to a migrating upgradient plume. In addition, the contaminant transport modeling and calculations required as part of closure (IEPA, 2020, Part 845.220(d)(3) and 845.710(d)(2)) are capable of evaluating contributions from multiple sources to determine whether observed downgradient impacts are a result of a release from a particular SI or are due to an upgradient contribution.

5.2 Groundwater monitoring analytes should be representative of CCRs.

Part 845.600(a)(1) lists 20 analytes that must be tested in all groundwater monitoring programs at CCR SIs (IEPA, 2020, Part 845.600(b)(3)(B-C); see Table 5.1). These analytes are consistent with the analytes included for monitoring in the Federal CCR Rule (Table 5.1). In the Federal CCR Rule, US EPA determined that monitoring these 20 constituents, which are listed in Appendices III and IV to Part 257, would be sufficient to assess releases from CCR SIs into the environment (US EPA, 2015, Appendices III and IV, see also discussion on p. 21404) and would be protective of human health and the environment (US EPA, 2015, p. 21412).[7]

US EPA has determined that these analytes are indicative of CCR SI impacts and that controlling levels of these constituents is protective of human health and the environment. No additional analytes are necessary.

[7] "Once the facility has removed all of the assessment monitoring constituents listed in appendix IV down to background levels or MCLs the groundwater is considered to be 'clean' and closure is complete" (US EPA, 2015, p. 21412).

Table 5.1 Groundwater Monitoring Analytes

Analyte	Part 845.600(a)(1)	Federal CCR Rule Appendix III	Federal CCR Rule Appendix IV
Antimony	X		X
Arsenic	X		X
Barium	X		X
Beryllium	X		X
Boron	X	X	
Cadmium	X		X
Chloride	X	X	
Chromium	X		X
Cobalt	X		X
Fluoride	X	X	X
Lead	X		X
Lithium	X		X
Mercury	X		X
Molybdenum	X		X
pH	X	X	
Selenium	X		X
Sulfate	X	X	
Thallium	X		X
Total Dissolved Solids	X	X	
Radium 226 and 228 Combined	X		X

Note:
Sources: Part 845.600(a)(1) analytes: IEPA (2020); Federal CCR Rule Appendix III and IV analytes: US EPA (2015, p. 21500).

6 Consolidating CCRs does not create unacceptable risks.

Moving CCRs from one location at a site to combine them with CCRs at another location at the site for the purposes of CIP, *i.e.*, consolidating CCRs, does not create unacceptable risks. On the contrary, consolidating CCRs can have several benefits; for example, the recent proposed rule for Part B of the holistic approach to closure (US EPA, 2020b) proposes a process by which CCRs can be used during CIP to support the construction of the final cover system for an SI (US EPA, 2020b). This proposed rule cites the benefits of CCR consolidation, including a reduced footprint where CCRs are located at a site, the elimination of long-term threats to groundwater and surface water from CCR SIs serving as the source of the consolidated CCRs, and the ability to allow owners and operators to focus "long-term monitoring, care and cleanup obligations on a single unit rather than multiple units" (US EPA, 2020b, p. 12463). In order to allow for the benefits of consolidating CCRs to be realized, Part 845.750 (IEPA, 2020) should allow for the consolidation of CCRs from multiple SIs into a single SI, which can then be closed by CIP, and Part 845.750(d) should allow for the consolidation of CCRs for purposes beyond just "grading and contouring in the design and construction of the final cover system" (IEPA, 2020). Allowing for on-site CCR consolidation does not alter or affect the ability to meet the required performance criteria in Parts 845.750(a-c) (IEPA, 2020) or Part 845.710 (IEPA, 2020), which ensure protectiveness (Section 6.1). By moving CCRs into a single SI, on-site consolidation will effectively reduce the footprint of CCRs at a site, creating benefits (Section 6.2). Finally, on-site consolidation of CCRs will not meaningfully affect the time required to achieve GWPSs (Section 6.3).

6.1 CCR consolidation does not alter or affect the ability to achieve closure performance criteria.

Performance standards for CCR SI closures with a final cover system (*i.e.*, CIP) are defined in Part 845.750 (IEPA, 2020). As discussed in Section 3, Part 845.710 (IEPA, 2020) also establishes performance criteria for the evaluation of all CCR SI closures. Allowing for on-site CCR consolidation does not affect the ability of the owner/operator to meet the requirements of either Part 845.750 or Part 845.710, which ensure that selected SI closures are designed to minimize the risk of potential impacts related to CCRs and to be protective of human health and the environment.

Part 845.710 establishes a framework for evaluating closure alternatives in a comprehensive manner and assures that all CCR SI closures will be protective of human heath and the environment (see Section 3.1; IEPA, 2020). Consolidation of CCRs from multiple SIs into a single SI at the same site does not change the performance standards that must be met as defined in Part 845.710. Moreover, consolidation of CCRs does not preclude the ability to meet the performance criteria listed in Part 845.710. Capping an SI that contains consolidated ash above the water table from several SIs at the same site can be protective of human health and the environment if implemented properly.

Part 845.750(a-c) establishes the standards for all final cover systems that must be achieved for CCR SIs that are closed by CIP and specifically identifies the measures that must be taken to mitigate the potential infiltration of water into the SI (IEPA, 2020). These measures, which include slope stabilization, drainage systems, and cap design elements, including the hydraulic conductivity and thickness of the low-permeability layer that inhibits the flow of water and the thickness and coverage area of the final cap (IEPA, 2020), are designed to be protective of human health and the environment. Part 845.750(d) establishes further requirements for CCR consolidation used to support SI closures. Consolidated CCRs are required to have a consistent composition (IEPA, 2020, Part 845.750(d)(1)) and be placed above the groundwater table and within the perimeter berms of the receiving SI (IEPA, 2020, Part 845.750(d)(2-3)). Therefore, the potential post-closure impacts to the environment and the footprint of the impacts are not changed by the addition of CCRs atop existing impounded CCRs.

Consolidating CCRs from SIs at the same site above the water table does not affect the ability of a cap to be constructed that meets the requirements of Part 845.750 and can be protective of human health and the environment, consistent with the requirements of Part 845.710 (IEPA, 2020).

6.2 On-site consolidation can effectively reduce the CCR footprint at a site.

Consolidating CCRs into a single SI can result in a number of benefits if implemented properly and consistent with the requirements of Part 845.710 and 845.750 (IEPA, 2020). If some CCR SIs at a site are closed by CBR and CCRs excavated from those facilities are consolidated into a single SI, which would then subsequently be closed by CIP, the overall footprint of the CCR disposal area at the site would be reduced. The benefit of consolidating CCRs in this way is that potential future liabilities to the environment would also be consolidated, *i.e.*, CCRs would be completely removed from some areas of a site and aggregated, above the water table and without any lateral expansions, into a single SI, such that potential future risks to groundwater and surface water are limited to just the consolidated CCR SI. Additionally, by focusing future operation, maintenance, and monitoring on a single capped SI, costs would likely be reduced. Furthermore, the land areas at the site where the CCR SIs were excavated would become available for future development and reuse.

In its recent proposed rule for Part B of the holistic approach to closure, US EPA provided an example of the benefits of consolidating CCRs at a site (US EPA, 2020b):

> Consolidating multiple units into a single unit would result in an overall smaller CCR unit footprint. Closing two 10-acre impoundments by removal of CCR and using the removed CCR for the purpose of achieving subgrade elevations necessary to support the closure and final cover system of a third 35-acre CCR unit is an example of consolidation resulting in a smaller CCR disposal footprint. One environmental benefit of this closure scenario would be the elimination of any long-term threat of impact to groundwater and surface water from 20 acres of land (two 10-acre units) as well as concerns about the long-term performance of a final cover system had these units been closed alternatively with CCR in place. In addition, upon closure of the two 10-acre impoundments, a total of 20 acres of land would become available for other uses. Finally, there may be benefits to allowing an owner or operator to focus their long-term monitoring, care and cleanup obligations on a single unit rather than multiple units. (US EPA, 2020b)

In order to allow for the benefits of consolidating CCRs to be realized, Part 845.750 should permit the consolidation of CCRs from multiple SIs into a single SI, which can then closed by CIP, and Part 845.750(d) should allow for the consolidation of CCRs for purposes beyond just "grading and contouring in the design and construction of the final cover system" (IEPA, 2020).

6.3 On-site consolidation of CCRs does not increase the time required to achieve GWPSs for a capped SI.

On-site consolidation of CCRs, implemented either to reduce the footprint of the CCR disposal area at a site or as a replacement for soil fill used in support of SI cap construction (Figure 6.1a and 6.1b), will not adversely impact the time required to achieve GWPSs. The time to achieve GWPSs could only be adversely affected if the on-site consolidation of CCRs results in an increase of CCR constituent mass migrating to the underlying aquifer. However, on-site CCR consolidation in an existing SI that increases the height of the stored CCRs above the water table will not increase the hydraulic flux that migrates through the cap and into the underlying groundwater (Section 6.3.1), nor will it affect the leachate concentrations that migrate vertically downward, and, consequently, the consolidation of CCRs will not increase the addition of CCR constituent mass to the aquifer (Section 6.3.2). Because consolidating CCRs above the water table will not cause an increase of CCR constituent mass to the aquifer, it will not adversely affect the time to achieve GWPSs. Finally, the primary factors that determine the time and rate at which GWPSs are achieved in an aquifer underlying a capped CCR SI are unrelated to the post-closure CCR volume and thickness and, thus, are unaffected by the consolidation of CCRs into a single SI (Section 6.3.3).

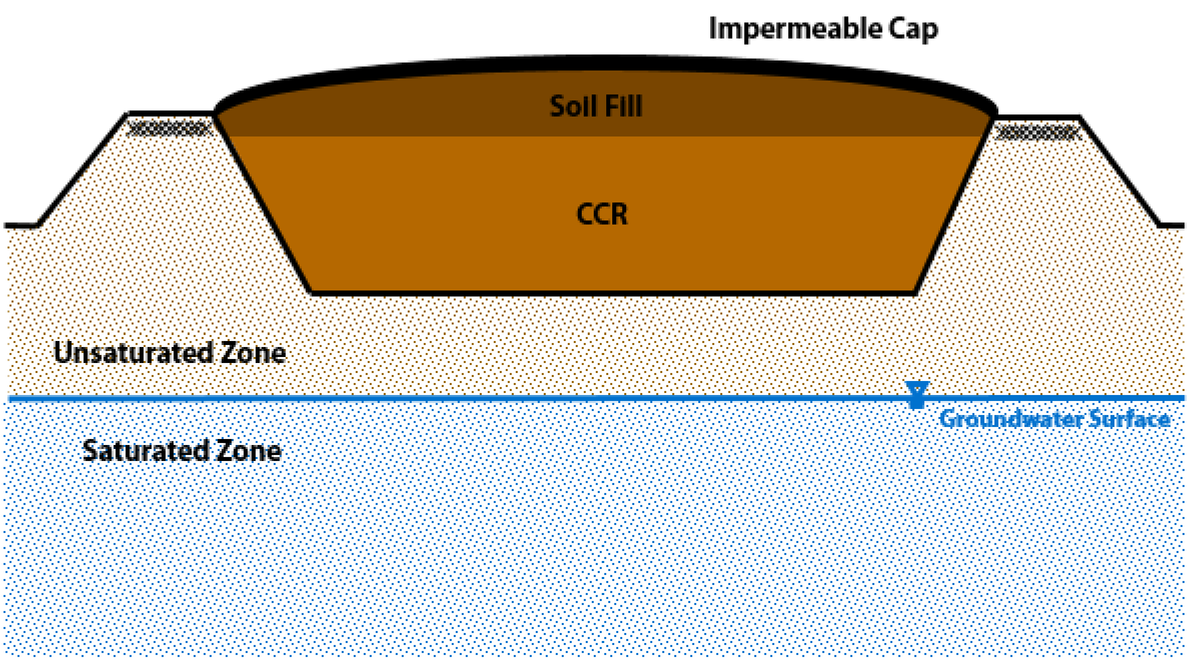


Figure 6.1a Closure-in-Place for CCR Surface Impoundment Using Soil Fill

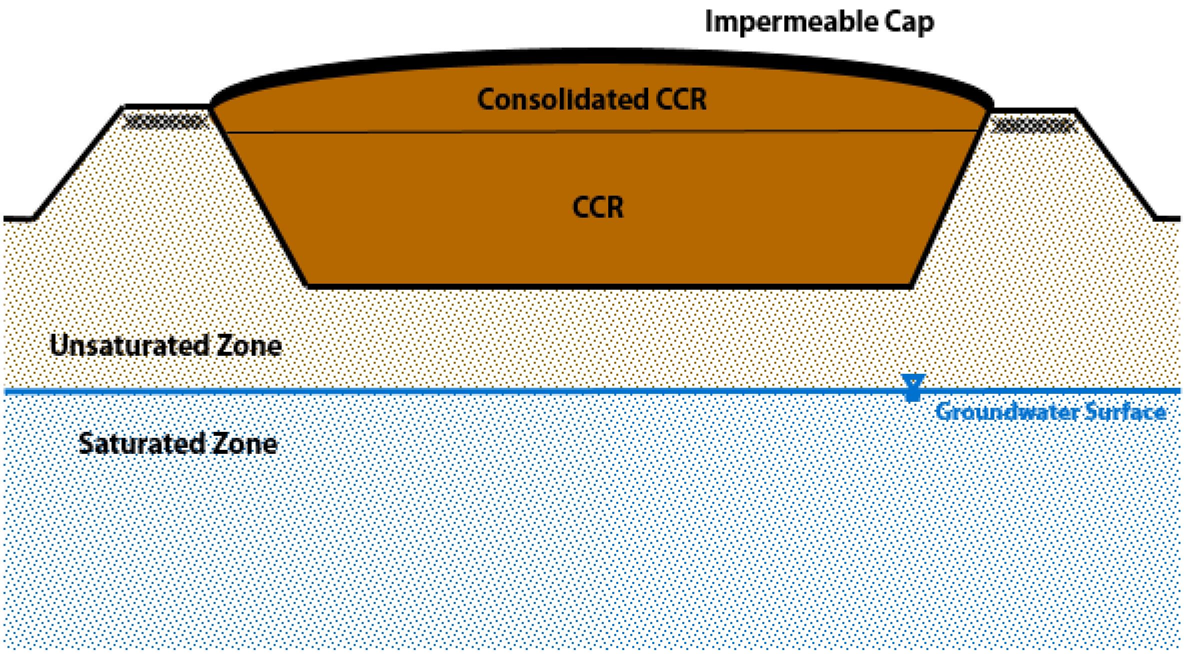


Figure 6.1b Closure-in-Place for CCR Surface Impoundment Using Consolidated CCRs

6.3.1 On-site consolidation of CCRs does not affect post-closure hydraulic flux to the aquifer.

Once a cap has been constructed over a CCR SI, the hydraulic flux, and the resulting CCR constituent mass flux to the aquifer, is controlled by the impermeable cap and, in the case of an SI constructed with intersecting groundwater conditions, the depth of groundwater intersection and hydrogeology. Increasing the vertical height of CCRs stored in the SI above the groundwater table will not increase the amount of water infiltrating from the SI to the underlying groundwater because infiltration is controlled by the permeability of the cap as defined in Part 845.750 (IEPA, 2020). Consequently, consolidating CCRs into a single SI will not affect the post-closure hydraulic flux that migrates through an SI into the underlying groundwater.

6.3.2 Post-closure leachate concentrations are not affected by the presence of consolidated CCRs.

Post-closure leachate concentrations are not affected by the presence of consolidated CCRs above the original impounded CCRs in an SI. The constituent concentrations in SI porewater will reach an equilibrium concentration controlled by the soil-water partition coefficient and the characteristics of the CCRs (US EPA, 2015, p. 21442); the ash porewater will maintain this equilibrium concentration as it migrates into the subsurface underlying the SI. The addition of more CCR volume into the SI (*i.e.*, consolidated CCRs) that is chemically similar to the original CCRs does not change the soil-water partition coefficients and will not increase the equilibrium leachate concentration.[8] Because leachate concentrations are controlled by the partition coefficients of the individual constituents and the characteristics of the CCRs,

[8] If the consolidated CCRs were generated by the combustion of coal sourced from a different location or is a different type of CCR (*i.e.*, bottom ash, fly ash, or flue-gas desulfurization waste) compared to the original impounded CCRs, there may be differences in the associated leachate concentrations. However, I expect that in most cases, the chemical differences between the consolidated CCRs and the original impounded CCRs to be minimal, because, as required by Part 845.750(d)(1) (IEPA, 2020), the CCRs must have been generated at the same facility and are, thus, likely reflective of the same coal sources and the same types of CCRs.

the dissolved concentrations will be constant relative to the solid concentrations regardless of the thickness of the stored CCRs through which the infiltrating water passes. Thus, consolidating CCRs above the water table into a single SI, and thereby increasing the volume and thickness of CCRs in an SI, does not increase the resulting ash porewater concentration in the SI or the leachate concentrations that migrate vertically downward toward the underlying groundwater.

Consequently, because consolidating CCRs into a single SI does not affect either the hydraulic flux through the SI to the underlying groundwater (see Section 6.3.1) or the constituent concentrations in the CCR leachate, the mass flux of CCR constituents to the aquifer is also not affected by the consolidation of CCR. Because consolidating CCRs does not cause an increase of CCR constituent mass to groundwater, it will not adversely impact the time required to achieve GWPSs in the underlying and surrounding aquifer.

6.3.3 Consolidation of CCRs does not impact the time it takes to achieve GWPSs.

The time required to achieve GWPSs in groundwater underlying and surrounding a CCR SI is primarily determined by the amount and distribution of mass that was released to the aquifer prior to the closure of the SI and the hydrogeological characteristics of the aquifer. Neither of these factors are affected by consolidating CCRs above the water table during the closure of a CCR SI and, thus, the consolidation of CCRs has no meaningful impact on the time required to achieve GWPSs.

7 No timeframe limits should be prescribed for completing groundwater corrective action.

Part 845.670(f) requires that owners or operators specify a schedule for implementing and completing remedial activities "within a reasonable period of time," considering the nature and extent of the contamination, probability of achieving compliance, availability of treatment or disposal capacity, potential risks to human health and the environment, resource value of the aquifer, and other relevant factors (IEPA, 2020, Part 845.670(f)). This is consistent with decades of contaminated groundwater remediation under CERCLA, for which US EPA allows for site-specific variability in the time to complete remediation and to restore groundwater. Notably, federal regulations do not prescribe a numerical time limit by which groundwater corrective actions must be completed, stating only that groundwater restoration must occur within a "reasonable" timeframe: "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (US EPA, 2003, 40 CFR 300.430(a)(1)(iii)(F)).

Determining what constitutes a reasonable timeframe depends on a number of highly variable site-specific circumstances, including the construction and operational characteristics of the SI and the site hydrogeology. Examples of site-specific factors that may affect corrective action timeframes are summarized in Table 7.1.

Table 7.1 Factors that May Affect the Duration of Groundwater Corrective Action

Factor	Description
SI Characteristics	
Construction Depth	The depth of the bottom of the SI below ground surface, and the resulting amount of separation between the bottom of the SI and groundwater, may affect the volume of CCR constituent mass that migrates to groundwater and the size of the resulting groundwater plume.
Hydraulic Head in SI	The height of the liquid level in the SI above the constructed bottom of the SI governs the flux of mass into the subsurface.
SI Size/Acreage	SIs with larger footprints can have larger impacts on groundwater quality, requiring a longer time to address *via* corrective action.
Duration of Operation	Time from when CCRs were first sluiced to an SI until sluicing of CCRs to the SI ceased, which may affect the potential extent of groundwater impacts.
Leachate Concentrations of Relevant Constituents	The mass of leached constituent per water volume exiting the SI and entering the environment. Higher leachate concentrations may require longer corrective actions to achieve groundwater protection standards (GWPSs).
Hydrogeologic Characteristics	
Soil Type/Hydraulic Conductivity	Describes the ease with which a fluid travels through a soil, *i.e.*, how quickly groundwater can move and can transport dissolved constituents.
Hydraulic Gradient	The change in hydraulic head over distance is the driving force for groundwater flow. Vertically downward hydraulic gradients can push constituents deeper into the subsurface, complicating corrective actions.
Depth to Groundwater	The distance between the bottom of an SI and groundwater influences how quickly constituents in the SI leachate will contact groundwater.
Soil-Water Partition Coefficient for Relevant Constituents	The constituent concentration that is sorbed to soil particles divided by the concentration that is freely dissolved in groundwater. The tendency of a constituent to stay attached to soil particles rather than being transported as a dissolved species in groundwater determines the constituent's rate of migration relative to groundwater.
Pore Space/Porosity	The percentage of the soil matrix that is filled with air and groundwater influences how quickly constituents move through the subsurface.
Presence of Low-conductivity Lithology Layers that Serve as Secondary Sources	Discrete volumes of lower-hydraulic-conductivity material in the subsurface can extend corrective action times by retaining constituent mass longer than the surrounding soils.

Notes:
CCR = Coal Combustion Residual; SI = Surface Impoundment.

Because each of the above factors vary significantly for different sites, there is no standard timeframe that is considered reasonable for completing a groundwater corrective action. US EPA has acknowledged that there is no standard corrective action timeframe in CERCLA groundwater remediation guidance, defining a reasonable timeframe as follows.

> A reasonable timeframe for restoring groundwater to beneficial use depends on the particular circumstances of the site and the restoration method employed. The most appropriate timeframe generally is determined through an analysis of alternatives. The NCP also specifies that: "For groundwater response actions, the lead agency shall develop a limited number of remedial alternatives that attain site-specific remediation levels within different restoration periods utilizing one or more different technologies." Thus, a comparison of restoration alternatives from most aggressive to passive (i.e., natural attenuation) will provide information concerning the approximate range of time periods needed to attain groundwater cleanup levels. Although restoration timeframe

> is an important consideration, no single time period can be specified which would be considered excessively long for all site conditions. (US EPA, 2011, p. 30)

In the Preamble to the Federal CCR Rule, US EPA again emphasized that it is unable to specify what is a reasonable *versus* an unreasonable timeframe for groundwater corrective actions at CCR SIs, stating that "EPA was truly unable to establish an outer limit on the necessary timeframes—including even a presumptive outer bound" (US EPA, 2015, p. 21419).

Upper bounds on reasonable corrective action timeframes cannot easily be established because most groundwater moves slowly, much slower than most surface water. This means that groundwater remediation takes a long time to achieve GWPSs at all locations in the subsurface. Further, knowledge of the subsurface is typically based on sparse data (*e.g.*, discrete data from borings at a handful of locations), adding uncertainty to the timeline for corrective actions. Because of the lengthy and uncertain durations associated with groundwater corrective actions, it would be inappropriate, and contrary to established federal groundwater remediation programs, to set an arbitrary limit mandating a time by which groundwater corrective actions must be completed for all sites and all SIs.

References

American Road & Transportation Builders Association (ARTBA). 2015. "Production and Use of Coal Combustion Products in the U.S.: Historical Market Analysis." Report to American Coal Ash Association (ACAA). 74p., May. Accessed at https://www.acaa-usa.org/Portals/9/Files/PDFs/ReferenceLibrary/ARTBA-final-historical.compressed.pdf.

Electric Power Research Institute (EPRI). 2016. "Relative Impact Framework Application for a Hypothetical Coal Combustion Residual Surface Impoundment." 3002007544. 304p., May.

Harbaugh, AW. 2005. "MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model — the Ground-Water Flow Process." US Geological Survey (USGS). USGS Techniques and Methods 6-A16. 253p. Accessed at http://pubs.usgs.gov/tm/2005/tm6A16/PDF/TM6A16.pdf.

Illinois Environmental Protection Agency (IEPA). 2013. "Administrative Code: Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter I: Pollution Control Board, Part 620 Groundwater Quality." 60p.

Illinois Environmental Protection Agency (IEPA). 2018. "Title 35: Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Subchapter i: Solid Waste and Special Waste Hauling, Part 811: Standards for New Solid Waste Facilities." 167p.

Illinois Environmental Protection Agency (IEPA). 2020. "Title 35: Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Subchapter J: Coal Combustion Waste Surface Impoundments, Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Draft)." 133p., March.

Schroeder, PR; Lloyd, CM; Zappi, PA; Aziz, NM. 1994. "The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's guide for Version 3." Report to US EPA, Office of Research and Development, National Technical Information Service (NTIS). EPA/600/R-94/168a; NTIS PB95-212692. 103p., September.

Stantec Consulting Services Inc. (Stantec). 2017. Letter from M. Hoy and M. Vaughan [Stantec] to V. Modeer [Dynegy Midwest Generation, LLC] re: Closure options, ash ponds closure, Vermilion Site. 8p., November 27.

US Congress. 2016. "Public Law 114-322: Water Infrastructure Improvements for the Nation Act." PL 114-322; 130 Stat 1628, December 16.

US Court of Appeals, District of Columbia Circuit. 2018. "Opinion [re: Utility Solid Waste Activities Group, *et al. v*. Environmental Protection Agency; Waterkeeper Alliance, *et al*.]." No. 15-1219. 72p., August 21.

US EPA. 1988a. "Solid waste disposal facility criteria (Proposed rule)." *Fed. Reg.* 53(168):33314-33422. 40 CFR 257; 40 CFR 258, August 30.

US EPA. 1988b. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim final)." Office of Emergency and Remedial Response. OSWER Directive 9335.3-01; EPA-540/G-89-004. 186p., October.

US EPA. 1991. "Solid waste disposal facility criteria (Final rule)." *Fed. Reg.* 56(196):50978-51119. 40 CFR 257; 40 CFR 258, October 9.

US EPA. 1996. "The role of cost in the Superfund remedy selection process." Office of Solid Waste and Emergency Response (OSWER). OSWER Directive 9200.3-23FS; EPA 540/F-96/018; NTIS PB96-963245. 8p., September.

US EPA. 2003. "National Oil and Hazardous Substances Pollution Contingency Plan." 40 CFR 300, July 1.

US EPA. 2011. "Groundwater Road Map: Recommended Process for Restoring Contaminated Groundwater at Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9283.1-34. 31p., July. Accessed at http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery. 1237p., December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2015. "Hazardous and solid waste management system; Disposal of coal combustion residuals from electric utilities (Final rule)." *Fed. Reg.* 80(74):21302-21501. 40 CFR 257; 40 CFR 261, April 17.

US EPA. 2019a. "Criteria for municipal solid waste landfills." 40 CFR 258. 53p. Accessed at https://www.govinfo.gov/content/pkg/CFR-2019-title40-vol27/pdf/CFR-2019-title40-vol27-part258.pdf.

US EPA. 2019b. "Criteria for classification of solid waste disposal facilities and practices, Subpart B - Disposal standards for the receipt of Very Small Quantity Generator (VSQG) wastes at non-municipal non-hazardous waste disposal units: Selection of remedy." 40 CFR 257.27. 3p. Accessed at https://www.govinfo.gov/content/pkg/CFR-2019-title40-vol27/pdf/CFR-2019-title40-vol27-sec257-27.pdf.

US EPA. 2020a. "Hazardous and solid waste management system: Disposal of coal combustion residuals from electric utilities; A holistic approach to closure Part A: Deadline to initiate closure (Final rule) (Pre-publication copy)." 40 CFR 257. 190p., July 29. Accessed at https://www.epa.gov/sites/production/files/2020-07/documents/pre_publication_copy_of_ffrl_10013_20_olem_adm_errornoteadded.pdf.

US EPA. 2020b. "Hazardous and solid waste management system: Disposal of CCR; A holistic approach to closure Part B: Alternate demonstration for unlined surface impoundments; Implementation of closure (Proposed rule)." *Fed. Reg.* 85(42):12456-12478. 40 CFR 257, March 3.

Zheng, C; Wang, PP. 1999. "MT3DMSA Modular Three-Dimensional Multispecies Transport Model: Documentation and User's Guide (Release DoD_3.50.A)." Report to US Army Corps of Engineers. 239p., November. Accessed at http://www.geology.wisc.edu/~andy/g727/mt3dmanual.pdf.

Appendix A

Curriculum Vitae of Andrew B. Bittner, M.Eng., P.E.

GRADIENT

Andrew B. Bittner, M.Eng., P.E.
Principal
abittner@gradientcorp.com

Areas of Expertise

Contaminant fate and transport in porous and fractured media, migration of coal ash combustion products in groundwater and surface water, non-aqueous phase liquid (NAPL) transport, surface water and groundwater hydrology, groundwater and surface water modeling, remedial investigation design, remedy evaluation and optimization, cost allocation, South American regulatory compliance and remediation.

Education & Certifications

M.Eng., Environmental Engineering and Water Resources, Massachusetts Institute of Technology, 2000

B.S.E., Environmental Engineering, University of Michigan, 1997

B.S., Physics, University of Michigan, 1997

Licensed Professional Engineer: Idaho, New Hampshire

Professional Experience

2000 – Present GRADIENT, Boston, MA
Environmental Engineer. Specializes in the fate and transport of contaminants in groundwater and surface water, coal combustion products, groundwater hydrology, groundwater flow and contaminant transport modeling, NAPL transport, and remedial investigation and design. Has served as principle-in-charge, testifying expert, and consulting expert on large, multi-disciplinary projects at coal combustion product surface impoundments and landfills, pharmaceutical facilities, automotive facilities, manufacturing plants, dry cleaning facilities, and Superfund sites. Extensive experience in South America and other international sites.

1997 – 1999 PARSONS ENGINEERING SCIENCE, Canton, MA
Environmental Engineer. Specialized in industrial wastewater treatability. On-site supervisor for bioremediation bench scale treatment and laboratory study for a major pharmaceutical company. Built hydraulic models for pharmaceutical wastewater treatment facilities. Designed hazardous waste treatment systems for a major pharmaceutical company. Performed site investigations to delineate NAPL plumes and design remedial recovery plans.

Professional Affiliations

National Ground Water Association; Chi Epsilon – Environmental Engineering Honor Society

Technical Session Chair:

- World of Coal Ash Conference. Lexington, KY. May 8-11, 2017. Session title: "Groundwater."
- Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palm Springs, CA. May 23-26, 2016. Session title: "Coal Ash Facility Restoration".
- Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterey, CA. May 21-24, 2012. Session title: "Environmental Remediation in Emerging Markets."
- Defense Research Institute. Panelist for session titled "Groundwater-Surface Water Connectivity and the Clean Water Act." New Orleans, LA. May 13-14, 2019.
- World of Coal Ash Conference. St. Louis, MO. May 13-16, 2019. Session title: "Project-Specific Case Studies."

Projects – *Coal Combustion Products*

Electric Power Research Institute: Evaluated the performance of alternative liners, including engineered clay liners, natural clay liners, and geomembrane composite-lined systems at CCP impoundments. Used a probabilistic approach to model the flux of CCP constituents through each liner and the subsequent transport of constituents through the underlying vadose and saturated zone.

Industry Research Group: Developed methodology to evaluate performance equivalency of various surface impoundment liner systems. The methodology, which was submitted to US EPA in order to inform future rulemakings, presented a process to evaluate and compare hydraulic flux and travel times through different liner systems including geocomposite, compacted clay, and natural clay liners.

Confidential Client: Developed a screening level risk assessment for a manufacturing facility beneficially using coal fly ash as a soil stabilizer. The risk assessment compared estimated coal ash constituent exposure concentrations in soil, groundwater, and surface water to relevant benchmarks protective of human health and the environment.

Manufacturing Client: Performed beneficial use risk assessments consistent with US EPA Federal Coal Combustion Residual (CCR) Rule and Secondary Use Guidance for multiple commercial and construction products containing coal ash – including carpet backing, interior and exterior trim, and backer board. Analysis evaluated risks to groundwater, surface water, indoor air, and soil. Evaluation also considered exposure pathways for residents, construction workers, and landfill workers associated with installation of products, active life of the installed products, and post-life disposal in a landfill.

Electric Power Research Institute: Developed framework for creating alternative groundwater standards at CCP storage sites. The framework considers the development of alternative standards for the protection of human health and the environment, current and future uses of groundwater near CCP management units, and potential attenuation that may occur between the current point of compliance and a relevant point of exposure.

Utility Client: Prepared expert report related to the fate and transport of metal constituents in groundwater, including barium, boron, and arsenic, from multiple coal combustion residual surface impoundments.

Industry Research Group: Prepared technical comments regarding proposal to add boron to list of Appendix IV constituents to the Federal CCR Rule. Evaluated technical practicability and cost implications associated with the potential boron addition.

Industry Research Group: Prepared technical comments regarding portion of Federal CCR Rule that requires the groundwater protection standard (GWPS) of Appendix IV constituents with no MCL to be the background concentration. Evaluated technical practicability, cost implications, and potential benefits associated with the requirement for the four current Appendix IV constituents with no established MCL - cobalt, lithium, molybdenum, and lead.

Confidential Client: Developed a screening level risk assessment for a steel production and recycling facility that is beneficially using coal fly ash as a soil stabilizer. The risk assessment addressed a requirement in the Federal Coal Combustion Residuals (CCR) Disposal Rule for a characterization of risk from unencapsulated beneficial use of CCR. Used the Industrial Waste Evaluation Model (IWEM) to evaluate potential transport of coal ash constituents, including arsenic, in groundwater as a result of the beneficial reuse.

Utility Client: Prepared expert report interpreting data produced during a field investigation performed at a large Midwestern coal ash landfill.

Utility Client: For litigation support, modeled the fate and transport of arsenic and other coal ash related constituents in groundwater and surface water downgradient of a large Midwestern coal ash surface impoundment located in a karst environment. Model simulations compared potential impacts to groundwater and surface water resulting from potential surface impoundment closure scenarios.

Manufacturing Client: Performed beneficial use risk assessments consistent with US EPA Federal Coal Combustion Residual (CCR) Rule and Secondary Use Guidance for multiple commercial and construction products containing coal ash. Analysis evaluated risks to groundwater, surface water, indoor air, worker safety, and residential safety. Evaluation also considered exposure pathways associated with installation of products, active life of the installed products, and post-life disposal in a landfill. Used the Industrial Waste Evaluation Model (IWEM) to evaluate potential transport of coal ash constituents, including arsenic, in groundwater as a result of the beneficial reuse.

Industry Research Group: Developed a groundwater fate and transport model to evaluate the level of groundwater protection provided by various coal ash surface impoundment closure options, including closure in place and closure by removal. Model simulated transport of arsenic (III) and arsenic (V) in groundwater downgradient of coal ash disposal facilities. Model results are being used by utilities in support of closure planning which is required by Federal Coal Combustion Residual Rule.

Confidential Client: Prepared expert report on human health and ecological risks due to a potential spill of barged coal combustion byproducts (CCBs) on a large Midwestern river. Modeled the fate and transport of key CCB constituents, including arsenic, in surface water for a range of spill scenarios and river flow conditions and estimated potential downstream concentrations at drinking water intake locations.

Industry Research Group: Evaluated technical approach used by United States Environmental Protection Agency (US EPA) to simulate the migration of arsenic, selenium, and other metals in groundwater from overlying coal combustion storage units. Model analyses were included in regulatory comments submitted in response to US EPA's 2010 Coal Combustion Product Risk Assessment.

Industry Research Group: Developed relative risk framework to assess impacts to groundwater associated coal combustion product (CCP) surface impoundment closure scenarios. Framework identified potential deterministic and probabilistic modeling approaches to simulate potential migration of CCP constituents, including arsenic, boron, selenium, and molybdenum through the vadose and saturated zones for each closure alternative.

Industry Research Group: Modeled the downward migration of leachate from unlined coal combustion product surface impoundments using a probabilistic framework for a wide range of climatic and site conditions. Model results provided estimated durations for interactions between the impoundment leachate and nearby surface and groundwater.

Industry Research Group: As part of a relative risk framework, performed detailed sensitivity analysis of all factors associated with a coal ash surface impoundment closure that may impact the fate and transport of constituents in groundwater. Factors analyzed included surface impoundment characteristics (*e.g.*, volume, depth, and leachate quality), hydrogeological conditions (*e.g.*, hydraulic conductivity, hydraulic gradient, soil type, depth to groundwater, and surface water proximity), climatic characteristics (*e.g.*, precipitation), and closure details (*e.g.*, closure type and duration).

Projects – *Fate & Transport and Modeling*

Natural Gas Processing Facility: Prepared an expert report evaluating the hydrogeological conditions at and downgradient of a natural gas processing plant and provided assessment of the fate and transport over time of light non-aqueous phase liquids (LNAPLs) released from the plant and associated pipelines.

Confidential Client, Rhode Island: Designed and calibrated a groundwater flow and solute transport model at a Northeastern Superfund Site. Used one year long tracer test to calibrate model. Model was used to predict the future effectiveness of various remedial alternatives.

Confidential Client: Designed and calibrated a groundwater flow and solute transport model for a Superfund site that has groundwater impacted with volatile organic compounds including benzene, tetrachloroethylene, trichloroethylene, and vinyl chloride. The model was used successfully to present the case to US EPA for shutting down the source remedy.

Confidential Client, Brazil: Developed 3-D numerical groundwater and solute transport model using MODFLOW and MT3D for volatile organic compounds and pesticides. Used model to evaluate and design remediation alternatives. Managed multiple site investigation and characterization studies. Projects involved calculation of risks to human health from exposure to soils, groundwater, indoor air, and outdoor air.

Savage Well Superfund Site: For a potentially responsible party (PRP) group, managed the development of a 3-D numerical groundwater and solute transport model for tetrachloroethylene (PCE) at a Superfund site in New Hampshire. Calibrated the model using approximately 10 years of data with review and oversight by US EPA and United States Geological Survey (USGS). Designed an optimization algorithm to develop the optimal groundwater pump and treat system.

Confidential Client, Massachusetts: Developed a 2-D contaminant transport model for PCE to demonstrate that contaminant contribution from a dry cleaning operation to the town water supply wells was insignificant compared to contribution from other potential sources. Managed the installation and operation of a pump and treat system at the Site.

Confidential Client, Argentina: Developed a 2-D numerical groundwater and solute transport model using MODFLOW and MT3D. Used the calibrated model to design a hydraulic barrier system to control off-site migration.

Confidential Client: Performed site-specific vapor intrusion modeling using the Johnson-Ettinger model at a pharmaceutical facility. Performed a detailed sensitivity analysis for each model input parameter.

Confidential Client: Performed NAPL transport and travel time calculations through porous media vadose and saturated zones and clay confining layers.

Confidential Client: Wrote critique of US EPA geochemistry model.

Projects – *Remediation*

Confidential Client, Brazil: Designed and implemented nano-scale zero valent iron remedy to prevent off-site arsenic migration. Upon completion of remedy, negotiated site closure with state of Rio de Janeiro environmental agency.

Confidential Client, Brazil: Designed and implemented a pilot scale enhanced *in-situ* bioremediation remedy for groundwater impacted with chlorinated organic compounds at a former agricultural product manufacturing facility.

Confidential Client, New Hampshire: As an independent third party, performed a review of a proposed Electrical Resistive Heating remedy for a chlorinated solvent dense non-aqueous phase liquid (DNAPL) source zone.

Confidential Client, New York: Provided regulatory comments regarding a US EPA Proposed Remedial Action Plan at a Region II Superfund Site.

Confidential Client, New Jersey: Provided regulatory comments regarding a US EPA Proposed National Priorities List (NPL) listing at a Region II Superfund Site.

Confidential Client, Brazil: Managed multiple conceptual and detailed engineering remedial design projects for a soil vapor extraction system, dual-phase extraction system, and a pump and treat system. Remediation efforts focused on soil and groundwater contamination by pesticides and chlorinated solvents.

Confidential Client, Brazil: Managed site remediation projects to operate and maintain a soil vapor extraction system, dual-phase extraction system, and a hydraulic barrier system.

Confidential Client, Argentina: Managed conceptual and detailed engineering remedial design project for dual-phase extraction system focused on the remediation of volatile organic compounds in soil and groundwater.

Confidential Client: On-site supervisor for bioreactor bench scale study at a pharmaceutical wastewater treatment plant. Performed an in-depth investigation on the bio-inhibitory effects due to the chronic exposure of biomass to manganese. Performed laboratory work required to support the bioreactors including tests for mixed liquor volatile suspended solids (MLVSS), total suspended solids (TSS), chemical oxygen demand (COD), dissolved oxygen (DO), ammonia (NH_3), and respirometry.

Confidential Client: Lead environmental engineer for a belt filter press replacement project for a pharmaceutical company wastewater treatment plant. Designed and sized polymer addition system.

Projects – *Site Characterization*

Confidential Client, Brazil: Provided strategic oversight for a series of environmental investigations, remedial actions, and agency negotiations for an automotive facility located in São Paolo.

Confidential Client: Managed large-scale cost allocation at a Midwestern Superfund site. Forensically evaluated the sources of tar to river sediments considering site industrial operational history, contaminant fate and transport, chemistry, site modification and filling history, and observed contaminant patterns. Calculated the mass of tar present in the environment using both visual observations and analytical data.

Confidential Client, Brazil: Managed large-scale site investigations and human health risk assessment projects at a former pharmaceutical facility located in São Paulo. Key compounds were petroleum hydrocarbons and volatile organic compounds.

Confidential Client, New York: Served as consulting expert for large cost allocation involving over 16 responsible parties and chlorinated organic groundwater plumes extending for nearly 2 miles. Evaluated lateral and vertical groundwater flow direction, chemical usage history, and groundwater chemistry to support a *de minimis* contribution argument for our client.

Confidential Client, Ohio: Served as consulting expert for cost allocation project at a Midwestern landfill. Evaluated differences in toxicity and risk associated with municipal solid waste and industrial hazardous waste. Used data to devise risk-weighted allocation approach for remedy costs.

Confidential Client, Brazil: Managed site investigation to evaluate groundwater responses due to seasonal precipitation events and their effect on potential contaminant fate & transport.

Confidential Client: Managed site investigation project identifying sources of PCE present at a former electrical resistor manufacturing facility. Soil, groundwater, and soil gas data were evaluated and used to identify individual sources of PCE to the subsurface. The impact of each source on remediation costs related to the site was evaluated and successfully used as a tool to mediate between responsible parties. Served as consulting expert during mediation between responsible parties.

Confidential Client, New Jersey: Delineated NAPL plumes and investigated spill history, sewer maps, and gas chromatography fingerprint results at East Coast Superfund Site. Designed French Drain to recover NAPL from subsurface.

City of Pittsfield, Massachusetts: Technical consultant to the city for mediation between General Electric (GE) and governmental agencies. Evaluated reports and clean-up standards, and attended mediation sessions on behalf of the city.

Projects – *Clean Water Act*

Municipal Client, Ohio: Consulting expert for significant nexus evaluation to determine whether wetlands and surface water tributaries are jurisdictional waters of the United States.

Publications/Presentations

Briggs, N; Lewis, AS; Bittner, AB. 2020. "Evaluating Climate Change Impacts on CCP Surface Impoundments and Landfills." Presented at the World of Coal Ash (WOCA) Conference, St. Louis, Missouri, May 16.

Bittner, AB; Lewis, AS. 2020. "Beneficial use assessment of building materials containing CCPs." *Gradient Trends: Risk Science and Application* 77 (Winter):3,5.

Bittner, AB; Spak, MS; Cox, WS. 2019. "Carving out the Contours: The Clean Water Act and the Migration of Affected Groundwater to Waters of the United States." *For the Defense* 61(6):55-59.

Bittner, A. Lewis, A. 2019. "CCP Beneficial Use Risk Assessment: Case Studies for Three Different Applications." Presented at the World of Coal Ash (WOCA) Conference, St. Louis, Missouri, May 14.

Lewis, A. Bittner, A. 2019. "Risk Based Considerations for Establishing Alternative Groundwater Standards at Coal Combustion Product Sites." Presented at the World of Coal Ash (WOCA) Conference, St. Louis, Missouri, May 15.

Lewis, AS; Bittner, A. 2018. "Risk-Based Approaches for Establishing Alternative Standards at Coal Combustion Sites." Presented at the World of Coal Ash (WOCA) Ponded Ash Workshop, Louisville, Kentucky, October 30-31.

Lewis, AS; Bittner, A. 2017. "The Relative Impact Framework for Evaluating Coal Combustion Residual Surface Impoundment Closure Options: Application and Lessons Learned." *Coal Combustion and Gasification Products (CCGP)* 9:1-3.

Lewis, AS; Dube, EM; Bittner, A. 2017. "Key role of leachate data in evaluating CCP beneficial use." *ASH at Work* 1:32-34.

Lewis, AS; Bittner, AB; Lemay, JC. 2017. "Achieving Groundwater Protection Standards for Appendix IV Constituents: The Problem with Using Background Concentrations in the Absence of Maximum Contaminant Levels (MCLs)." Presented at the 2017 World of Coal Ash Conference (WOCA), Lexington, KY, May 8-11.

Bittner, A. 2017. "Evaluation of Groundwater Protectiveness of Potential Surface Impoundment Closure Options." Presented at the American Coal Ash Association's 7th Annual World of Coal Ash Conference, Lexington, KY, May 11.

Lewis, A; Bittner A; Radloff, K; Hensel, B. 2017. "Storage of coal combustion products in the United States: Perspectives on potential human health and environmental risks." In *Coal Combustion Products (CCPs): Characteristics, Utilization and Beneficiation, 1st Edition*. Woodhead Publishing, May 2.

Bittner, AB; Kondziolka, JM; Lewis, A; Hensel, B; Ladwig, K. 2016. "Groundwater Assessment Framework for Evaluating the Relative Impacts of Coal Ash Surface Impoundment Closure Options." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26.

Bittner, AB; Kondziolka, JM; Sharma, M; Nangeroni, P; McGrath, R. 2016. "Using Tracer Test Data to Calibrate a Groundwater Flow and Solute Transport Model." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26.

Bittner, A. 2016. "A Retrospective Look at Remediation in the State of Rio de Janeiro, Brazil: And What Lessons We Can Apply to Remediation Projects in Other Emerging International Markets." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26. 17p.

Bittner, A. 2016. "The Federal CCR Rule and How it is Impacting Coal Ash Disposal." Presented at Battelle's Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Palm Springs, CA, May 22-26. 17p.

Bittner, A. 2016. "Coal Ash Beneficial Reuse Assessment Consistent with Requirements of the 2015 Federal CCR Rule." Presented at EUCI's Sixth Annual Coal Combustion Residuals and Effluent Limitation Guidelines Conference, Charlotte, NC, March 30-31. 30p.

Herman, K; Flewelling, S; Bittner, AB; Tymchak, M; Swamy, M. 2015. "Alternate Endpoints for Remediating NAPL-Impacted Sites." Presented at the EPRI/AWMA Env-Vision Conference, Crystal City, VA, May 14.

Lewis, A; Bittner, AB; Herman, K; Dubé, E; Long, C; Hensel, B; Ladwig, K. 2015. "Framework for Evaluating Relative Impacts for Surface Impoundment Closure Options." Presented at the 2015 World of Coal Ash Conference, Nashville, TN, May 8.

Bittner, AB. Lewis, A; Herman, K; Dubé, E; Long, CM; Kondziolka, K, Hensel, B; Ladwig, K. 2015 "Groundwater Assessment Framework to Evaluate Relative Impacts of Surface Impoundment Closure Options." Presented at the 2015 World of Coal Ash Conference, Nashville, TN, May 7.

Bittner, AB. 2014. "Evolving environmental regulations in Brazil." *Gradient Trends: Risk Science and Application* 59 (Winter):4.

Bittner, AB. 2013. "Modeling Mass Discharge from the Source Zone." Presented at Second International Symposium on Bioremediation and Sustainable Environmental Technologies, Jacksonville, FL, June 11.

Bittner, AB. 2013. "Successful Implementation of a Risk-based Remedial Solution in Brazil." Presented at the 2013 NGWA Groundwater Summit, San Antonio, TX, April 28.

Bittner, AB. 2013. "Evolving methods for evaluating vapor intrusion." *Gradient Trends: Risk Science and Application* 57(Spring): 4.

Esakkiperumal, C; Bittner, A. 2013. "Use of Mass-Flux Based Approach to Optimize the Design of a Hydraulic Containment System." Presented at the 2013 NGWA Groundwater Summit, San Antonio, TX, April 28.

Bittner, A. 2010. "A Weight-of-Evidence Approach to Assess NAPL Mobility." Presented at the 7th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 27.

Herman, K; Bittner, A. 2010. "How Much Tar is In the Mud? – Reducing Uncertainty in Characterizing the Distribution and Mass of DNAPL in Sediments." Presented at the EPRI MGP 2010 Symposium, January 28.

Bittner, AB. 2009. "Is your NAPL mobile?" *Gradient Trends: Risk Science & Application* 45(Spring):3.

Herman, K; Bittner, A. 2008. "Reducing Uncertainty in DNAPL Characterization." Presented at the 24th Annual International Conference on Soils, Sediments, and Water, October 23.

Bittner, AB; Baffrey, RN; Esakkiperumal, C. 2006. "Using Sediment Transport Modeling to Support Environmental Forensic PCB Analyses." Presented at Society of Environmental Toxicology and Chemistry Conference, Montreal, Canada, November 8.

Bittner, AB. 2006. "Groundwater and Air Modeling Used to Support Forensic Analyses." Presented at the Gradient Breakfast Seminar Titled: Forensic Chemistry – The Intersection of Science and Law, May 16.

Bittner, AB. 2006. "M&A emerging issues and requirements." *Gradient Trends: Risk Science & Application* 36(Spring):4.

Sharma, M; Saba, T; Bittner, A. 2003. "Optimization of Groundwater Pump and Treat Systems." Presented at the 19th Annual International Conference on Contaminated Soil, Sediments and Water, Amherst, MA, October 23.

Sharma, M; Saba, T; Bittner, A. 2003. "Optimization of Groundwater Pump and Treat Systems Using Numerical Modeling and the Monte Carlo Approach." Presented at the National Ground Water Association Mid-South Focus Conference, Nashville, TN, September 19.

Bittner, AB; Halsey, P; Khayyat, A; Luu, K; Maag, B; Sagara, J; Wolfe, A. 2002. "Drinking water quality assessment and point-of-use treatment in Nepal." *Civil Eng. Practice* 17:5-24.

Bittner, AB. 2000. "Drinking Water Quality Assessment in Nepal: Nitrates and Ammonia [Thesis]." Submitted to Massachusetts Institute of Technology.

Testimony 6:

Mark Rokoff

Pre-filed Testimony of Mark D. Rokoff, PE

Proposed Illinois Administrative Code Title 35, Subtitle G, Chapter I, Subchapter j, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments

Prepared by

Mark D. Rokoff, PE

AECOM
1300 E. 9th Street, Suite 500
Cleveland, OH 44114

Prepared for
Schiff Hardin LLP
233 South Wacker Drive, Suite 7100
Chicago, IL 60606

August 27, 2020

Table of Contents

1. Executive Summary 4
  1.1 Opinion 1 - Closure in Place is Common 4
  1.2 Opinion 2 – Size Influences Closure Method 4
  1.3 Opinion 3 – Trigger Mechanisms do not Influence Closure Method 4
  1.4 Opinion 4 – External Factors Significantly Influence Closure Method 4
  1.5 Opinion 5 – The Proposed Illinois Rule is More Stringent that the Federal Rule 5
  1.6 Opinion 6 – The Timelines Proposed are Inadequate and Potentially Unattainable 5
2. Introduction 6
  2.1 Scope and Objectives 6
  2.2 Report Structure 6
  2.3 Qualifications 6
  2.4 Basis of My Testimony 7
3. Background 8
  3.1 Summary Background Section 8
  3.2 Surface Impoundment Closure Units and Characteristics 8
  3.3 Closure of CCR Units and Associated Data Sources 9
4. Opinions 11
  4.1 Opinion 1 - An Assessment of CCR Impoundment Closure Method Disclosures Reveals Most Have or Are Closing in Place. Across the Country, Closure in Place is Common and Certainly Not the Outlier 11
    4.1.1 Overall Summary of Planned CCR Unit Closures 11
    4.1.2 CCR Unit Closures by Impoundment Count 12
    4.1.3 CCR Unit Closures by Impoundment Surface Area 13
    4.1.4 CCR Unit Closures by Impoundment Volume 14
  4.2 Opinion 2 - Size or Volume of the Impoundment Typically Drives Closure Decision 15
    4.2.1 CCR Unit Closures by Count 15
  4.3 Opinion 3 - Trigger Mechanism for Closure is not a Driver for Closure Approach 16
    4.3.1 Influence of Trigger Mechanism for Cause 16
    4.3.2 Owner/Operators Not Selecting Closure by Removal for Ponds near the Aquifer with Groundwater Exceedances 18
  4.4 Opinion 4 - Outside Factors (e.g., Rate Recovery, Beneficial Use) are a Significant Driver for Closure Approach 20
    4.4.1 Opportunity for Cost Recovery 20
    4.4.2 Beneficial Use Considerations 24
  4.5 Opinion 5 - Many Aspects of the Proposed Illinois Rule are More Stringent Than the Federal Rule and Several Key Differences Will Influence Closure Decision Outcomes 25
  4.6 Opinion 6 – The Timetables for the Construction Permit Application Provided in Section 845.700, when Coupled with the Closure Alternatives and Public Participation Process Defined in the Proposed Illinois Rule, will Seek to Constrain the Process Leading to an Inadequate and Potentially Unattainable Closure Design Timeline 29
Appendix A Mark D. Rokoff Curriculum Vitae 32
Appendix B Summary of Ash Mart and Data Sources 37

Figures

Figure 3.1: Map of Surface Impoundments in the US 9
Figure 4.1: Impoundment Closure Method (% Based on Number)........ 12
Figure 4.2: Impoundment Closure Method (% Based on Area)........ 13
Figure 4.3: Impoundment Closure Method (% Based on Volume) 14
Figure 4.4: Closure Method per CCR Surface Impoundment Count in the US – By Unit Size 15
Figure 4.5: Impoundments Not Meeting Aquifer Separation and Having SSLs (% Based on Count) 18
Figure 4.6: Impoundments Not Meeting Aquifer Separation and Having SSLs (% Based on Volume) 18
Figure 4.7: Map of Regulated and Deregulated Electricity Markets 20
Figure 4.8: Impoundments Closure Method in Regulated States (% Based on Volume) 21
Figure 4.9: Impoundments Closure Method in Deregulated States (% Based on Volume) 22
Figure 4.10: Impoundments Closure Method in Regulated Sites (% Based on Volume)........ 23
Figure 4.11: Impoundments Closure Method in Non-Regulated Sites (% Based on Volume) 23
Figure 4.12: Summary of Closure Categories under Section 845.700 29

Tables

Table 1.1: Summary of Closure by Removal (%) in the US........ 4
Table 3.1. Surface Impoundment Statistics in the US 8
Table 4.1: Surface Impoundment Closure Method Summary Statistics in the US 11
Table 4.2: Summary of Closure by Removal (%) in the US........ 14
Table 4.3: Summary of US Units Triggering Closure 17

1. Executive Summary

As an expert in the field of Coal Combustion Residual ("CCR") management, I have been retained to provide testimony related to CCR surface impoundment closure methods, metrics and decisions. This testimony is a combination of my industry experience working with dozens of owner/operators of CCR impoundments and the "Ash Mart" data visualization tool developed jointly by FirmoGraphs and AECOM. Ash Mart is a compilation of public website data from various documents required to be posted under the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. Federal Register, v.80, no. 74, April 17, 2015 and subsequent amendments (Federal CCR Rule). This data supplemented by my direct experience has led me to several opinions, which I summarize below and then present in more detail throughout this document.

1.1 Opinion 1 - Closure in Place is Common

Regardless of the ways the data is evaluated and irrespective of the parameter by which the information is compared, closure in place is the dominant method of closure in the industry today. Therefore, closure in place (an appropriate means of closure per the Federal CCR Rule) is not an outlier. Rather, closure in place is owners/operators preferred method, as indicated in **Table 1.1** below. This table represents this fact through the three primary metrics of surface impoundments – count (or number of ponds), area (or final cover area), and volume (or volume of CCR within the pond).

Table 1.1: Summary of Closure Method (%) in the US

	% of US Surface Impoundments based on Count, Area and Volume		
	Count (units)	Area (acres)	Volume (CY)
Closure in Place	51%	76%	83%
Closure by Removal	47%	24%	17%

1.2 Opinion 2 – Size (Surface Area and Volume) Influences Closure Method

Surface impoundment size (surface area and volume) is the primary driver in closure decision-making. As pond size increases, so does the likelihood that a surface impoundment will close in place. Unless there is an external factor driving the closure decision, mid-sized and large ponds typically close in place.

1.3 Opinion 3 – Trigger Mechanisms Do Not Influence Closure Method

The Federal CCR Rule defines certain conditions under which a surface impoundment would be required to close. These conditions are called "triggers," as they trigger closure. The different triggers result in different closure timeframes but there is no observable trend indicating that different triggers lead to one closure method being used over another. More specifically, closure in place is widely adopted and a suitable means of closure, regardless of the "closure trigger" causing closure.

1.4 Opinion 4 – External Factors Significantly Influence Closure Method

The opportunity for a regulated utility to apply for rate recovery significantly impacts the chosen closure method, and closure by removal is rarely selected when there is no ability to recover costs. In fact, only 1% of the CCR material associated with non-regulated generators is expected to close by removal. Other external factors such as the opportunity to beneficially use the ash also impacts the closure method selection (e.g. an opportunity to beneficiallty use the ash would result in a greater likelihood that an owner/operator would choose closure by removal). These external factors are often not observed in isolation, and therefore there is a compounding effect.

1.5 Opinion 5 – The Proposed Illinois Rule is More Stringent that the Federal Rule

The closure alternatives evaluation in Section 845.710 of the proposed Illinois Environmental Protection Agency (IEPA) *Proposed Part 845 Rulemaking of the Illinois Administrative Code (Title 35, Subtitle G, Chapter I, Subchapter j)* ("Part 845") applies standards not included in the Federal CCR Rule and that will constrain closure decision outcomes. In addition, the provisions of Part 845 as interpreted by IEPA potentially regulate a significantly larger number of surface impoundments than regulated under the Federal CCR Rule.

1.6 Opinion 6 – The Timelines Proposed are Inadequate and Potentially Unattainable

The construction permit application timeline in Section 845.700 of the proposed Illinois Rule could constrain the closure process when coupled with the closure alternatives and public participation process. Constraining this process could potentially lead to either inadequate or potentially unattainable closure design timelines.

The above six opinions (as supported by industry data) are the basis of my testimony.

2. Introduction

2.1 Scope and Objectives

I have been retained as an employee of AECOM Technical Services, Inc. (AECOM) to provide testimony on behalf of Dynergy Midwest Generation, LLC; Kincaid Generation, LLC; Illinois Power Resources Generating Company; Illinois Power Generating Company; and Electric Energy Inc. related to the Illinois Environmental Protection Agency (IEPA) *Proposed Part 845 Rulemaking of the Illinois Administrative Code (Title 35, Subtitle G, Chapter I, Subchapter j)* ("Part 845"). Part 845 establishes standards and requirements associated with the design, construction, operation, closure, and post-closure care of CCR surface impoundments. Specifically, my opinions are focused on surface impoundment closure decisions as supported by industry data.

The opinions in this testimony are based upon my experience and data compiled from disclosures required by *40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. Federal Register, v.80, no. 74, April 17, 2015* and subsequent amendments ("Federal CCR Rule"). This data is compiled by FirmoGraphs and AECOM in the Ash Mart data visualization tool.

2.2 Report Structure

I have structured this testimony document as follows:

- Section 1 provides an executive summary of my opinions;
- Section 2 provides introductory material;
- Section 3 provides background related to the data used to support my opinions; and
- Section 4 provides a discussion of each of my opinions along with supporting data.

2.3 Qualifications

My name is Mark Rokoff and I am a Senior Vice President the AECOM serving as the director for power services for the environmental business line in the Americas as well as the national lead for AECOM's CCR management practice. I have served as an executive lead on numerous programs where I have supported project teams with strategic guidance; aided with problem solving; aligned project teams with the expectations and understanding of risk of key stakeholders; established, maintained, and deepened relationships with utility clients; implemented measures to improve consistency, quality and efficiency among project teams; and developed and monitored critical success factors for project and solution delivery. As a partner to AECOM's clients, I have helped to deliver on their core values while integrating with management to best align the project work products. As a subject matter expert on coal ash management, I have performed and been involved with geotechnical, civil, and geo-environmental engineering designs as well as construction related programs/projects through the full life-cycle of multi-disciplinary permitting and remediation projects (e.g. CCR management). In these programs and projects, I have developed expertise in the design and application of CCR management solutions including regulatory compliance in an evolving industry, innovative approaches and answers to site and design challenges, complimentary services in water and groundwater management as well as conveyance systems, and overall expertise in the development and operation of disposal and beneficial use facilities. More recently, and in conjunction with the coal ash rule changes, I have conducted regulatory review and evaluation of best practices as well as strategic planning for potential regulatory changes to operations and management. I am a frequent speaker on this subject and a recognized expert in this field.

2.4 Basis of My Testimony

The foundation of my testimony is a combination of my industry experience, as outlined in my abbreviated Curriculum Vitae (CV) in **Appendix A**, and CCR management industry data compiled within the “Ash Mart” data visualization tool. Simply stated, the Federal CCR Rule prescribes that specific information be posted to a publicly available website. In knowing what information will be made available, where it will be recorded, and when it is scheduled to be posted, the data can be mined and combined in a robust database tool. This tool is referred to herein as Ash Mart, and a summary of Ash Mart and its data sources are provided within **Appendix B**. Some background information for this testimony also comes from the FirmoGraphs’ Power Mart database, which is based on data from public sources such as the US Energy Information Administration (EIA). For example, plant regulatory status (utility vs. wholesale) information comes from the EIA.

3. Background

3.1 Summary Background Section

The purpose of this section is to provide an overview of the CCR units (i.e., surface impoundments) regulated by the Federal CCR Rule, to explain the basis for data used in this testimony, discuss terminology, and present considerations related to the data used in this testimony. As the themes, terms, and considerations addressed in this section are discussed throughout my testimony, this section is intended to provide context such that these items do not need to be repeated and redefined regularly throughout my testimony. Further, because my testimony focuses on items and factors influencing closure decisions as supported by associated closure-related data obtained from Ash Mart, this section does not provide a comprehensive discussion of CCR units and their history, design and operation, but rather focuses on those factors and considerations affecting and influencing the method of closure. As landfills are not regulated under the proposed Part 845, landfills are not discussed within this testimony and the data presented is obtained solely from surface impoundment disclosures.

Certain terms I repeatedly use in this testimony, such as surface impoundment, CCR unit, closure by removal, closure in place, groundwater protection standard, etc., are defined by the Federal CCR Rule (for the purposes of the scope of this testimony, the Part 845 definitions are the same or similar to those of the Federal CCR Rule). Additional information on Ash Mart development, the data sources incorporated within the model, and the validation and update measures performed to enhance data reliability is provided in **Appendix B**.

3.2 Surface Impoundment Closure Units and Characteristics

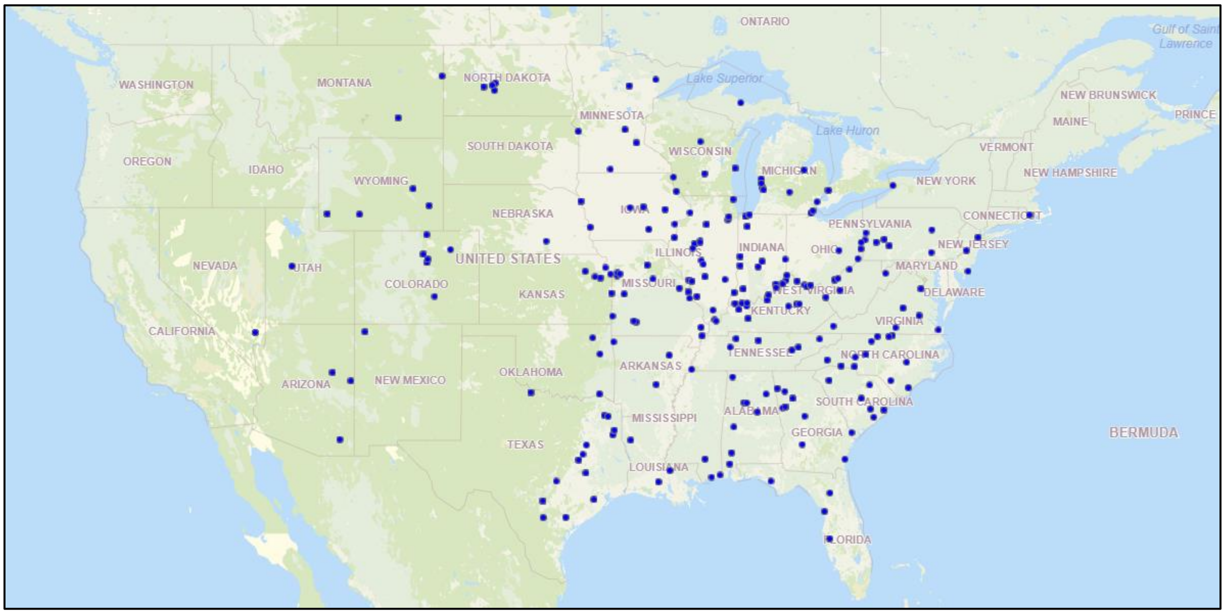
Prior to presenting the opinions, which create the foundation of my testimony, I will provide an overview of the number, size, and geometry of the US CCR surface impoundments that are currently regulated by the Federal CCR Rule. **Table 3.1** below summarizes surface impoundments within the US that are regulated under the Federal CCR Rule.

Table 3.1. Surface Impoundment Statistics in the US

Total CCR Surface Impoundments	Approximate Total CCR Volume (CY)	Approximate Total Final Cover Area (acres)
503	973,825,000	22,590

In summary, there are 503 US surface impoundments currently regulated under the Federal CCR Rule. This number tends to change slightly from year to year as new units are constructed. These 503 units currently contain an approximate total volume of 973.8 million cubic yards (MCY) of CCR material and comprise an aggregate total area of approximately 22,590 acres (based on Federal CCR Rule Closure Plan filings). Note cubic yard or CY is a measure of volume equal to a cube one yard long on each side. As shown on Figure 3.1 below, these units are distributed throughout the US and are more concentrated in the Midwest and Southeast, as these regions have historically been the primary locations of coal fueled generating stations (note that multiple CCR units may be located at a single site or dot in the figure).

Figure 3.1: Map of Surface Impoundments in the US



3.3 Closure of CCR Units and Associated Data Sources

The Federal CCR Rule provides for two methods of closure as described by 40 CFR § 257.102, which are defined as "*closure through removal of CCR*" (referenced in my testimony as closure by removal) and "*closure by leaving CCR in-place*" (referenced as closure in place). The Federal CCR Rule does not mandate one method or the other and does not provide criteria for the selection of one closure method over another. Rather, the Federal CCR Rule provides performance standards for each closure method that need to be met and certified by a qualified registered professional engineer. The owner/operator can select *either* closure method meeting the performance standards based on *any* criteria it chooses. I discuss these concepts throughout my testimony.

The understanding of surface impoundment closure approaches and other size and closure-related information represented by the aggregated data presented in this testimony is based primarily on several publicly available data sources:

1. Location restriction demonstrations required under the Federal CCR Rule, which have been posted to websites (40 CFR §§ 257.60-64).
2. Structural stability assessments for surface impoundments required under the Federal CCR Rule, which have been posted to websites (40 CFR § 257.73(d)).
3. Safety factor assessments for surface impoundments required under the Federal CCR Rule, which have been posted to websites (40 CFR § 257.73(e)).
4. Annual inspection reports for surface impoundments required by the Federal CCR Rule, which have been posted to websites (40 CFR § 257.83(b)).
5. Closure plans required under the Federal CCR Rule, which have been posted to websites (40 CFR § 257.102 (b)).
6. Posted notices of intent to complete closure required by the Federal CCR Rule, which have been posted to websites (40 CFR § 257.102(g)).
7. Closure completion notices required by the Federal CCR Rule posted to websites (40 CFR § 257.102(f)).
8. Non-Federal CCR Rule elements – This can include publicly available data such as US Energy Information annual reporting, news reports, and press releases.

A few clarifications regarding data presented in this testimony should also be noted:

1. While AECOM is working on approximately 25% of the regulated CCR units within the US, the database used for this testimony is based solely on publicly available sources and includes all units in the US regulated by the Federal CCR Rule. AECOM is bound by non-disclosure agreements on many of our projects, and this project-specific information is wholly excluded from Ash Mart and my testimony.
2. A number of the approximately 500 written closure plans involve implementation of hybrid closures. Hybrid closures generally consist of consolidation of CCR materials from within the limits of a given unit with the goal of minimizing the final cover footprint and/or facilitating drainage. A final cover system is then placed over the consolidated footprint such that part of the area is a removal and the other part is closure in place. For the purposes of closure approach discussed in this testimony, these hybrid closures have been tagged as closure in place as the CCR material remains onsite and within the unit limits. In scenarios where closure involves removal of the majority of CCR material from within the surface impoundment limits (and placed in a landfill or beneficially used), but some amount of material remains onsite due to removal complications (e.g., material below an existing landfill, etc.), these units have been considered to be closed by removal.
3. The surface impoundment material volumes have been determined based on a “best available estimate” approach. In general, data from the most recent annual inspection report (typically 2019) represents the best available data. In some cases, this is not available and data from the closure plan is used. Unit area data follows a similar approach. Where this data is not available in either the inspection or closure report, it has been estimated using Google Earth.
4. Similar to the above items, a small number of closure plans do not specifically state the closure method—either closure in place or closure by removal. In general, these units are described as “not specified” in the tables and graphs provided in this testimony. Not specified units are outliers, representing eight of the total 503 surface impoundments.
5. In some cases, we know from public disclosures that a surface impoundment is required to close by removal based on agency or public disclosures even though the closure plan has not been updated to reflect this announcement. In these cases, and to provide the most accurate representation of closure metrics, the method of closure has been adjusted within the database to reflect the closure method announced in public disclosures.
6. The Ash Mart data is based on public disclosures and is continually changing as information becomes available. Therefore, the data presented in my testimony is believed accurate based on current documents and the applied analytics. However, this testimony represents a snapshot in time as the data is continually evolving. The data contained herein is accurate as of the most recent Ash Mart data update (July 7, 2020).

4. Opinions

4.1 Opinion 1 - An Assessment of CCR Impoundment Closure Method Disclosures Reveals Most Have or Are Closing in Place. Across the Country, Closure in Place is Common and Certainly Not the Outlier

My opinion, based on a review of data sources, is that closure in place is the most common method for closure of CCR surface impoundments across the US; it is not an outlier. In this section, I will back up this opinion through a review and evaluation of available surface impoundment closure data.

As I will discuss in detail in Opinion 5, closure in place is considered an "equally protective" closure method when implemented properly and compliant with the Federal CCR Rule closure standards. In fact, as stated in the Federal CCR Rule Preamble (Preamble page 21412), both methods of closure (closure in place and closure by removal) "*can be equally protective, provided they are conducted properly*." The EPA also indicated on this same page of the Preamble that they considered closure in place to be the default method of closure, stating that most facilities will not excavate their units *"…given the expense and difficulty of such an operation*." Finally, the EPA affirmatively stated in this Preamble that "*they did not propose to require [closure by removal] nor establish restrictions on the situation in which [closure by removal] would be appropriate*" (Preamble page 21412). A review of the information on the CCR websites confirms that closure in place is indeed the most commonly selected method.

4.1.1 Overall Summary of Planned CCR Unit Closures

My testimony considers CCR surface impoundments throughout the US regulated under the Federal CCR Rule that have disclosed their closure method in either closure plans or through notices of intent to close. In this scenario, notices of intent to close have governed if there is a difference between these two disclosures, as it is more affirmative and indicative of intent than the closure plans, which are updated regularly.

Table 4.1 below summarizes the number of all regulated nationwide CCR surface impoundments and indicates the disclosed closure method of each impoundment. As the below table indicates, "not specified" units represent only 8 of the total 503 regulated US surface impoundments.

Table 4.1: Surface Impoundment Closure Method Summary Statistics in the US

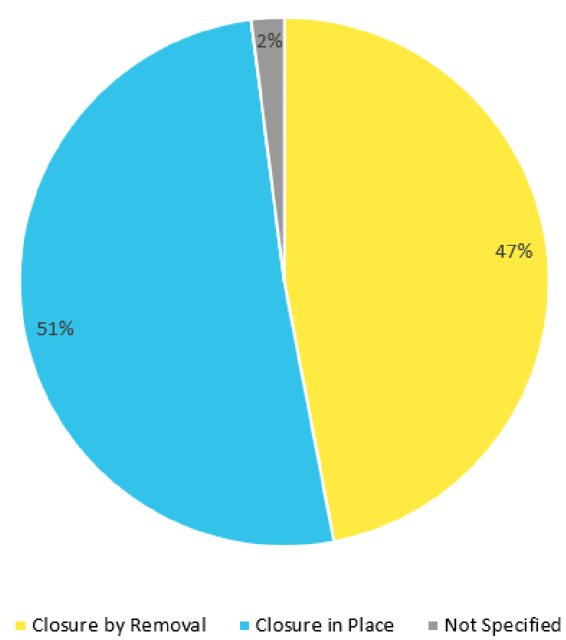
Closure Method	Units	Final Cover Area (acres)	CCR Volume (CY)
Total	503	22,590	973,825,000
Closure by Removal	236	5,300	170,348,000
Closure in Place	259	17,245	803,125,000
Not Specified	8	39	352,000

This table provides an overall summary of closure method, and the data is further assessed in the sections below. To truly capture the industry's closure method selections, it is important to acknowledge that not all ponds are sized the same or contain the same volume of CCRs. For this reason, assessing the approach to closure based on count (number of CCR units), area (final cover area), and volume (volume of CCRs within the unit) each confirm that closure in place is the most commonly selected method.

4.1.2 CCR Unit Closures by Impoundment Count

The following pie chart shows the closure method for impoundments by the percentage of the total number slated for closure by each method. In the pie charts below, yellow represents closure by removal, blue represents closure in place, and grey represents units that have not specified a closure method documented on owners/operators CCR websites. This statistic does not consider the size of the surface impoundments and treats all surface impoundments the same regardless if 1 acre or 1,000 acres. Note that, based on a pure count (or number of ponds), 51% of US surface impoundments regulated under the Federal CCR Rule plan to close in place.

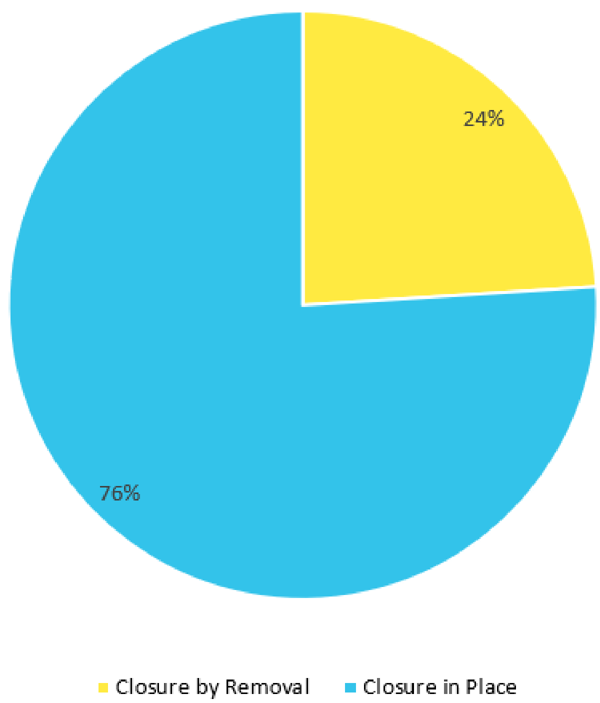
Figure 4.1: Impoundment Closure Method (% Based on Number)



4.1.3 CCR Unit Closures by Impoundment Surface Area

The next pie chart (**Figure 4.2**) shows the total aggregate surface area of surface impoundments being closed in place versus closed by removal. From this chart, we see that 76% of cumulative surface area for all the regulated US CCR surface impoundments are being closed in place, a large increase over the 51% determined based on count (above). The reason for the variance between the first chart and this one presented below is that the size of the pond matters rather than normalizing all ponds to a single value for the unit. This conclusion supports the trend that larger surface impoundments are typically closed in place, while smaller surface impoundments are the ones favored for closure by removal, a factor explored further in Opinion 2.

Figure 4.2: Impoundment Closure Method (% Based on Area)

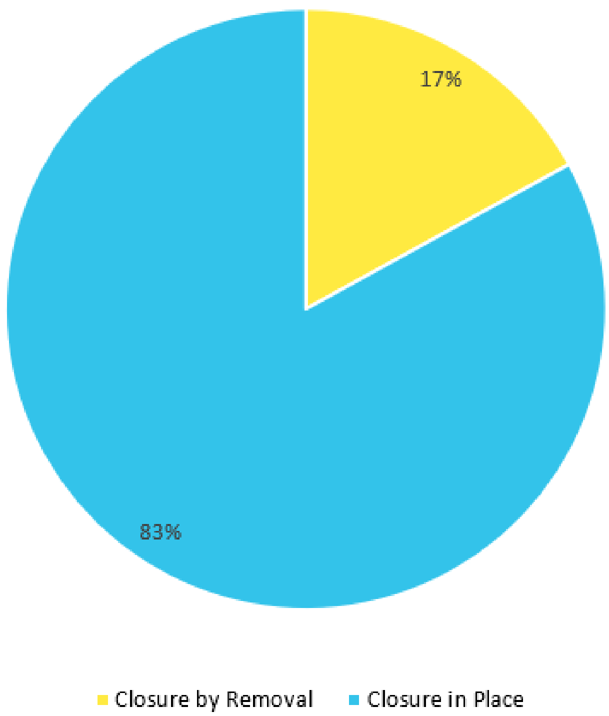


4.1.4 CCR Unit Closures by Impoundment Volume

As I continue to assess the impact of size, it is worth noting that the first comparison assumes all ponds contain an equal amount of CCR. So, to consider the true influence of size on the selection of closure method, the volume of CCR within the pond is the best representation because it truly characterizes the size of the unit.

The following pie chart (**Figure 4.3**) shows the total volume of material being closed in place versus closed by removal. More than 83% of CCR material in surface impoundments plans to close in place. This approach (evaluation by volume) best represents the direct impact volume has on the closure decision. This phenomenon is evaluated further as part of Opinion 2.

Figure 4.3: Impoundment Closure Method (% Based on Volume)



In conclusion, regardless of the ways the data is evaluated and irrespective of the parameter by which the information is compared, closure in place is the dominant method of closure. Therefore, closure in place (an appropriate means of closure as established by the Federal CCR Rule) is not an outlier; it is the preferred closure method by owners/operators as summarized in the below **Table 4.2**.

Table 4.2: Summary of Closure by Removal (%) in the US

	% of US Surface Impoundments based on Count, Area and Volume		
	Count	Area (acres)	Volume (CY)
Closure in Place	51%	76%	83%
Closure by Removal	47%	24%	17%

4.2 Opinion 2 - Size or Volume of the Impoundment Typically Drives Closure Decision

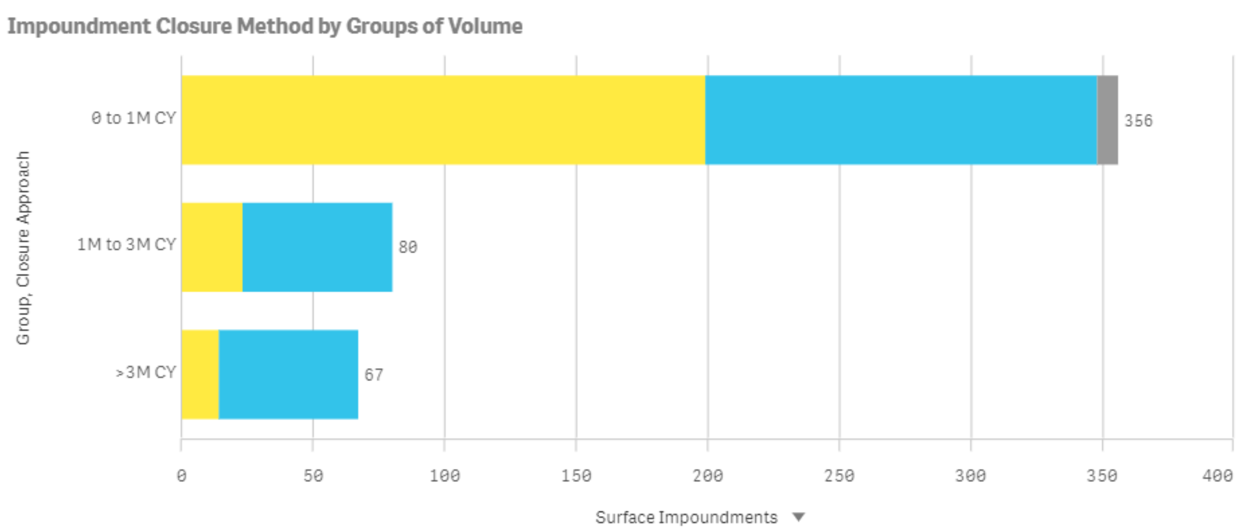
Based on my experience in the CCR management industry and the available data, it is my opinion that unit size or volume, by far, tends to be the most significant driver of closure method decisions. In general, closure by removal favors a small pond with less than 1 MCY of ash (often located near a larger pond where the CCR material may be relocated) or a pond with a larger footprint (area) that contains notably less material than the capacity will allow.

4.2.1 CCR Unit Closures by Count

Given all the data from the CCR websites, I have calculated the average volume of CCR within a surface impoundment to be approximately 2 MCY. For this reason, I have set this to be a key middle threshold within the next series of charts. I have divided surface impoundments into three subcategories to differentiate what I will refer to as small ponds (volume of CCR less than 1 MCY), mid-sized ponds (volume between 1 and 3 MCY), and large ponds (volume greater than 3 MCY).

Now that I have established representative size thresholds, I will discuss selected closure methods based on unit size. In the bar chart below (Figure 4.4), yellow again represents closure by removal, blue represents closure in place, and grey represents units that have not specified a closure method that has been documented on owner/operators CCR website. Again, these "non-specified" units only represent eight units within the US.

Figure 4.4: Closure Method per CCR Surface Impoundment Count in the US – By Unit Size



This bar chart shows that, for units less than 1 MCY, the number of units planning for closure by removal slightly exceeds those that will likely close in place while the remaining ponds did not disclose the approach within the small pond band. However, looking at the next group of 1 to 3 MCY, very few units are planning to close by removal as compared to those identified to close in place. Even fewer in the third category over 3 MCY are planning to close by removal, and each of these are each affected by some significant external factor (i.e., regulatory directive, lawsuit settlement, beneficial use opportunity, etc.).

The very small numbers of large volume CCR units closing by removal is consistent with the factors associated with implementation of these projects. CCR removal from large ponds are significant projects that take many years to implement, making it challenging to comply with the completion timelines established by the Federal CCR Rule. This is true even when applying the maximum closure extensions provided in 40 CFR § 257.102. In addition, implementation of these large excavation projects creates other environmental problems, safety challenges, and community impacts. These projects typically involve complex dewatering and the hauling of hundreds of thousands of truckloads of CCR material to a landfill. Landfill permitting and development alone can often take several years to implement before excavation of the surface impoundment can start. When considering all these factors, it is not surprising that these large closure by removal projects typically cost in the hundreds of millions of dollars to implement. This is consistent with EPA's preamble statements that most ponds would not be expected to close by removal given the "*expense and difficulty of such an operation*" (Federal CCR Rule Preamble page 21412).

In conclusion, size is the primary driver in closure decision-making. Smaller ponds are more likely to close via closure by removal, but as pond size increases, so does the likelihood that a surface impoundment will close in place Unless there is an external factor driving the closure decision, most mid-size (those between 1 – 2 MCY in volume) and large ponds (those over 3 MCY in volume) close in place.

4.3 Opinion 3 - Trigger Mechanism for Closure is not a Driver for Closure Approach

The Federal CCR Rule not only provides criteria for the safe design and operation for a CCR unit, it also provides the requirements for when the unit must close. These closure triggers consist of the following, with the last three often referred to as triggers for cause:

- End of unit life [40 CFR § 257.102(e)]
- Safety factor assessment [40 CFR § 257.73(h)]
- Groundwater impacts [40 CFR § 257.95]
- Location restrictions [40 CFR §§ 257.60 to 64]

Location restrictions comprise five individual location-based criteria (1) placement above the uppermost aquifer, (2) wetlands, (3) fault areas, (4) seismic impact zones, and (5) unstable areas.

If a unit cannot affirmatively establish compliance with each of these criteria, closure of the unit is triggered under the provisions and timetables established in the Federal CCR Rule. While these triggers significantly affect the timing of surface impoundment closure, there is not a significant correlation between triggers and closure approach. In fact, there is no clear or significant trend that indicates selection of one closure method over another for a given trigger mechanism, and the Federal CCR Rule does not prescribe a closure method, recognizing that simply triggering closure does not mean that closure by removal is necessary. The data indicates that closure in place is the preferred method of closure for units triggering closure and the closure method breakdown generally follows the averages for all US surface impoundments.

4.3.1 Influence of Trigger Mechanism for Cause

As we consider the influence of trigger mechanisms on closure method, it is important to first establish the population of regulated ponds that have triggered closure based on cause. Based on Ash Mart data, the below table (**Table 4.3**) provides a summary of this information as well as closure method both based on unit count and volume.

Table 4.3: Summary of US Units Triggering Closure

Trigger for Closure for Cause	Count	Percentage Based on Count			Approximate Volume	Percentage Based on Volume		
	Ponds that Triggered (#)	Ponds that Triggered (%)	CIP (%)	CbR (%)	Ponds that Triggered (CY)	Ponds that Triggered (%)	CIP (%)	CbR (%)
Safety Factor Assessment	11	2%	73%	27%	9,430,000	1%	78%	22%
Location restrictions (wetlands, seismic zones, unstable areas, faults)	32	6%	34%	66%	91,890,000	9%	28%	72%
Location restrictions (aquifer separation)	177	35%	50%	48%	654,620,000	67%	79%	21%
Groundwater Impacts	219	44%	55%	44%	662,780,000	68%	78%	22%
Combined for all Triggers*	318	63%	53%	46%	785,040,000	81%	79%	21%

* = Since a pond could result in more than one trigger for cause, the combination is not a direct summation of the above; Note that six CCR units have not specified a method of closure in the documentation on their corresponding CCR websites. These units are not included in the data set.

In reviewing the data, two important foundational elements are necessary to consider. First, the Federal CCR Rule does not prescribe the method of closure for CCR impoundments that trigger closure for cause. Rather, the Federal CCR Rule still provides the opportunity for a triggering CCR unit to close in place or by removal, provided it meets the performance standards set forth in the Federal CCR Rule. And second, owners/operators also did not immediately jump to the conclusion that triggering closure for cause means that their impoundments need to close by removal. Many are confident that closure in place is an appropriate solution and the data from the CCR websites supports this.

From the table above, we note that very few units (only 11 out of the total population of 503 units) triggered closure based on the results of the safety factor assessment. In summary, almost all the 503 units (98%) were stable in 2016 and not subject to failure under the safety factor criteria provided in the Federal CCR Rule. And of those that did fail this category, the majority elected to close in place.

Further, it should be noted that while a significant number of location restriction failures occurred, the majority of these are associated with the aquifer separation criteria rather than with units failing the wetland criteria or being problematically located within fault areas, unstable areas, or seismic impact zones. Again, this indicates that approximately one third of the units could not satisfy the aquifer separation requirement under the Federal CCR Rule due to their proximity to aquifer systems. However, again, these units more commonly have selected closure in place both based on count and volume.

Finally, it should also be noted that, while a notable number of units impact groundwater above the established groundwater protection standards (generally drinking water standards or background), this represents a minority of sites (approximately 44% of the overall population of CCR units) and more than half of these units will comply with the Federal CCR Rule by selecting to close in place. Again, this is true for both count and volume.

In summary, if we look at the totality of units triggering closure for cause, we see that the closure method based on count (53% closure in place/46% closure by removal) and volume (79% closure in place/21% closure by removal) generally mirrors the closure method breakdown for the overall population of US units presented in **Table 4.2.**

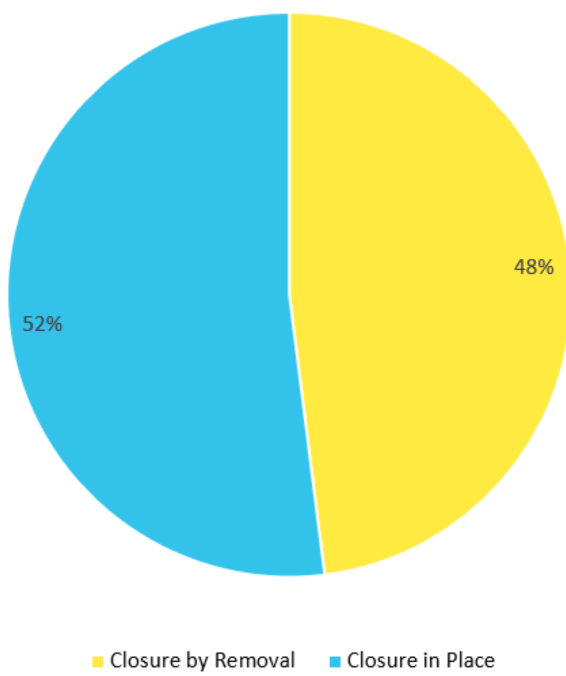
4.3.2 Owner/Operators Not Selecting Closure by Removal for Ponds near the Aquifer with Groundwater Exceedances

In addition to the assessments presented in Section 4.3.1 above, it is also worth focusing on the convergence of two of the triggers—location restriction due to the placement above the uppermost aquifer and groundwater exceedances.

Where a pond has an exceedance of Federal CCR Rule groundwater protection standards (GWPS) and fails to satisfy the location restriction for aquifer separation, closure is required (if the unit is unlined). However, while EPA had the opportunity to prescribe a particular closure method, it did not do so.

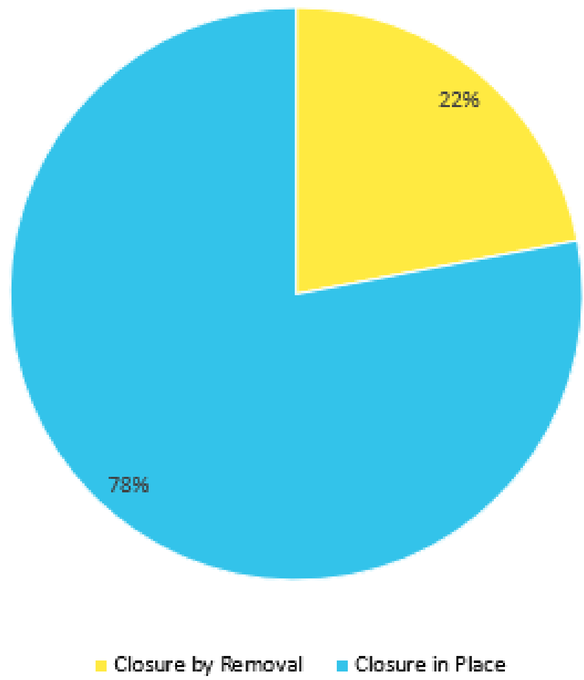
In these instances, and in the absence of an EPA prescription, closure by removal is not the most frequent occurrence, as **Figure 4.5** below indicates. Data from CCR websites shows that 118 CCR units fall into this category of triggering closure for both groundwater quality and the aquifer separation location restriction. Of these 118 sites, closure by removal was chosen for 48% of the sites and closure in place was chosen for the remaining 52%. Simply stated, there is no trend that closure by removal is more frequently selected in these circumstances. This suggests that the closure decision is being driven by factors unrelated to groundwater quality and proximity to uppermost aquifer.

Figure 4.5: Impoundments Not Meeting Aquifer Separation and Having SSLs (% Based on Count)



If we look at the same population of sites, except this time by percent volume, the results are even more telling. Of these 118 sites, **Figure 4.6** below indicates closure in place was chosen for 78% of the CCR volume within these units and closure by removal was chosen for the remaining 22%. Simply stated, there is no trend that closure by removal is more frequently selected in these circumstances. This suggests that the closure decision is being driven by factors unrelated to groundwater quality and proximity to uppermost aquifer.

Figure 4.6: Impoundments Not Meeting Aquifer Separation and Having SSLs (% Based on Volume)



In conclusion, in full compliance with the Federal CCR Rule, ponds that triggered closure because they could not satisfy the groundwater separation requirement and reported an exceedance of a groundwater protection standard are split between closure in place and closure by removal. It is clear that closure in place has been widely accepted and employed as a suitable and compliant approach.

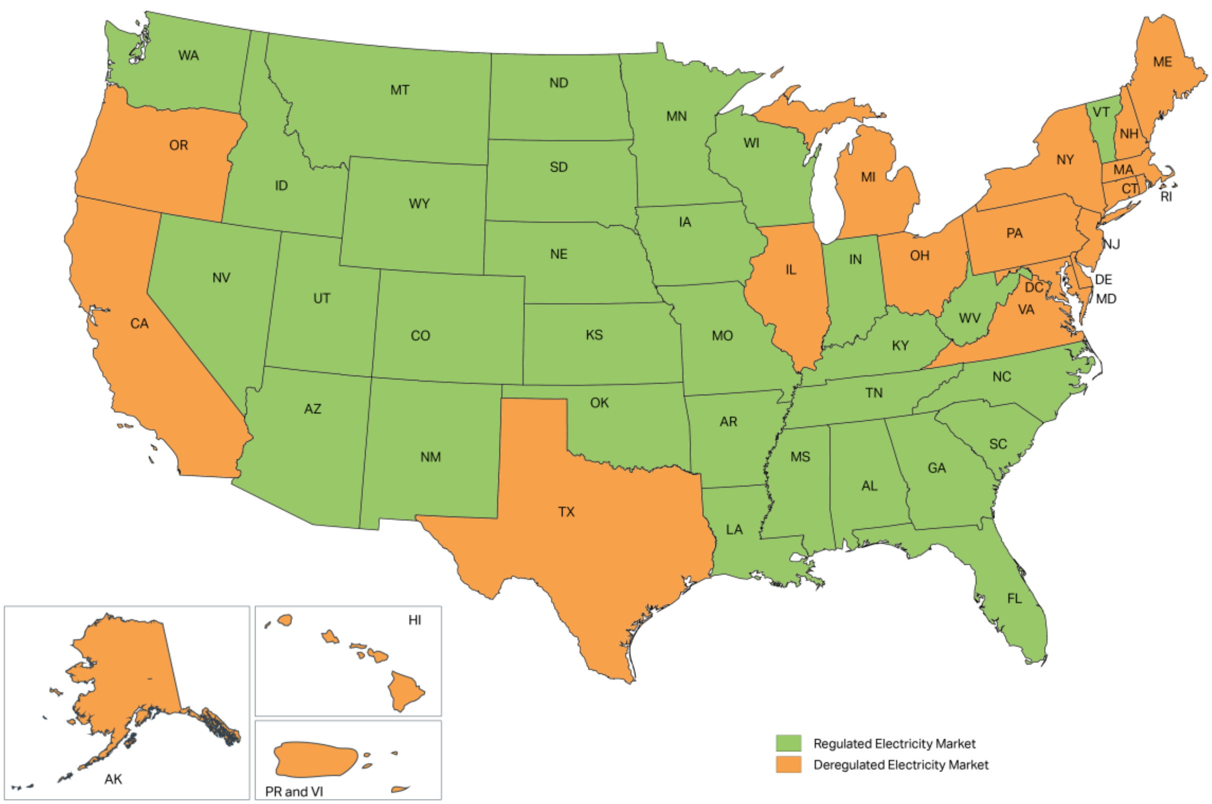
4.4 Opinion 4 - Outside Factors (e.g., Rate Recovery, Beneficial Use) are a Significant Driver for Closure Approach

As discussed in Opinion 1 above and as further discussed in Opinion 5 below, the Federal CCR Rule established two closure methods, both considered *"equally protective,"* and allows owners/operators to select the closure method for a given CCR unit. In spite of this, my opinion is that outside factors (most commonly rate recovery and the opportunity for beneficial use of the CCR) can also drive closure approach decisions. This is especially true for larger units that decide on closure by removal. In this section of my testimony, I present these typical scenarios and supporting data for instances where these two external key drivers, rate recovery and beneficial use opportunities, affect the closure decision process.

4.4.1 Opportunity for Cost Recovery

The ability to pursue and obtain cost (or "rate") recovery is a significant factor driving final closure method decisions. Electricity generation and distribution is regulated at the state level and there are significant differences and regulatory nuances from state to state regarding the application of these state regulations. As illustrated in **Figure 4.7** below, different states across the US have either regulated or deregulated electricity markets. In regulated electricity markets, the cost of electricity is regulated by the state Public Utility Commission (PUC) and utilities often can apply for rate recovery to cover the cost of environmental remediation, such as that mandated by regulation, as well as other necessary capital costs. Conversely, electricity generators in deregulated states often do not have a rate recovery option, as the markets are more open to market forces.

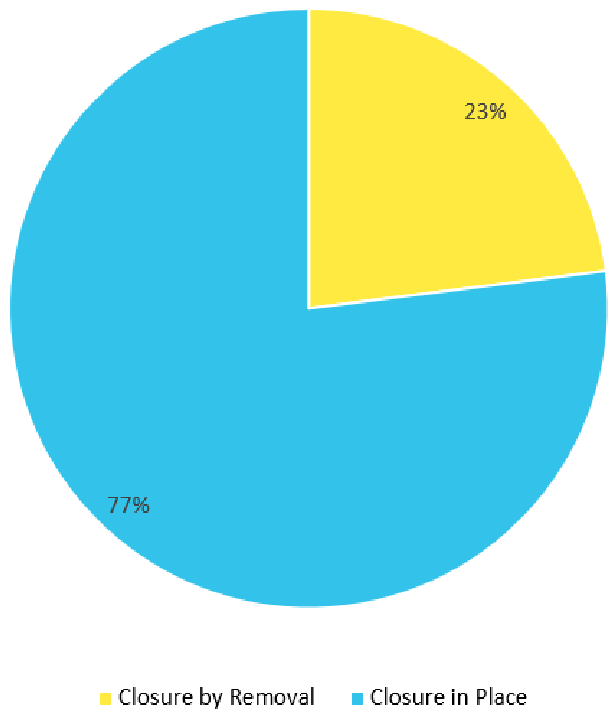
Figure 4.7: Map of Regulated and Deregulated Electricity Markets



For this evaluation, I have grouped states with regulated electricity markets and those with deregulated electricity markets (such as Illinois) and will evaluate closure method based on this breakdown.

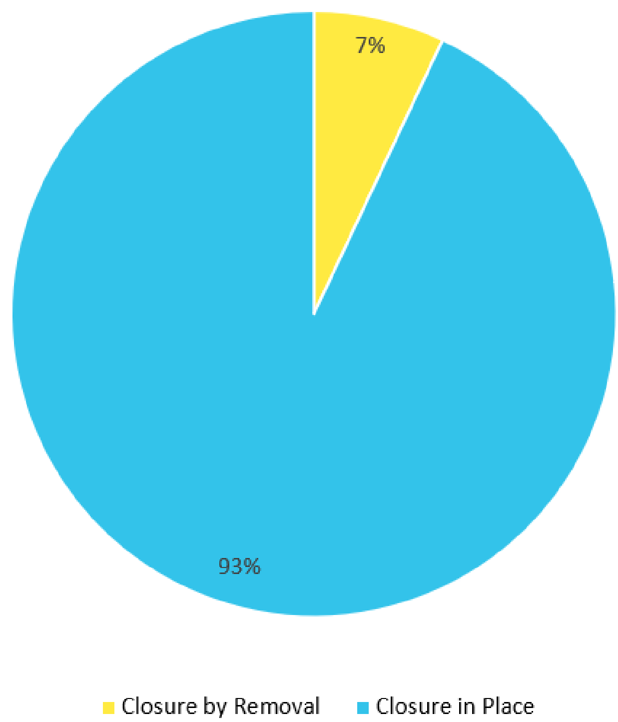
The data confirms that the ability to recover the cost of environmental remediation through rate recovery has a direct impact on the closure method chosen, as illustrated by the figures below. **Figure 4.8** shows the closure method breakdown by CCR volume (as a percent of total CCR volume) located in states with regulated electricity markets, where there is higher potential for cost recovery. In these states, the graph below indicates that 23% of the overall CCR volume in these states has been determined to close by removal based on Federal CCR Rule website disclosures.

Figure 4.8: Impoundments Closure Method in Regulated States (% Based on Volume)



By contrast, **Figure 4.9** illustrates the closure method breakdown by CCR volume (as a percent of total CCR volume) for units located in states with deregulated electricity markets. This pie chart indicates that in deregulated states, approximately 7% of material (by volume) has been determined to be closed by removal. Comparing **Figure 4.8** and **Figure 4.9** clearly shows that the percentage of total volume closing by removal is significantly higher in states with regulated electricity markets than in states with deregulated electricity markets.

Figure 4.9: Impoundments Closure Method in Deregulated States (% Based on Volume)



While looking at data in this manner (by regulated vs deregulated state) is certainly a worthy effort and strong indicator, there are limitations to this methodology as regulated states also include non-regulated sites. Therefore, in addition to looking at the percentage of total volume of units closing by removal versus closing in place on a state regulatory level, it can also be evaluated from a site regulatory level (considering utility vs wholesale). Electricity generators are required to submit an annual form to the EIA, EIA Form 860, in which they self-report whether they are regulated or non-regulated (i.e., wholesale generation facility or independent power producers (IPP)). Power producers who are regulated can be classified as “utilities” for my purpose, while power producers who are non-regulated can be classified as “wholesale” or “IPPs”. Looking at rate recovery on a site-by-site basis is more accurate than looking at it on a state-by-state basis because looking just at the state level does not capture the granularity of the different types of power producers and their ability to apply for rate recovery, which can vary significantly between states.

Drilling down to the site level shows an even more pronounced trend. **Figure 4.10** below shows the closure method breakdown by percent total volume for sites who report that they are regulated. This breakdown indicates that approximately 23% of CCR material (by volume) will be associated with closure by removal.

Figure 4.10: Impoundments Closure Method in Regulated Sites (% Based on Volume)

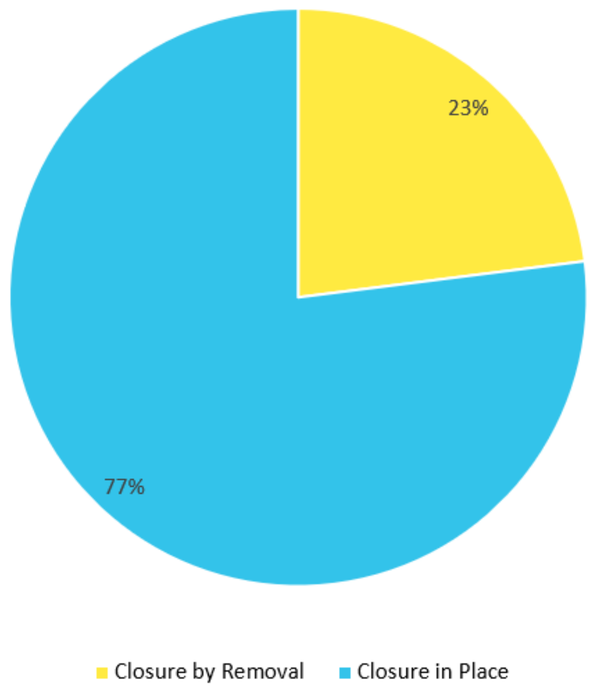
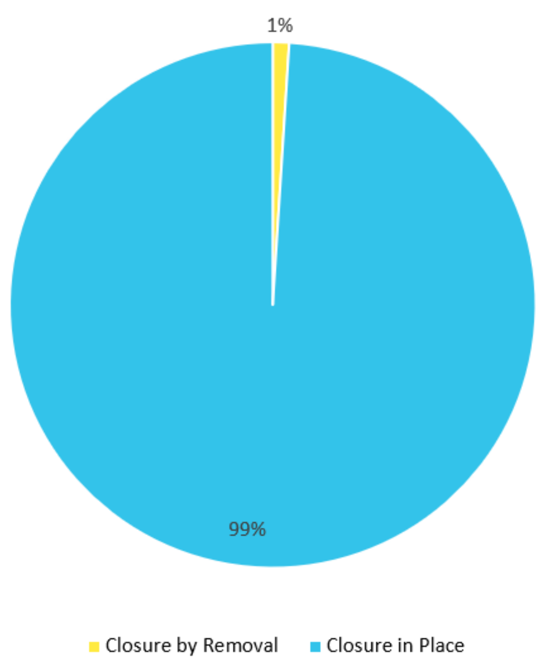


Figure 4.11 below shows the same closure method breakdown by percent total volume for sites who report that they are non-regulated. Only 1% of the CCR material associated with non-regulated or “wholesale” generators is expected to close by removal. By comparing **Figure 4.10** and **Figure 4.11**, the percentage of total volume closing by removal is much larger for sites that report being regulated than for sites that report being non-regulated. In short, closure by removal is rarely selected at a non-regulated site.

Figure 4.11: Impoundments Closure Method in Non-Regulated Sites (% Based on Volume)



In summary, the ability of electricity generators to apply for and obtain rate recovery directly and profoundly influences closure decision on both a regulated state and regulated site level. Closure by removal is rarely selected when there is no ability to recover costs.

4.4.2 Beneficial Use Considerations

In addition to the ability for cost recovery, the opportunity for beneficial use also has a direct effect on the closure approach decision. I discuss this direct effect in this section.

Numerous EPA publications, including the Federal CCR Rule, provide that beneficial use of CCR is an effective and environmentally friendly solution for managing coal ash under the right circumstances by creating a market for CCR potentially offsetting closure by removal's high costs and/or leading to a higher level of stakeholder consensus regarding closure decisions. When there is a market for coal ash, CCR is transformed from a waste material to a desired commodity, used in construction materials such as cement, concrete, or wallboard. For example, many cement kilns across the country use coal ash as an additive to produce cement. While it would be ideal if all the ponded CCR across the country could be beneficially used, however, there is often limited or no viable or economic beneficial use opportunities within a given region.

To have a viable beneficial use scenario, four primary factors need to align: (1) a market demand for the material, (2) proximity of the beneficial use facility to the source of CCR, (3) the economics of dewatering ponded coal ash and transporting the ash to the beneficial user, and (4) the desirability and consistency of the chemical characteristics and physical properties of the ash.

Based on public disclosures, the following are a few examples of regulated CCR impoundments where the material is currently or will be beneficially used:

- **Santee Cooper in South Carolina** – Santee Cooper's Winyah is using a process referred to as Staged Turbulent Air Reactor (STAR) technology "to transform coal ash from surface impoundments or ponds into a high quality, sustainable product for the concrete industry". STAR plants generate ash with desirable material characteristics, making it easier to find beneficial users that can utilize the material as it is readily usable in Portland cement.[1]
- **Duke Energy in North Carolina** – Recycling of ash is planned at the Buck, H.F. Lee and Weatherspoon facilities in North Carolina.[2]
- **Vectren Corporation in Indiana** – Vectren announced in August 2019 that it would be excavating coal ash from its A.B. Brown surface impoundment in Indiana and recycling it for beneficial reuse (CenterPoint Energy, 2019).[3]
- **Dominion Energy in Virginia** – The state of Virginia passed legislation in January 2019 that requires Dominion Energy to excavate all coal ash at their plants in Virginia and to recycle at least 25% of that ash. The surface impoundments at the Bremo, Chesterfield, Possum Point and Chesapeake facilities have been influenced by this legislative directive.[4]

There are many other examples, but the surface impoundments identified above are all very large units that will be closing by removal and beneficially using a significant portion of the removed material.

[1] SEFA, 2020 - "STAR Plants." SEFA. Accessed April 30, 2020. https://www.sefagroup.com/services/star-technology/star-plants/

[2] https://www.duke-energy.com/our-company/about-us/power-plants/ash-management/our-progress

[3] CenterPoint, 2019 - "Vectren Finalizes Plan for Beneficial Reuse for Coal Ash Pond Excavation and Recycling." CenterPoint Energy. Published August 14, 2019. https://investors.centerpointenergy.com/news-releases/news-release-details/vectren-finalizes-plan-beneficial-reuse-coal-ash-pond-excavation

[4] Morehouse, 2019 - Morehouse, Catherine. "Virginia Governor Approves Law Requiring Dominion to Excavate All Coal Ash." Utility Dive. Updated March 21, 2019. https://www.utilitydive.com/news/virginia-governor-passes-law-requiring-dominion-to-excavate-all-coal-ash/546815/

In conclusion, the ability for rate recovery and beneficial use opportunities play a significant role in an owner/operator's deciding to close by removal, particularly for larger units that would have otherwise likely closed in place.

4.5 Opinion 5 - Many Aspects of the Proposed Illinois Rule are More Stringent Than the Federal Rule and Several Key Differences Will Influence Closure Decision Outcomes

As established by the Water Infrastructure Improvements for the Nation (WIIN) Act, states may develop and submit a state-level CCR permit program to US Environmental Protection Agency (EPA) for approval. This program is not required to be identical to the Federal CCR Rule but is required to be "at least as protective" as the Federal CCR Rule. In my view, the proposed Part 845 is expansive and significantly more stringent and prescriptive than the Federal CCR Rule and other rules proposed or enacted by other states. This includes, but is not limited to, various technical criteria such as requiring a formalized construction quality assurance program in Section 845.290, requiring annual certification of the structural stability assessment, safety factor assessment, etc. in Section 845.550 (rather than every 5 years as required by the Federal CCR Rule), requiring leachate collection and removal systems for new surface impoundments (which EPA rejected when considering comments on the draft Federal CCR Rule) in Section 845.420, requiring a closure alternatives assessment in Section 845.710, and requiring financial assurance under Subpart I (a topic absent from the Federal CCR Rule altogether).

In my testimony, I am concentrating on the closure decision process and considerations related to this process. Therefore, I will focus on several key differences of the proposed Part 845 that are not only more restrictive than the Federal CCR Rule but will affect the closure method decision-making and closure implementation processes in ways not likely intended by the Federal CCR Rule. Specifically, I will focus on the following considerations:

- The closure alternatives evaluation process in Section 845.710 applies standards and criteria not expressed by the Federal CCR Rule, which could result in constraining the closure decision outcomes.
- Part 845 is much more stringent than the Federal CCR Rule as evidenced by the significantly greater number of CCR units IEPA identified as being regulated under the proposed Illinois Rule than under the Federal CCR Rule.

The basis for and demonstration of this opinion is provided in the following sections.

The closure alternatives evaluation process in Section 845.710 applies standards and criteria not expressed by the Federal Rule, which will result in constraining the closure decision outcomes

To best understand the EPA's expressed intent during development of the provisions regarding CCR regulation, we are best served by considering the EPA's statements contained in the Federal CCR Rule Preamble.

As I discussed in detail in Opinion 1, closure in place is considered an "*equally protective"* closure method when implemented properly and compliant with the established closure standards. In fact, the EPA, when issuing the Federal CCR Rule, anticipated that closure in place would be the most common method due to the cost of and difficulty associated with closure by removal (Federal CCR Rule, Preamble page 21412). When discussing CCR unit excavation, the EPA references one condition where closure by removal would be preferable: in the "*instance of land re-use and redevelopment.*" While I discussed a number of additional reasons why owners/operators choose to close by removal earlier in my testimony (i.e., rate recovery, beneficial use opportunity, etc.), it is important to note that the Federal CCR Rule Preamble focuses on the concept of site redevelopment as the reason why closure by removal would be preferable and also indicates cost and difficultly as challenges associated with closure by removal implementation.

Further, EPA's expressed intent under the Federal CCR Rule is to allow individual owner/operators the freedom and flexibility to select a closure method, and the Federal CCR Rule does not mandate the criteria on which this selection is made, nor does it preclude the considerations of cost and constructability. In fact, the EPA has listed these as the primary factors for decisions not to close by removal. Indeed, the Preamble states that the Federal CCR Rule "…*allows the owner or operator to determine whether clean closure or closure with the waste in place is appropriate for their particular unit*" and notes that most facilities will not excavate their units "…*given the expense and difficulty of* *such an operation.*" Thus, EPA recognized that owners/operators would consider costs when selecting a closure method.

Rather than mandating the closure method decision or constrain the process by providing defined criteria to be used by owners/operators in the decision-making process, the EPA establishes performance standards for each closure method that must be met to ensure the safe and environmentally protective implementation of closure. These performance standards for closure by removal and closure in place are defined in 40 CFR § 257.102(c) and (d), respectively and are summarized below:

> **Closure by Removal.** This closure method must be performed by "*removing and decontaminating all areas affected by releases from the CCR unit. CCR removal and decontamination of the CCR unit are complete when constituent concentration throughout the CCR unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring concentrations do not exceed the groundwater protection standard established pursuant to 40 CFR § 257.95(h) for constituents listed in appendix IV…*"
>
> **Closure in Place.** The performance standard of this closure method requires that the unit is closed in a manner that will:
>
> 1. *Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;*
> 2. *Preclude the probability of future impoundment water, sediment, or slurry;*
> 3. *Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;*
> 4. *Minimize the need for further maintenance of the CCR unit; and*
> 5. *Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.*

The closure in place requirements of 40 CFR § 257.102 also contains minimum requirements for waste stabilization to support the final cover system as well as minimum technical criteria for the final cover system. Each of these performance criteria work together to provide a system that results in a safe and protective closure, the expressed intent of the Federal CCR Rule itself.

When considering the above performance standards, it is important to note that the Federal CCR Rule does not preclude using additional engineering components (i.e., deep mixing walls, slurry ways and other physical/hydraulic barriers, etc.) to achieve the performance standards required under the Federal CCR Rule. From our work in the industry, we know that closure in place solutions can, at times, include these additional components for reasons that may include environmental containment and/or stability. These components can also be used to meet requirements of the defined performance standards. However, it is important to note that these components are not mandated or prescribed in the Federal CCR Rule, as long as the defined performance standards are met.

In summary, the Federal CCR Rule establishes two equally protective closure methods. The process provides flexibility for owners/operators when designing and selecting a closure method based on defined decision criteria. Additionally, EPA's interests in safe and protective closure are maintained through required compliance with defined performance standards, as well as documentation, reporting, and prescribed timelines. These various elements, when applied together, result in a closure system that is safe, protective, and conforming to additional decision-making criteria applied by owners/operators.

Similar to the Federal CCR Rule, Part 845 also allows closure by removal and closure in place as closure options and generally applies performance standards similar to the Federal CCR Rule for each closure method. However, Part 845 does not provide same flexibility as the Federal CCR Rule, as the decision-making process is not left exclusively to the owners/operators but is beholden to specific additional selection criteria.

Contrary to the approach established in the Federal CCR Rule, the proposed Section 845.710 includes provisions that require development of a prescriptive closure alternatives analysis. The process requires identification and development of alternatives (including complete excavation and "*any other method*" requested by the Agency (Section 845.710(c))). Further, the alternatives analysis process applies a series of prescriptive criteria defined by the IEPA (Section 845.710(b)) that must be used for considering and evaluating each alternative —such criteria are absent from the Federal CCR Rule.

Section 845.710 states that the closure alternative analysis must include the following four main categories for each closure method: (1) long- and short-term effectiveness and protectiveness, (2) future effectiveness in controlling releases, (3) ease or difficulty of implementation, and (4) degree the concerns of locals are addressed. The first three categories have specific factors that need to be identified and analyzed, which are summarized below.

1. *Long- and short-term effectiveness and protectiveness*
    i. *existing risk reduction*
    ii. *residual risk reduction*
    iii. *long-term management*
    iv. *short-term risks*
    v. *closure and post-closure timelines*
    vi. *potential for exposures*
    vii. *long-term reliability*
    viii. *potential for future corrective action*
2. *Future effectiveness in controlling releases*
    i. *future release reduction*
    ii. *requirement of treatment technologies*
3. *Ease or difficulty of implementation*
    i. *technology construction difficulty*
    ii. *technology operational reliability*
    iii. *approval and permit coordination*
    iv. *equipment and specialist availability*
    v. *treatment, storage and disposal capacity*

Also, the defined criteria of Section 845.710(b) primarily include environmental factors such as long- and short-term effective and protectiveness, potential for exposure to humans and environmental receptors to remaining wastes, and the effectiveness of closure method in controlling future releases. While these are important factors that I often see utilized in weighing alternatives during the closure evaluation and decision-making process, other considerations (most notably cost and the ability to satisfy the required timelines) are not specifically listed in Section 845.710(b) as a decision criterion.

The Section 845.710 process inherently removes the flexibility of the Federal CCR Rule in that it no longer permits owners/operators to consider two "*equally protective*" closure methods (as stated by the EPA) through an owner's/operator's approach. Rather, it defines the basis and criteria on which the selection must be made while omitting significant criteria in an effective decision-making effort.

Additionally, Sections 845.240 and Section 845.710(c) require that at least two public meetings be held at least 30 days prior to submission of a construction permit application where closure options are presented. This requirement is not included in the Federal CCR Rule.

In conclusion, by defining the criteria, which omits key parameters necessary in the selection approach, and prescribing the method on which closure selection is made, the proposed Illinois Rule removes some of the flexibility and decision-making from owners/operators responsible for implementation and long-term performance. Key elements such as the ability to satisfy regulatory timelines and cost are not explicitly listed as criteria.

Part 845 is much more stringent than the Federal CCR Rule by regulating a significantly greater number of CCR units than the Federal CCR Rule.

The applicability scope of Part 845 as interpreted by IEPA is also broader than the Federal CCR Rule's, resulting in a significantly greater number of potentially regulated surface impoundments than are regulated under the Federal CCR Rule.

In summary, the Federal CCR Rule applies to existing and inactive surface impoundments at "*active electric utilities or independent power producers*". An active electric utility or independent power producer is defined under the Federal CCR Rule as "…*any facility subject to the requirements of this subpart that is in operation on October 14, 2015*" (40 CFR §257.53). Based on these criteria and the definitions contained in the Federal CCR Rule, owners/operators have provided website disclosures for a total of 36 surface impoundments regulated under the Federal CCR Rule within the state of Illinois.

In its Statement of Reasons, IEPA references 73 surface impoundments within Illinois that have been identified to fall under Part 845's scope. This is more than double the 36 surface impoundments regulated under the Federal CCR Rule. It is my opinion that this is due to several expansive factors, described below.

Part 845 provides broader applicability than the current Federal CCR Rule by also capturing "legacy units" (i.e., units located at sites that were no longer generating electricity at the time of the effective date of the Federal CCR Rule). These legacy units are surface impoundments that are not currently regulated under the Federal CCR Rule. While it is known from the *USWAG decision* published on August 21, 2018 that "legacy units" will be regulated under the Federal CCR Rule at some point in the future, Part 845 preempts EPA's rulemaking process and includes these units now.

In addition to regulating "legacy units", Part 845 also expands the definition of inactive CCR surface Impoundments. "Inactive CCR Surface Impoundments" are defined under the Federal CCR Rule as "*a CCR surface impoundment that no longer receives CCR on or after October 14, 2015 and still contains* ***both CCR and liquids*** *on or after October 14, 2015.*" (40 CFR §257.53). Conversely, Section 845.120 broadens the definition of Inactive CCR Surface Impoundments to mean "*a CCR surface impoundment in which CCR was placed before but not after October 19, 2015 and will contain* ***CCR*** *on or after October 19, 2015*." By removing the reference to "*liquids*" as a component of the definition, a greater number of units will potentially be regulated under Part 845 as compared to the Federal CCR Rule. Also, IEPA through Section 845.170 proposes to regulate inactive closed CCR surface impoundments that may not be subject to Federal regulations.

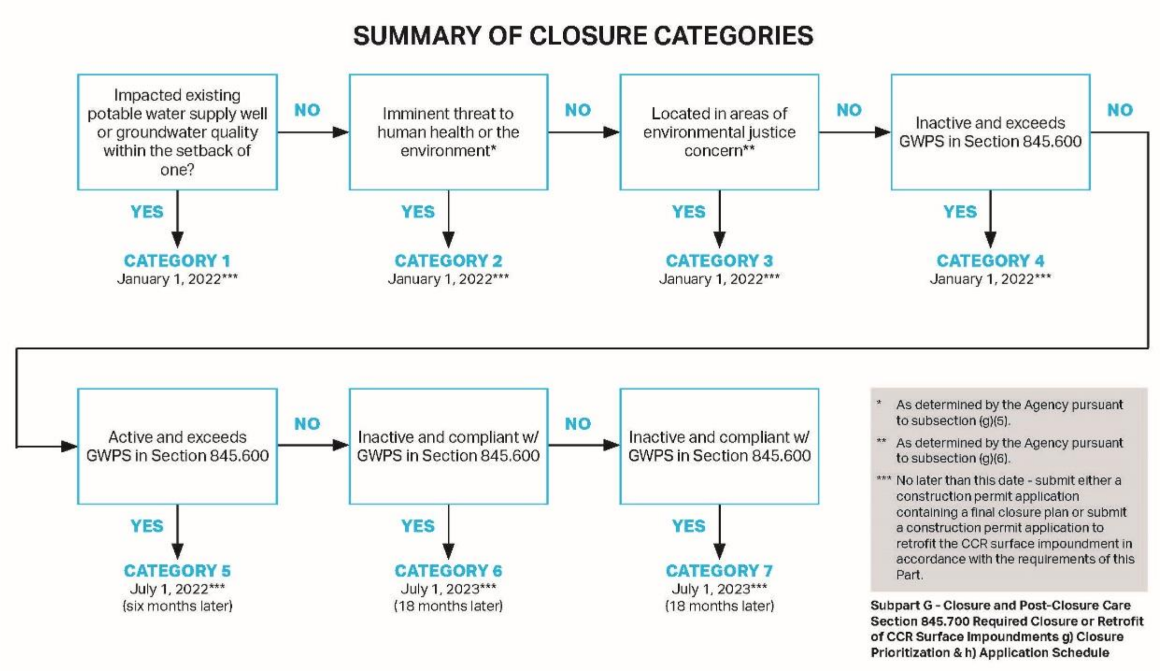
Part 845 as interpreted by IEPA thus broadens the regulatory applicability of the Federal CCR Rule in a number of key areas, resulting in a significant increase (from 36 to 73) of the number of potentially regulated units.

4.6 Opinion 6 – The Timetables for the Construction Permit Application Provided in Section 845.700, when Coupled with the Closure Alternatives and Public Participation Process Defined in the Proposed Illinois Rule, will Seek to Constrain the Process Leading to an Inadequate and Potentially Unattainable Closure Design Timeline

In AECOM's CCR practice, we are currently working on or have completed a significant number of impoundment closure design and construction projects. From this work, we have considerable experience with the development of design drawings, specifications, and related pre-design and design activities that need to be completed to support a proper closure. For our closure by removal sites, there is also often a landfill siting, design, and permitting process that can take considerable time (often on the order of 2 or more years). While the CCR units on which we work vary in terms of size and complexity, the closure investigation and design process alone takes considerable time from initiation through construction level drawings. This process commonly takes a year, and complex sites may take over two years.

The proposed Part 845 provides a system of closure/permit application development prioritization, defined in Section 845.700. As shown on **Figure 4.12**, this process assigns a series of seven priority categories to closure permit applications based on closure risk and other considerations. These priorities are organized into seven distinct categories with Category 1 the highest priority and Category 7 the lowest priority. For Categories 1 through 4, the closure construction permit application must be submitted no later than January 1, 2022. For Category 5, closure permit applications must be submitted by July 1, 2022. For Categories 6 and 7, by January 1, 2023.

Figure 4.12: Summary of Closure Categories under Section 845.700



The Vistra Illinois Subsidiaries anticipate that the majority of their regulated impoundments will be categorized as Category 4 or 5. This will require a large number of sites to complete designs (to construction plans and specifications required by Section 845.220) and submit permit applications by January 1, 2022 or July 1, 2022.

Understanding that the proposed Part 845 is required to be effective by March 30, 2021, this will leave from 9 months to 15 months to complete the design activities for the majority of the impoundments in the state. This schedule may be achievable for less complex sites. However, as indicated in the Illinois Rule's Statement of Reasons, IEPA has acknowledged the expansive nature of proposed Part 845, and that proposed Rule contains many additional requirements not required by the Federal CCR Rule (e.g. new groundwater monitoring for sites currently not regulated by the Federal Rule, groundwater modeling for each alternative, alternatives analysis process with two public meetings, comprehensive quality assurance program).

It is my opinion that the process is inadequate and potentially unattainable within the timelines provided when considering the various additional requirements, robust alternatives analysis, and public involvement process. All these items would need to be completed (as well as construction plans and specifications) prior to the closure construction application deadline established under each category.

The inclusion of groundwater modeling required to be performed as part of this process and submitted with the construction application increases this inadequate time concern, especially when considering the time required for data collection to support such models. A high-quality and safe process should not be excessively rushed as this can lead to negative and unexpected outcomes and would directly conflict with the EPA's established goals for the CCR program.

For purposes of illustration, if a large CCR surface impoundment triggered closure due to failure to demonstrate adequate separation from the uppermost aquifer (40 CFR § 257.60), the unit would be required to cease flows and initiate closure (under the provisions of 40 CFR § 257.102(e)(3)) by October 31, 2020 or seek extensions as appropriate under "no alternate CCR disposal capacity" (40 CFR § 257.103(a)) or "permanent cessation of a coal-fired boiler by a date certain" (40 CFR § 257.103(b)). However, if this CCR unit is in Illinois, it becomes subject to the proposed Section 845 requirements (and further assuming no delays in the anticipated process), on March 30, 2021, nearly 5 months later. The owner/operator would be required to pause closure actions and complete the closure assessment process beginning on March 30, 2021. Assuming this is a Category 1-4 surface impoundment beginning required activities on day 1, it would mean that a unit would have 9 months to complete a full alternatives analysis with groundwater modelling, facilitate two public meetings, and prepare a complete construction permit application. While the proposed Section 845 rule does not offer a timeline to complete this process for either a typical Illinois CCR surface impoundment or anticipated ranges that would substantiate the proposed approach, based upon experience, this process typically takes 6 months to 2 years or longer depending upon the site complexity and, given the increased requirements as noted above. 9 months would not be sufficient for a more complex unit to complete this process.

In conclusion, I believe that the timetables for the construction permit application provided in Section 845.700 of the proposed Part 845, when coupled with the closure alternatives and public participation process, will constrain the process leading to an inadequate and potentially unattainable closure design timeline. As stated several times in the Federal CCR Rule Preamble, law and regulation cannot compel actions that are physically impossible (pages 41422 and 41423), and, without modifications to the milestone dates or provisions for extensions, the established schedule and alternatives analysis process of the proposed Part 845 may result in just that.

Mark D. Rokoff
Curriculum Vitae

A

Appendix A Mark D. Rokoff Curriculum Vitae

Professional history

Mark D. Rokoff, P.E.

Senior Vice President – Environment
Market Sector Director, Energy
Coal Ash Management – National Practice Lead

Education
MS/Civil Engineering (Geotechnical)/1999/Case Western Reserve University
BS/Civil Engineering (Structural)/ 1997/Case Western Reserve University

Registrations/Certification
Professional Engineer, Ohio - No. E-67217

Years of Experience
With AECOM: 21

Professional History
1/99-Present: AECOM
8/04-5/09 - Adjunct Professor at Case Western Reserve University, Cleveland, Ohio-ECIV 398 – Senior Project (Fall and Spring semesters)

Areas of Expertise
Executive and Program Leadership
Coal Combustion Products,
Coal-Fired Power Projects,
Solid Waste Management and Permitting,
Geotechnical Engineering,
Geo-Environmental Engineering, Civil Engineering

Professional Affiliations
American Society of Civil Engineers (ASCE), Cleveland Section
International Society of Soil Mechanics and Foundation Engineers
Build Up Greater Cleveland (BUGC) Human Resources Task Force (for Civil Engineering) 2004 to 2006

Training
Certified Project Manager
Troxler Nuclear Density Gauge Certification
ACI Technician – Grade I

Mr. Rokoff serves as the director for power services for the environmental business line in the Americas as well as the national practice lead for coal ash management projects. He has served as an executive lead on numerous programs where he supports project teams with strategic advice and aids with problem solving, aligns project teams with the expectations and understanding of risk of key stakeholders, establishes, maintains, and deepens relationships with utility clients, implements measures to improve consistency, quality and efficiency among project teams, and develops and monitors critical success factors for project and solution delivery. As a partner to AECOM's clients, Mr. Rokoff helps to deliver on their core values while integrating with management to best align the project work products. As a subject matter expert on coal ash management, Mr. Rokoff has performed and been involved with geotechnical, civil, and geo-environmental engineering designs as well as construction related programs/projects through the full life-cycle of multi-disciplinary permitting and remediation projects (e.g. coal combustion products (CCP) management). In these programs and projects, Mr. Rokoff has developed expertise in the design and application of CCP solutions including regulatory compliance in an evolving industry, innovative approaches and answers to site and design challenges, complimentary services in water and groundwater management as well as conveyance systems, and overall expertise in the development and operation of disposal and beneficial use facilities. More recently, and in conjunction with the coal ash rule changes, Mr. Rokoff has conducted regulatory review and evaluation of best practices as well as strategic planning for potential regulatory changes to operations and management. He is a common speaker on this subject and is a recognized expert in this field.

Selected project experience

Project Manager & CCP Lead, Duke, CCR Program. Provided technical leadership in the development of the CCP program to manage coal ash throughout their fleet. Key services included (1) program establishment and development of technical procedures, (2) preparation and strategy around compliance with the Federal CCR Rule since before the effective date, (3) O&M guidance for disposal and beneficial use facilities throughout the fleet, and (4) technical and regulatory strategy, planning, and engineering associated with existing and new CCR units. Responsibilities include providing direction to the AECOM leadership and technical teams as well as effective communication and guidance to all consultants supporting CCP management. Further responsibilities also centered on project and task management, technical delivery, and more.

Assistant Program Manager & CCP Management Technical Lead, TVA, Coal Ash Program. Retained by TVA to provide engineering, permitting, design, and construction quality control services for the management of CCP materials at 5 of coal plants in Tennessee and Alabama. These tasks are centered on (1) siting, permitting, and construction of new landfills; (2) closure and high hazard evaluation of existing ash impoundments; (3) remedial tasks to address instabilities and other similar concerns; (4) engineering design for new spillways; and (5) closure of existing wet and dry facilities. Since then, our services have expanded to include operational support, owner's engineer for Dewatering facilities, and more.

A key responsibility has been the direct involvement in technical expertise during the establishment of new programmatic policies and metrics for the CCP Management group, including a Programmatic Document. This Document provides appropriate standards for the design, permitting, construction, operation, and inspection of facilities managing CCP materials. In addition, an extensive multi-state beneficiation study was performed to define the demand for CCPs in the concrete market.

Principal, TVA, Material Characterization Testing Program. A total of 30 different CCP materials from 11 power stations in 3 states were collected according to sampling plans that were developed and executed. CCP materials were verified and a testing program was implemented to establish the characterization of the CCP for an array of 20 physical tests and 7 separate chemical tests. The results were incorporated into a customizable database alongside historical data from previous studies for which training was created and provided to both advanced and standard users. Responsibilities included overall project quality, successful execution of all aspects of the scope, oversight of internal project delivery and management, and communication with the client.

Principal, TVA, CCP Benchmarking Survey. Assisted with the development of a CCP beneficial reuse survey to identify best management practices among other utilities for the beneficial reuse of fly ash, bottom ash, FGD and boiler slag. 48 utilities were contacted in a double-blinded survey. The team developed and conducted the survey, evaluated the data and prepared a summary PowerPoint presentation with the key findings from the survey. The presentation focused on relationships between corporate policy and beneficial reuse rates, CCP revenue and production, ways that utilities subsidize CCP beneficial reuse, challenges, use of in-house vs. outside marketers and best management practices used by industry. A second presentation was prepared with findings and trends which was sent to the survey respondents. Responsibilities included overall project quality, successful execution of all aspects of the scope, oversight of internal project delivery and management, and communication with the client.

Project Manager, Engineering and Cost Assessment of Listed Special Waste Designation of Coal Combustion Residuals Under Subtitle C, Electric Power Research Institute (EPRI), Milwaukee, Minnesota. Developed the scope of improvements necessary to comply with the proposed Subtitle C (hazardous waste) regulatory scenario and corresponding costs for model plants defined to represent the utility industry in the US by following the release of the US EPA's proposed CCR Rules. Continued services included aiding an economic company (Veritas) in the further development of these costs in an industry-wide financial impact study. The team documented the scope, costs, and assumptions in a report that accompanied the final product. In addition, various interpretations of the proposed rule including the application of seismic design criteria were developed and documented.

Project Manager and Subject Matter Expert, Disposal Site Economic Model for Coal Combustion Residuals Under Proposed Federal Non-Hazardous Waste Regulations, Electric Power Research Institute (EPRI), Milwaukee, Minnesota. In response to the US EPA's proposed CCR Rules, a report was developed that provided the baseline capital and operational costs for existing impoundment closure, existing CCR landfill closure, development and closure of a new surface impoundment, and development and closure of a new CCR landfill. These baseline costs were then broken into generalized unit costs that are more easily extrapolated for high-level budgetary estimates. Finally, qualitative discussion and, where possible, quantitative estimates for the schedule and cost impacts of additional items outside of the baseline assumptions are given.

Project Manager and Subject Matter Expert, Strategic Planning and Regulatory Evaluations Subject to the US EPA's Proposed CCP Rules, Confidential Clients (6 Leading US Utility Clients). In response to the US EPA's proposed CCR Rules, six major utility clients (under separate, and confidential projects) retained the team to perform similar scopes to support management planning activities in response to the pending changes in CCP management at their coal plant fleets. Specific activities varied, but included well documented development of outcomes of the proposed Rules and the impact to current management methods (both for Subtitle D and C scenarios), documented assessment of the impact to minefilling operations, conceptual design and budgetary costing of the possible outcomes new landfills and pond closures (one project exceed 100 cost estimates), review of current practices and recommendations for short and long-term actions, assessment of current facilities, and strategic planning for innovative solutions that meet the proposed rule. Each of these studies concluded in a comprehensive report for the client to use as a high-level planning tool in the continued and future operation of CCP management.

Principal, Dry Ash Conversion Study – Pond/Landfill Evaluation, DTE Energy, Monroe Power Plant, Michigan. Performed an evaluation to close and convert the existing surface impoundment to a dry landfill engineered over the closed section of the impoundment and assessed the feasibility of constructing a haul road (including a high performance bridge)from the plant to the dry landfill. The team worked other internal personnel in evaluating the dry conversion of the power plant processes. A final report contained the alternative configurations and conceptual designs, cost estimates, and project schedule as well as an overall assessment of path forward. Responsibilities included overall project quality, successful execution of all aspects of the scope, oversight of internal project delivery and management, and communication with the client.

Project Manager, Confidential Client, Pennsylvania. Retained to provide siting study services to explore a multi-state area for a regional landfill. Services included the implementation of Opti-Site, an approach for siting that overlays exclusionary and preferential criteria on a GIS based mapping before rasterizing the data and producing a ranking of viable candidate sites. Conveyance alternatives were a key component of this large study.

Project Manager, FirstEnergy, Toronto, Ohio. Provided permitting and regulatory services in the repurposing of a coal-fired plant to a biomass facility. Regulatory approaches and documentation was developed in support of Corporate Environmental Staff. This project was cancelled before completion.

Project Manager, American Electric Power, Conesville Plant, Coshocton, Ohio. Engineering services for the design and preparation of construction documents for a four-mile haul road design to comply with MSHA standards as well as a 200 ft bridge design evaluation. Design investigation services for the project centers around surveying, geotechnical engineering, and hydraulics & hydrology specialties.

Project Technical Reviewer, American Electric Power, Big Sandy Plant, Central Kentucky. Served as the technical reviewer for the permitting and design of a residual waste facility to be located over a fly ash pond at a central Kentucky location. The project includes negotiations with state regulatory officials, preparation of the three-tiered permit application to site and permit the residual waste facility, and preparation and oversight of construction documents.

Project and Client Manager, FirstEnergy Generation Corp., Gypsum Landfill Permitting and Design and Pipe Conveyor System, Straton, Ohio. Design and permitting services for a scrubber byproduct (Gypsum) disposal facility to accommodate a 20 year design life, in accordance with OAC 3745-30 regulations. Design aspects of the project include an evaluation of both dry and wet disposal management alternatives (e.g. traditional landfilling, wet stacking, and slurry ponding). As Project Manager, responsibilities include coordination, management (project and client), and execution of all services including an extensive siting study (over an 8 mile radius), project site investigations (e.g. geotechnical, hydrogeological, and wetlands delineation), and design and permitting with all applicable Agencies (including USCOE, ODNR, OEPA, Ohio Department of Historical Preservation and others). Project management responsibilities extend to also include assistance to the Client with financial, schedule, and other overall project related tasks. In addition to the landfill design and permitting tasks, the project included preparation of construction documents for a three-mile pipe conveyor system foundation systems, access and permanent roads, and large gypsum drop pad as well as all surveying, property research and execution of ecological and geotechnical site investigations to transport the gypsum from the plant to the landfill. Special considerations for this pipe conveyor system included crossing over streams, roads and a 400 foot elevation change resulting in a support structure that reaches 100 feet above ground for over 1000 ft.

More recently, services have been extended to include assistance in operational development of the site including ongoing reporting and permitting services. The team has also been developing construction documents for the continued development of the landfill into phase 2. In these projects, the role of project (and subsequently, client) manager continues.

Lead Engineer – CCP Evaluations, Mirant, Westland, Faulkner, and Brandywine Ash Storage Facilities, Maryland. Engineering services to evaluate three existing Ash Storage Facilities and Controlled Storage Areas (CSA) for cap & closure systems, leachate management improvements, and additional storage capacity. Each report serves as a detailed decision tool by thoroughly evaluating the alternatives against a set of defined evaluation criteria (including technical, schedule, economic, regulatory and other key factors), ranking the options, and developing budgetary estimates.

Lead Geotechnical Engineer and Project/Client Manager, J.M. Stuart Station (Dayton Power & Light), Aberdeen, Ohio. Fly Ash Pond 10. Planning, design and permitting services for a new fly ash tailings pond located at an electric utility plant in southern Ohio. Responsibilities included geotechnical engineering analyses and report preparation related to settlement, slope stability, and seepage.

Fly Ash Landfill 11. Planning, investigation, design and permitting services for a new fly ash landfill constructed over the footprint of existing fly ash tailings ponds for an electric utility plant located in southern Ohio. As lead geotechnical engineer, responsibilities included coordination, management, and execution of site investigations, laboratory testing programs, in-situ monitoring activities, and design evaluation, analyses, and recommendations. Special geotechnical considerations for the design of the landfill over a loose saturated fly ash pond (i.e., two adjacent existing ponds) included. 1) Site investigations included a piezo-cone investigation, standard soil boring explorations, and installation and monitoring of piezometers, observation wells, and settlement plates within the existing ponds (a large scale preloading program over the closed pond was employed to verify and calibrate predicted responses); 2) Global settlement and slope stability analyses using the SLOPE/W computer program; 3) Design and evaluation of a pore pressure management system within the existing ponds; and 4) Alternative landfill liner system evaluation and demonstration involving a mixed fly ash/clay equivalent system (Ohio Environmental Protection Agency granted approval), which included management of a laboratory testing program for hydraulic conductivity testing of coarse and fine grained soils as well as mixed materials. Later, during construction, responsibilities as project manager included receiving, developing engineering responses, and presenting solutions for modification requests.

Fly Ash Landfill 11E and Construction Documents. Following the close of the adjacent (east) fly ash pond, an evaluation of the pond conditions was performed, the Permit was amended, and a construction level drawings and technical specifications were prepared. As project manager and lead geotechnical engineer, responsibilities included coordination, management, and execution of the investigation and subsequent engineering evaluations, coordination and development of the construction package (including incorporation of the feedback from the construction of Landfill 11W and ongoing monitoring program) as well as financial, schedule, and other overall project related tasks.

Publications: Mr. Rokoff is a regular speaker about CCR at various venues across the US dating back to 2010. He is nationally recognized for his expertise and market perspective, and has spoken multiple times at World of Coal Ash Forum and specialty workshops, ACAA technical meetings, USWAG-focused workshops on CCR, EUEC, PowerGEN and many more.

Summary of Ash Mart and Data Sources

B

Appendix B Summary of Ash Mart and Data Sources

The Ash Mart is a database jointly developed by FirmoGraphs and AECOM that contains data on the management of CCR by power generating facilities in the United States. For example, the database tracks publicly available data on CCR units regulated by 40 CFR Part 257, attributes of those units such as volumes and areas, and relevant compliance documentation required to be accessible to the public via the Federal CCR Rule. This dataset is continually maintained and updated as data is made available.

The Ash Mart is a fee-based subscription service maintained by FirmoGraphs that provides access to the database, which is continually maintained and updated as new data becomes publicly available. The visualization tool used with the Ash Mart is Qlik Sense. Qlik Sense is an off-the-shelf, commercially available data visualization tool that allows easy charting, graphing, and reporting.

All the data available through Ash Mart is publicly available. Most of the data is collected from websites maintained by owners/operators of CCR units regulated by the Federal CCR Rule. The Federal CCR Rule sets out recordkeeping and reporting requirements as well as the requirement for each facility to establish and post specific information to a publicly accessible website. AECOM assisted FirmoGraphs in identifying what information would be available, where the data would be found, and when it would be posted to the CCR websites.

By curating the data and maintaining it on a regular basis, FirmoGraphs makes the information consistent and easily accessible to paying customers.

The following table lists some of the Ash Mart source documents:

Ash Mart Source Documents Summary

File Type	File Name	Publication Requirement	Update Frequency
	Location Restrictions	§257.60(a) – Placement above the uppermost aquifer. New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer. §257.61(a) – Wetlands. New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section. §257.62(a) – Fault areas. New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the	Once only

File Type	File Name	Publication Requirement	Update Frequency
		owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit. §257.63(a) – Seismic impact zones. New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. §257.64(a) – Unstable areas. An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.	
	Safety Factor Assessment	§257.73(e) Periodic safety factor assessments. (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.	Once only
Compliance	**Notice of Intent to Initiate Closure**	§257.105(j)(5). No later than the date the owner or operator initiates closure of a CCR unit, the owner or operator must prepare a notification of intent to close a CCR unit.	Once only
Compliance	**Closure Plan**	§257.102(b)(1) The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices.	Once, and then as plans are changed by the owner-operator
Compliance	**Annual Inspection Report**	§ 257.83 (b)(4)(2) In any calendar year in which both the periodic inspection by a qualified professional engineer and the quinquennial (occurring every 5 years) structural stability assessment by a qualified professional engineer required by §§ 257.73(d) and 257.74(d) are required to be completed, the annual inspection is not required, provided the structural stability assessment is completed during the calendar year. If the annual inspection is not conducted in a year as provided by this paragraph (b)(4)(ii), the deadline for completing the next annual inspection is one year from	Yearly

File Type	File Name	Publication Requirement	Update Frequency
		the date of completing the quinquennial structural stability assessment.	
Compliance	**Groundwater Monitoring and Corrective Actions Report**	§ 257.91(a) The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths.	once only
Compliance	**Notice of Closure Completion**	§ 265.112 (d)(1) The owner or operator must submit the closure plan to the Regional Administrator at least 180 days prior to the date on which he expects to begin closure of the first surface impoundment, waste pile, land treatment, or landfill unit, or final closure if it involves such a unit, whichever is earlier.	Once only

Different CCR site owners/operators maintain their websites in different formats. As a result, FirmoGraphs uses several search methodologies to help assure that all the needed reports are found. FirmoGraphs regularly compares reports from prior years to those of the current year to make sure that there are no programmatically required reports missing.

There are 10,000s of values sourced from 1,000s of documents each year. Naturally, data quality is very important. FirmoGraphs uses several quality assurance procedures to assure and maintain the data accuracy, including:

- Where possible, the use of tools to electronically convert data from text document format to tabular spreadsheet format. This reduces the possibility of human data transcription errors with type values.
- Validation lists are used both for data entry efficiency and quality control checks. Units of measure (UOM) for each input parameter are scrutinized for consistency. This is critical since different report authors may use different UOM. Once the data is curated, business intelligence software is used to visually identify outliers in the data.

As part of the data validation effort, AECOM also provides reviews of data, resolves data interpretation issues, and reviews outputs generated by Ash Mart. Based on AECOM's industry knowledge, these reviews improve the usability and reliability of data.

Testimony 7:

Dr. Rudolph Bonaparte

Pre-filed Testimony

IEPA Proposed Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments

Rudolph Bonaparte, Ph.D., P.E., NAE

Geosyntec Consultants, Inc.

EXECUTIVE SUMMARY

At the request of Vistra Corporation's Illinois Subsidiaries (collectively referred to herein as "Dynegy"), I have been asked to offer my professional opinions with respect to several sections of the Illinois Environmental Protection Agency (IEPA) Proposed Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (hereafter referred to as "Part 845"). The proposed standards were filed by IEPA with the Illinois Pollution Control Board on March 30, 2020. My background and qualifications relevant to offering these opinions are provided at the end of this written testimony.

In summary, I offer the following opinions which have been organized into four broad categories: (1) closure and cover-system requirements; (2) slope limitations when consolidating CCR; (3) factors to consider when conducting a closure alternatives analysis; and (4) assessment, inspection, and reporting requirements. My opinions are:

Closure and Cover System Requirements (Sections 845.740 and 845.750)

- Opinion 1: Part 845 allows for the closure of coal combustion residual (CCR) surface impoundments using either "Closure by Removal" (Section 845.740) or "Closure with a Final Cover System" (Section 845.750). Both closure methods have been successfully used in the past in Illinois and other states. Part 845 provides performance standards and other requirements for each closure alternative such that when properly implemented, each can be protective of human health and the environment.
- Opinion 2: Modern final cover system technology is well-established through extensive research and thousands of applications around the U.S. These systems can be designed and constructed to be reliable and durable and too often achieve the performance standards of Section 845.750(a). At site-specific locations where the final cover system alone (along with the drainage and stabilization requirements of Section 845.750(b)) will not meet a specific performance standard, the final cover system can often be supplemented with one or more additional engineering measures (selected by the qualified professional engineer preparing the closure design) to meet the performance standard.

- Opinion 3: Section 845.750(c)(1) provides prescriptive minimum design requirements for the low permeability layer component of final cover systems used when CCR surface impoundments undergo Closure with a Final Cover System. Section 845.750(c)(1)(A) allows for the use of compacted earth for this layer, while Section 845.750(c)(1)(B) allows for the use of a geomembrane. Section 845.750(c)(1)(A) requires that when the low permeability layer is constructed of compacted earth, it must be at least 36 inches thick. This thickness will often be more than is needed to meet the cover system performance standards of Section 845.750(a) on a site-specific basis. This requirement is also more stringent than the 18-inch prescriptive minimum thickness for earthen low permeability layers in the Federal CCR Rule (40 CFR §257.102(d)(3)(i)(B)). I suggest that Part 845 prescribe a minimum required thickness for compacted-earth low permeability layers of 18 inches, consistent with the Federal CCR Rule. The qualified professional engineer responsible for designing the final cover system would select, and IEPA would require, a low permeability layer thickness larger than 18 inches should site-specific conditions warrant such.
- Opinion 4: Section 845.750(c)(2) provides prescriptive minimum design requirements for the final protective layer component of final cover systems used when CCR surface impoundments undergo Closure with a Final Cover System. Specifically, Section 845.750(c)(2)(B) requires that the final protective layer be at least 36 inches thick. This thickness is required whether the underlying low permeability layer is compacted earth or a geomembrane. I suggest that Part 845 prescribe a minimum final protective layer thickness of 18 inches when the underlying low permeability layer is a geomembrane. This thickness is adequate to protect the geomembrane in most site-specific applications. I note the required minimum thickness for this layer in the Federal CCR Rule is only 6 inches (40 CFR §257.102(d)(3)(i)(C)). The qualified professional engineer responsible for designing the final cover system would select, and IEPA would require, final protection layer thicknesses larger than these prescribed minimum should site-specific conditions warrant such.
- Opinion 5: The costs to construct final cover systems in accordance with the proposed prescriptive minimum design requirements of Section 845.750(c) (i.e., 36-inch thick compacted-earth low permeability layer and 36-inch thick final protective layer) are considerably higher than the costs associated with constructing a final cover system using the prescriptive design minimums I proposed in the preceding opinions.
- Opinion 6: The changes I am proposing to the final cover system prescriptive minimum design requirements of Section 845.750 (Closure with a Final Cover System) are consistent with and in some instances more stringent than final cover systems previously approved by IEPA for closure of CCR surface impoundments in Illinois. They are also more stringent than the prescriptive minimums of the Federal CCR Rule**.**

Slope Limitations When Consolidating CCR (Section 845.750(d))

- Opinion 7: Section 845.750(d) allows the placement of CCR under prescribed conditions "for the purposes of grading and contouring" a closing CCR surface impoundment prior to installation of the final cover system. One of the prescribed conditions is that if CCR is placed for the purposes of grading and contouring, the final cover system slope can be no steeper than 5% unless IEPA "determines that a steeper slope is necessary based on conditions at the site, to facilitate run-off and minimize erosion, and that side slopes are evaluated for erosion potential based on a stability analysis to evaluate possible erosion potential." Slopes steeper than 5% are suitable for facilitating the goals of managing run-off and minimizing erosion. Allowing slopes steeper than 5% would, in some cases, enable on-site consolidation of CCR, thereby reducing the CCR surface impoundment footprint and reducing the overall CCR management impacts at a site and possibly in the local community.

Factors to Consider When Conducting a Closure Alternatives Analysis (Section 845.710)

- Opinion 8: Section 845.710 presents requirements for using a closure alternatives analysis in the selection of a method for CCR surface impoundment closure on a site-specific basis. Section 845.710(b) provides a list of factors that must be considered in the analysis. To assure that a closure alternatives analysis under Section 845.710 is complete, neutral, and accounts for all important evaluation factors, cost of closure, worker safety, and greenhouse gas emission/climate change impacts should be explicitly added to the list of factors in Section 845.710. While these three additional factors are implicitly included within the scope of the existing Part 845 factors, they could be overlooked or excluded. Given their importance in conducting a closure alternatives analysis for a specific site, they should all be explicitly referenced in Section 845.710.
- Opinion 9: Explicitly including the cost of closure in the closure alternatives analysis required by Section 845.710 better enables the owner or operator to propose, and IEPA to approve as appropriate, a closure alternative that not only satisfies all applicable performance criteria of Part 845, but that is also cost effective. The importance of making this factor explicit is reflected by the substantial potential differences in cost associated with the available closure methods.

Assessment, Inspection, and Reporting Requirements (Part 845 Subpart D: Design Criteria and Subpart E: Operating Criteria)

- Opinion 10: Section 845.540(b) requires that a CCR surface impoundment undergo annual inspections by a qualified professional engineer. Unlike Section 845.540(a) that addresses annual inspections by a qualified person and requires regular inspections during the post-closure care period, Section 845.540(b) does not provide a clear statement as to whether the annual qualified professional engineer inspection requirement applies during the 30-year post-closure period. I suggest that Part 845 be clarified in this regard. Moreover, annual inspections by a qualified professional engineer are not needed during the post-closure care period. Therefore, I suggest that Part 845 make it clear that annual qualified professional engineer inspections can cease at the initiation of closure. However, if IEPA retains a requirement in Part 845 that annual inspections by a qualified professional engineer must occur during the post-closure care period, I suggest they be conducted once every five years rather than annually. I note that the Federal CCR Rule does not contain any requirement for qualified professional engineer inspections during the post-closure care period.

- Opinion 11: The Federal CCR Rule requires that hazard potential classification, structural stability, and safety factor assessments be performed at existing CCR surface impoundments at least once every five years. Part 845 requires that these assessments (i.e., Hazard Potential Classification Assessment [Section 845.440], Structural Stability Assessment [Section 845.450], and Safety Factor Assessment [Section 845.460]) be conducted annually. This annual frequency is five times greater than that required by the Federal CCR Rule; it is excessive and more than needed. Also, the Federal CCR Rule has no requirement to conduct these assessments during the closure or post-closure care periods. Part 845 is silent with respect to the need to conduct these assessments during the post-closure care period. Such assessments during the post-closure care period are not necessary. I suggest that Part 845 be clarified in this regard.
- Opinion 12: The Federal CCR Rule requires that groundwater monitoring (i.e., detection and assessment monitoring per 40 CFR §257.94 and .95) be conducted semi-annually during the active life and post-closure care period of a CCR surface impoundment. The federal rule allows the owner or operator to propose an alternative monitoring frequency, up to annually, for limited site-specific conditions. Part 845 requires that groundwater monitoring be "at least quarterly during the active life of the CCR surface impoundment and the post-closure care period or period specified in Section 845.740(b) when closure is by removal." There is no provision in Part 845 for an alternative monitoring frequency. I suggest that IEPA consider provisions for allowing an alternative monitoring frequency in Part 845 when a technical demonstration (certified by a qualified professional engineer and approved by IEPA) shows that the alternative frequency satisfies applicable performance criteria (to also be added to Part 845). This suggestion can be considered separately for both the operating life of the CCR surface impoundment and the post-closure care period.

OPINIONS AND SUPPORTING INFORMATION

1. CLOSURE AND COVER SYSTEM REQUIREMENTS (Sections 845.740 and 845.750)

Opinion 1: Part 845 allows for the closure of coal combustion residual (CCR) surface impoundments using either "Closure by Removal" (Section 845.740) or "Closure with a Final Cover System" (Section 845.750). Both closure methods have been successfully used in the past in Illinois and other states. Part 845 provides performance standards and other requirements for each closure alternative such that when properly implemented, each can be protective of human health and the environment.

- The performance standards and other requirements contained throughout Part 845 provide the mechanism for IEPA to ensure that CCR surface impoundment closures are protective of human health and the environment considering site-specific conditions. Appropriate to this framework, Part 845 has no categorical exclusion of any closure method allowed by Part 845 for any site, including, for example, sites where an existing CCR surface impoundment has a bottom extending below the groundwater table, is located in a floodplain, or fails to meet a location criterion.
- The closure alternatives analysis requirements of Section 845.710(b)(c)(d) provide the basis for evaluating both allowable closure methods on a site-specific basis. This section of Part 845 requires evaluation of potential closure alternatives with respect to:
    - The long- and short-term effectiveness and protectiveness of the closure method ((b)(1));
    - The effectiveness of the closure method in controlling future releases ((b)(2));
    - The ease or difficulty of implementing a potential closure method ((b)(3));
    - The degree to which the concerns of the residents living within communities where the CCR will be handled, transported and disposed are addressed by the closure method; and
    - The analysis of each alternative must: (i) meet or exceed a class 4 [cost] estimate under the AACE Classification Standard; (ii) contain the results of groundwater contaminant transport modeling; (iii) include a description of fate and transport of contaminants with the closure alternative over time; and (iv) assess impacts to waters of the state ((d)(1)(2)(3)(4)).

Taken together, these requirements are designed to ensure that any considered alternative is thoroughly evaluated with respect to its ability to meet the Part 845 performance standards given the site-specific conditions.[1]

---

[1]For example, in evaluating whether a CCR surface impoundment that extends below the water table can meet the requirements of Part 845 using Closure with a Final Cover System, the owner or operator would need to demonstrate how the proposed closure alternative exhibits short-term and long-term effectiveness, controls future releases, and

- I note that, in the preamble to the 2015 Federal CCR Rule, the U.S. Environmental Protection Agency (USEPA) came to a similar conclusion: *"both methods of closure (i.e., clean closure and closure with waste in place) can be equally protective, provided they are conducted properly."* (Federal Register, Vol. 80, No. 74, p. 21412, April 17, 2015).

Opinion 2: Modern final cover system technology is well-established through extensive research and thousands of applications around the U.S. These systems can be designed and constructed to be reliable and durable and too often achieve the performance standards of Section 845.750(a). At site-specific locations where the final cover system alone (along with the drainage and stabilization requirements of Section 845.750(b)) will not meet a specific performance standard, the final cover system can often be supplemented with one or more additional engineering measures (selected by the qualified professional engineer preparing the closure design) to meet the performance standard.

- The ability of properly designed and constructed final cover systems to meet the performance standards of Section 845.750(a) has been amply demonstrated through numerous technical publications, including USEPA guidance documents, and more than 35 years of industry experience.
- Final cover systems have been installed as part of numerous CCR impoundment closures in Illinois and other states.
- At many sites, the final cover requirements of Section 845.750(c), coupled with the drainage and stabilization requirements of Section 845.750(b) and the other components common to the overall closure design, should be enough to achieve the regulatory performance standards. Generally, Closure with a Final Cover System will include the following components:
    - Site preparation, construction of haul roads and contractor laydown and stockpile areas;
    - Removal of standing water in the impoundment;
    - Dewatering of CCR to remove enough interstitial water to meet performance criteria, enable grading of the CCR surface, and allow installation of the final cover system);
    - Grading and in some cases consolidation of the CCR to reduce the impoundment size (footprint);
    - Placement of fill as needed to meet closure grades;
    - Installation of the components of the final cover system;
    - Establishment of vegetation and erosion controls on the final cover system;

satisfies the other requirements of Part 845.710, as well as the performance standards of Section 845.750. To meet these standards and requirements at some sites, the closure design may need to include additional engineering measures.

  - Construction of the final stormwater management system for the closed impoundment; and
  - Long-term post-closure monitoring and maintenance.
- For certain site-specific conditions, it may be necessary to supplement these components with one or more additional engineering measures to achieve the performance standards.[2,3]
- There is a broad array of engineering measures, from relatively minor to more substantial, that can be used to address site-specific conditions. A few examples of such measures are: erosion control measures, hydraulic energy dissipation structures, slope flattening and/or buttressing; slope armoring; dike raising; retaining walls; subsurface grouting; trench drains; subsurface hydraulic cutoff walls; and groundwater control and collection systems.

Opinion 3: Section 845.750(c)(1) provides prescriptive minimum design requirements for the low permeability layer component of final cover systems used when CCR surface impoundments undergo Closure with a Final Cover System. Section 845.750(c)(1)(A) allows for the use of compacted earth for this layer, while Section 845.750(c)(1)(B) allows for the use of a geomembrane. Section 845.750(c)(1)(A) requires that when the low permeability layer is constructed of compacted earth, it must be at least 36 inches thick. This thickness will often be more than is needed to meet the cover system performance standards of Section 845.750(a) on a site-specific basis. This requirement is also more stringent than the 18-inch prescriptive minimum thickness for earthen low permeability layers in the Federal CCR Rule (40 CFR §257.102(d)(3)(i)(B)). I suggest that Part 845 prescribe a minimum required thickness for compacted-earth low permeability layers of 18 inches, consistent with the Federal CCR Rule. The qualified professional engineer responsible for designing the final cover system would select, and IEPA would require, a low permeability layer thickness larger than 18 inches should site-specific conditions warrant such.

- Part 845 (in Section 845.750), like the Federal CCR Rule (40 CFR§ 257.102(d)(1)), contains both performance standards and complementary prescriptive minimum design requirements for final cover systems used in CCR surface impoundment closures. Also like the Federal CCR Rule, Part 845 requires that the final cover system be designed by a qualified professional engineer. It is the application of these three things together, the performance standards, prescriptive minimum design requirements, and the design by a

---

[2]Examples of site-specific conditions that could possibly necessitate one or more additional engineering features include, unstable areas (e.g., karst), floodplains, and existing CCR impoundment slopes with inadequate factors of safety.

[3]At some sites, there may also be additional regulatory requirements to be met, such as requirements of the Federal Emergency Management Agency (FEMA) and/or state and local agencies for construction in floodplains.

qualified professional engineer, that results in a final cover system that is protective of human health and the environment. Indeed, there are sites where the federal prescriptive minimum requirements, which are less onerous than the Part 845 prescriptive minimums, can meet both the performance standards and the design requirements established for the site by the qualified professional engineer. Stated differently, there is no need to have prescriptive minimum design requirements that are protective at every site, which appears to be the case with the current Part 845 prescriptive minimums. These requirements should be considered minimum criteria, not universally protective criteria.

- With respect to compacted-earth low permeability layers, the 36-inch minimum thickness requirement has precedent in Illinois regulations for final cover systems at municipal solid waste (MSW) landfills (35 Ill. Adm. Code 811.314). However, MSW and CCRs have different mechanical properties, including long-term compressibility, that leads to differing behavior of the disposal units and differing requirements for the minimum thickness of a compacted-earth low permeability layer.
- MSW is a high organic-content waste (e.g., food waste, paper, yard waste). Long-term biodegradation of this organic material makes MSW compressible resulting in large settlements at MSW landfills, with much of this settlement typically occurring during the landfill post-closure care period, after the final cover system has been installed. Post-closure landfill settlements can be as large as 15-20%[4] of the height of the landfill. Consequently, large MSW landfills can experience tens of feet of cover system settlement resulting in distortion and cracking of (i.e., the potential for damage to) the compacted-earth low permeability layer. A thicker compacted earth layer can better maintain its integrity under these conditions than a thinner compacted-earth liner.[5] In contrast to MSW, CCRs have very little organic material that degrades, and CCR material is inherently less compressible than MSW, particularly in the post-closure care period. CCR surface impoundments do not experience the large magnitude of post-closure settlements experienced by MSW landfills.[6] Therefore, it is not necessary to

[4]Bonaparte R., Daniel D.E., and Koerner, R.M., 2004. "(Draft) Technical Guidance Document for RCRA/CERCLA Final Covers." U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, EPA 540-R-094-007, OSWER 9283.1-26, 421p.

[5]In my opinion, this MSW regulation is conservative as a 36-inch thick compacted-earth low permeability layer may not be needed in some MSW landfill closures. On a technical basis, a thinner layer may be adequate based on the height of the landfill, composition of waste, level of compaction of the waste, thickness of the soil bedding layer below the low permeability layer, timing of cover system construction, and other factors.

[6]Post-closure settlements of CCR surface impoundments are typically only a few percent of the thickness of the CCR. In addition, CCR thickness in a CCR surface impoundment is typically considerably less than MSW thickness in an MSW landfill.

require that compacted-earth low permeability layers used in CCR impoundment closures be at least 36-inches thick.

- The Federal CCR Rule prescriptive minimum thickness for the low permeability layer (called an infiltration layer in the Federal CCR Rule) is 18 inches (40 CFR §257.102(d)(i)(B)). I note that this requirement is patterned after the minimum requirement for infiltration layers for MSW landfills contained in 40 CFR §258.60(a). In my opinion, depending on the site, an 18-inch thick compacted-earth low permeability layer can be as effective as a 36-inch thick layer in achieving the performance standards of Section 845.750(a). As a step in the design of a final cover system for a specific site, the qualified professional engineer will assess whether the prescribed minimum thickness for the low permeability layer is acceptable, or if instead, a thicker layer is needed. I believe it is appropriate to provide the qualified professional engineer with more flexibility and ability to customize the closure design to the site-specific conditions. This approach also provides IEPA with more flexibility to assess when in fact additional layer thickness or other engineering measures are needed.

Opinion 4: Section 845.750(c)(2) provides prescriptive minimum design requirements for the final protective layer component of final cover systems used when CCR surface impoundments undergo Closure with a Final Cover System. Specifically, Section 845.750(c)(2)(B) requires that the final protective layer be at least 36 inches thick. This thickness is required whether the underlying low permeability layer is compacted earth or a geomembrane.[7] I suggest that Part 845 prescribe a minimum final protective layer thickness of 18 inches when the underlying low permeability layer is a geomembrane. This thickness is adequate to protect the geomembrane in most site-specific applications. I note the required minimum thickness for this layer in the Federal CCR Rule is only 6 inches (40 CFR §257.102(d)(3)(i)(C)). The qualified professional engineer responsible for designing the final cover system would select, and IEPA would require, final protection layer thicknesses larger than these prescribed minimum should site-specific conditions warrant such.

- As I discuss above in the supporting discussion for Opinion 3, there is no need to have prescriptive minimum design requirements that are so conservative that they are protective at every site, which appears to be the case in selecting a 36-inch minimum thickness for the final protective layer no matter the type of underlying low permeability layer. These requirements should be considered minimum criteria, not universally protective criteria.

[7]Part 845 (Section 845.750(c)(2)) prescribes a minimum final protective layer thickness of 36 inches for the stated purpose of protecting the low permeability layer from freezing and root penetration. This requirement applies whether the low permeability layer consists of a compacted earth layer or a geomembrane layer.

- Part 845 provides two reasons for prescribing a minimum final protective layer thickness of 36 inches, those being to protect the low permeability layer from root penetration and from freezing (Section 845.750(c)(2)(B)).
- A 36-inch thick final protective layer may be justified when a compacted-earth low permeability layer is used in cold climates (at locations where freeze-thaw depths can extend several feet) or when it is used at a site where the cover system is not maintained and deep-rooted plants (e.g., large shrubs and trees) are allowed to become established. However, a final protective layer of this thickness would typically not be needed when the low permeability layer for a CCR impoundment final cover system is a geomembrane.
- Studies have shown that geomembranes are not adversely affected by freeze-thaw cycles (Comer et al. 1996; Hsuan, et al., 2013).[8,9] The available technical information also shows that intact geomembranes are not subject to root penetration. Roots can penetrate through a geomembrane hole, but in a properly designed and constructed cover system, such holes are very infrequent. Moreover, if the cover system is maintained with shallow rooted plants (e.g., grass), as is often the case, the root zone will for the most part not even extend to the bottom of an 18-inch thick final protective cover layer. Stated differently, the thickness of the final protective layer can be selected by the qualified professional engineer in part by the root depth of the type(s) of vegetation the engineer specifies for the project.
- An 18-inch prescribed minimum thickness for the final protective layer is adequate where a geomembrane is used as the low permeability layer.[10] On a site-specific basis, the qualified professional engineer designing the closure project can evaluate the adequacy of this thickness based on type of cover vegetation and moisture retention requirements, other required components of the cover system design (e.g., a drainage layer installed between the final protective layer and the geomembrane), and whether there is any site-specific condition that would cause the engineer to specify a greater layer thickness.

Opinion 5: The costs to construct a final cover system in accordance with the proposed prescriptive minimum design requirements of Section 845.750(c) (i.e., 36-inch thick

[8]Comer, A.I., Sculli, M.L., and Hsuan, Y.G., 1996. "Freeze-Thaw Cycling and Cold Temperature Effects on Geomembrane Sheets and Seams." U.S. Environmental Protection Agency Project Summary, National Risk Management Reduction Laboratory, EPA/600/S-96/004, 4p.

[9]Hsuan, Y.G., Koerner, R.M., and Comer, A.I., 2013. "Cold Temperature and Freeze-Thaw Cycling Behavior of Geomembranes and Their Seams." GSI White Paper #28, Geosynthetic Institute, Drexel University, 10p.

[10]Bonaparte et al. (2004) state "If the surface and protection layers are combined into a cover soil, then the minimum thickness of the cover soil should be evaluated considering the plant rooting depth. A typical minimum thickness of the cover soil is 0.45 to 0.6 m [18 to 24 inches] for cover systems with hydraulic barriers." (page 2-9).

compacted-earth low permeability layer and 36-inch thick final protective layer) are considerably higher than the costs associated with constructing a final cover system using the prescriptive design minimums I proposed in the preceding opinions.[11]

- The cost to construct a compacted-earth low permeability layer is dependent on several factors and will vary from site to site. Based on the experience of my firm, Geosyntec Consultants, in the closure of CCR impoundments and MSW landfills in Illinois, a representative "fully loaded" installed/constructed cost for this layer is about $30 per cubic yard (CY). A fully loaded cost includes the owner or operator's costs for engineering and overhead. The estimated cost for a 36-inch thick compacted-earth low permeability layer would thus be $145,200 per acre. At a thickness of 18 inches, the estimated cost would be $72,600 per acre. Thus, the cost of the prescriptive minimum design for the low permeability layer in Part 845 is twice the cost of my suggested prescriptive minimum design.
- Based on the same experience I mentioned in the previous bullet, a representative fully loaded installed/constructed cost for the final protective layer is $23 per CY. The estimated cost for a 36-inch thick final protective layer would thus be $111,300 per acre. At a thickness of 18 inches, the estimated cost for this layer would be $55,700 per acre. The thinner final protective layer would only be used in conjunction with the use of a geomembrane low permeability layer. Thus, the proposed Part 845 requirement is doubling the cost of the final protective layer compared to my proposal for closures in which a geomembrane is used as the final protective layer.
- Using the material unit cost estimates given above, and only considering these costs and not others that would be common to all scenarios (e.g., revegetation, stormwater management system, surface erosion control), the following per-acre final cover system cost estimates are obtained.[12]

	LPL (36 inches)	**LPL (18 inches)**	**LPL (GMB)**[12]
FPL (36 inches)	$256,500	$183,900	$160,100
FPL (18 inches)	N/A	N/A	$104,500

[11]Similarly, the costs to construct final cover systems following the minimum thicknesses I am suggesting herein for the low permeability layer and final protective layer are considerably higher than the costs for the prescriptive minimum cover system components of the Federal CCR Rule (40 CFR§101(d)(3)) which consist of an 18-inch thick low permeability layer with a permeability no greater than $1x10^{-5}$ cm/sec and a 6-inch thick final protective layer.

[12]LPL = low permeability layer; FPL = final protective layer; GMB = geomembrane. Geomembrane cost is based on $1.12 per fully loaded installed square foot ($48,800 per acre). Estimated costs are on a per acre basis.

- From the foregoing, it can be seen that a final cover system meeting the prescriptive minimums of Part 845 is nearly 40% more expensive than a final cover system meeting my suggested prescriptive minimums when a compacted-earth low permeability layer is used and nearly 150% more expensive when a geomembrane low permeability layer is used.
- The estimated cost for a final cover system meeting the prescriptive minimum design requirements of Part 845 can also be compared to the cost of a final cover system meeting the prescriptive minimums of the Federal CCR Rule (40 CFR 257.101(d)).[13] The costs are $256,500 per acre for the Part 845 prescriptive minimum final cover system and $91,200 per acre for the Federal CCR Rule prescriptive minimum final cover system. Thus, the Part 845 cost estimate is nearly three times the estimate for the Federal CCR prescriptive minimum final cover system.[13]

Opinion 6: The changes I am proposing to the final cover system prescriptive minimum design requirements of Section 845.750 (Closure with a Final Cover System) are consistent with and in some instances more stringent than final cover systems previously approved by IEPA for closure of CCR surface impoundments in Illinois. They are also more stringent than the prescriptive minimums of the Federal CCR Rule.

- I present several examples in the following bullets where the thickness for the low permeability layer of final protective layer are less than the proposed Part 845 prescriptive minimum requirements. The thicknesses are generally closer to what I am recommending as prescriptive minimum design requirements. Presumably, because these closures have been reviewed and approved by IEPA, they have been assessed in their site-specific settings and found to be protective of human health and the environment.
- The closure plan for the Duck Creek Power Station Ash Ponds 1 and 2, Canton, Illinois (AECOM, March 2016) describes the following final cover system components, from top to bottom:
  - vegetated surface
  - 6-inch thick final protective layer
  - 18-inch thick low permeability layer (permeability not greater than $1x10^{-6}$ cm/sec)
- The closure plan for Baldwin Energy Complex Fly Ash Pond System, Baldwin, Illinois (AECOM, March 2016) describes the following final cover system components, from top to bottom:
  - vegetated surface

[13] I note that the estimated cost for a final cover system constructed to the prescriptive minimum requirements contained in the Federal CCR Rule is $91,200. This estimate uses the same unit costs as for the other considered alternatives. The final cover system components are: (1) 18-inch thick LPL with a permeability of $1x10^{-5}$ cm/sec or less; and (2) 6-inch thick FPL.

  - 6-inch thick final protective layer
  - 18-inch thick low permeability layer (permeability not greater than $1x10^{-5}$ cm/sec)
- The closure plan for Coffeen Power Station Ash Pond 2, Coffeen, Illinois (AECOM, January 2017) describes the following alternative final cover system components, from top to bottom:
  - vegetated surface
  - 24-inch thick final protective soil layer
  - geocomposite drainage layer
  - 40-mil thick linear low-density polyethylene (LLDPE) geomembrane low permeability layer
- The closure plan for Hennepin Power Station Old West Ash Pond and Old West Polishing Pond, Hennepin, Illinois (Geosyntec Consultants, December 20, 2017) describes the following final cover system components for the Old West Ash Pond, from top to bottom (Note: The Old West Polishing Pond was closed by removal with placement of the CCR in the Old West Ash Pond):
  - vegetated surface
  - 24-inch thick final protective soil layer
  - geocomposite drainage layer (only along steeper slope segments)
  - 40-mil thick LLDPE geomembrane low permeability layer

2. SLOPE LIMITATIONS WHEN CONSOLIDATING CCR (Section 845.750(d))

Opinion 7: Section 845.750(d) allows the placement of CCR under prescribed conditions "for the purposes of grading and contouring" a closing CCR surface impoundment prior to installation of the final cover system. One of the prescribed conditions is that if CCR is placed for the purposes of grading and contouring, the final cover system slope can be no steeper than 5% unless IEPA "determines that a steeper slope is necessary based on conditions at the site, to facilitate run-off and minimize erosion, and that side slopes are evaluated for erosion potential based on a stability analysis to evaluate possible erosion potential." Slopes steeper than 5% are suitable for facilitating the goals of managing run-off and minimizing erosion. Allowing slopes steeper than 5% would, in some cases, enable on-site consolidation of CCR, thereby reducing the CCR surface impoundment footprint and reducing the overall CCR management impacts at a site and possibly in the local community.

- The qualified professional engineer designing a Closure with a Final Cover System should be allowed to utilize slopes steeper than 5% for placed CCR as long as the design meets all applicable performance standards of Part 845.[14] This suggestion is consistent with the most recent proposal from USEPA, which does not specify a maximum slope for CCR placed as part of the closure of a CCR surface impoundment provided the applicable provisions of the proposed rule are met.[15]

- Final cover systems of the type required by Section 845.750 have been successfully constructed and maintained at slopes of 33% (3H:1V) and 25% (4H:1V) for many years. In fact, most MSW and CCR landfill units are constructed with final cover slopes in this range.
- I have personally been the engineer-of-record for projects where the final cover system slopes for waste management facilities were in the aforementioned range and the performance criteria for the cover included managing run-off from design storms and limiting erosion.
- By allowing a steeper final cover slope when consolidating ash in accordance with Section 845.750(d), additional CCR could be placed that would, in some cases, allow reduction in the size of the CCR surface impoundment footprint. There are multiple potential benefits to such a strategy. USEPA has recognized these benefits stating "there can be benefits associated with closing units under the conditions of this proposal. For example, a facility could consolidate the CCR from one or more units into a single unit….Consolidating multiple units into a single unit would result in an overall smaller CCR unit footprint….there may be benefits to allowing an owner or operator to focus their long-term monitoring, care and cleanup obligations on a single unit rather than multiple units." (Federal Register, Vol. 85, No. 42, p. 12463, March 3, 2020)
- CCR consolidated under the provisions of Section 845.750(d) would be dewatered prior to or during relocation, it would be placed above the existing CCR only after the existing CCR had undergone drainage and stabilization in accordance with Section 845.750(b), and it would be covered with a final cover system that meets the performance standards of 845.750(a) and the minimum prescriptive design requirements of Section 845.750(c). Under these conditions, the consolidated CCR can effectively be isolated from environmental transport pathways. By using CCR consolidation under these conditions, with slopes steeper than 5% for the consolidated CCR, the land area occupied by the CCR surface impoundment can be reduced and the performance standard of Section 845.750(a)(1) can be more readily achieved.

---

[14] I note that the general closure requirements of Section 845.750 do not impose a limitation on the maximum slope for the final cover system; it is only when CCR is used for the purposes of grading and contouring that the 5% slope limitation is imposed. There is no engineering rationale for this limitation.

[15] Federal Register, Vol. 85, No. 42, p. 12456-12478, March 3, 2020. Hazardous and Solid Waste Management System: Disposal of CCR; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments; Implementation of Closure.

- I also note that steeper final cover system slopes reduce the potential for infiltration into the closed CCR surface impoundment compared to flatter final cover systems, all other factors being the same.
- Final cover systems with slopes steeper than 5% can in most cases be designed to meet the applicable performance standards of Part 845, including the Structural Stability Assessment (Section 845.450), Safety Factor Assessment (Section 845.460), and Closure with a Final Cover System performance standards (Section 845.750).
- The approach I am suggesting herein is consistent with USEPA's proposed changes to the Federal CCR Rule (Federal Register, Vol. 85, No. 42, p. 12,456-12,478, March 3, 2020). In its proposal, USEPA provides procedures for "Exemption for the use of CCR in a CCR surface impoundment closing for cause." (40 CFR§257.102(d)) USEPA states "The approved closure plan must demonstrate that the use of CCR during closure would pose no reasonable risk of adverse effects during the closure and post-closure care periods by showing that the placed CCR will remain contained (i.e., isolated) in the unit closed in accordance with the closure performance standards of placement of §257.102(d) so as to limit contact of the CCR in the unit with water and to prevent releases to the environment, including releases through surface transport by precipitation runoff, releases to soil and groundwater, windblown dust, and catastrophic unit failures."

3. *FACTORS TO CONSIDER WHEN CONDUCTING A CLOSURE ALTERNATIVES ANALYSIS (Section 845.710)*

Opinion 8: Section 845.710 presents requirements for using a closure alternatives analysis in the selection of a method for CCR surface impoundment closure on a site-specific basis. Section 845.710(b) provides a list of factors that must be considered in the analysis. To assure that a closure alternatives analysis under Section 845.710 is complete and neutral, and accounts for all important evaluation factors, cost of closure, worker safety, and greenhouse gas emission/climate change impacts should be explicitly added to the list of factors in Section 845.710. While these three additional factors are implicitly included within the scope of the existing Part 845 factors, they could be overlooked or excluded. Given their importance in conducting a closure alternatives analysis for a specific site, they should all be explicitly referenced in Section 845.710.

- Section 845.710(b) requires that the closure alternatives analysis examine for each considered closure alternative: (1) the long- and short-term effectiveness of the closure method considering an analysis of eight specific factors; (2) the effectiveness of the closure method in controlling future releases considering an analysis of two specific factors; (3) the ease or difficulty of implementing the potential closure method considering an analysis of five specific factors; and (4) the degree to which the concerns of the residents living within communities where the CCR will be handled, transported and disposed are addressed by the closure alternative.

- The factors listed in (1) to (4) of Section 845.710(b) are all relevant and appropriate for a comparative evaluation of closure alternatives and could be interpreted to indirectly include cost of closure, worker safety, and greenhouse gas emission/climate change impacts within the scope of the alternatives evaluation. However, given the importance of these latter three factors, they should be explicitly included for the analysis of each closure alternative to ensure a complete and neutral evaluation on a site-specific basis.
- The cost of closure is an appropriate factor for inclusion in the closure alternatives analysis. USEPA includes cost as a factor to be addressed in the detailed analysis of alternatives for CERCLA feasibility studies (analogous to the closure alternatives analysis of Part 845).[16] A review of the Federal CCR Rule and its proposed amendments shows that cost-benefit analyses of the rule provisions were thoroughly considered by the Agency in the development of the original rule and the current proposed amendments. I note that cost of closure is not only an appropriate factor to consider in comparing closure approaches (i.e., Closure with a Final Cover System versus Closure by Removal), but also an appropriate factor to consider for alternatives using the same closure approach (for example, in the evaluation of using CCR fill versus soil fill for Closure with a Final Cover System, and in evaluating disposal options and modes of transportation for Closure by Removal).
- Section 845.710(b)(1)(D) lists short term risks to the community as a factor to be considered in the closure alternatives analysis. This rule section specifically calls for the analysis of "potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants." The health and safety of the work force implementing a closure should be explicitly considered as a "potential threat to human health." This work force in most cases is drawn in significant part from members of the community, so short-term risks to the work force directly impacts the health and safety of the community. The importance of protecting workers is recognized by USEPA. The agency includes it as a factor to be addressed in the detailed analysis of alternatives for CERCLA feasibility studies (analogous to the closure alternatives analysis of Part 845). USEPA provides the following factor: "Protection of workers during remedial actions – This factor assesses threats that may be posed to workers and

[16] USEPA, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final." Office of Emergency and Remedial Response, EPA/540/G-89/004, October 1988, 187p.

the effectiveness and reliability of protective measures that would be taken."[17] The U.S. government established the Occupational Safety and Health Administration (OSHA) with the mission "…to ensure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance."[18] Evaluation of the potential health and safety impacts of a closure alternative is consistent with UPEPA policy, federal regulations, and the scope of a complete alternatives analysis.

- Anthropogenic greenhouse gas (GHG) emissions are the most important single cause of global warming over the past 50 years.[19] As a policy matter, USEPA advocates for GHG emissions as a factor to be considered in environmental projects. The Agency has stated that it is "dedicated to developing and promoting innovative cleanup strategies that restore contaminated sites to productive use, reduce associated costs, and promote environmental stewardship. EPA strives for cleanup programs that use natural resources and energy efficiently, reduce negative impacts on the environment, minimize or eliminate pollution at its source, and reduce waste to the greatest extent possible."[20] Further, EPA has identified the following five elements to be considered in evaluating alternatives with respect to green and sustainable remediation (GSR) projects: (1) total energy use and renewable energy use; (2) air pollutants and greenhouse gas emissions; (3) water use and impacts to water resources; (4) materials management and waste reduction; and (5) land management and ecosystem protection. It is appropriate to consider GHG emissions and GSR principles in the complete evaluation of potential closure alternatives.[21]
- Modifying the factors set forth in Section 845.710 would not make Part 845 less stringent than the Federal CCR Rule. The federal rule allows an owner or operator to select a closure method without having to evaluate each potential closure alternative against a specific set of criteria. In other words, under the federal rule, an owner or operator can select a closure method that meets the performance standards based on any criteria it so chooses, including costs, worker safety, greenhouse gases, etc. Thus, the

[17]USEPA, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final." Office of Emergency and Remedial Response, EPA/540/G-89/004, October 1988, 187p.

[18]About OSHA, https://www.osha.gov/aboutosha.

[19]USEPA, Greenhouse Gases, https://www.epa.gov/report-environment/greenhouse-gases.

[20]USEPA, "Green remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites." Office of solid Waste and Emergency Response, EPA 542-R-08-002, April 2008, 56p.

[21]USEPA, Principles for Greener Cleanups, https://www.epa.gov/greenercleanups/epa-principles-greener-cleanups.

specification of any criteria makes Part 845.710 more stringent than the corresponding requirement in the federal rule.

Opinion 9: Explicitly including the cost of closure in the closure alternatives analysis required by Section 845.710 better enables the owner or operator to propose, and IEPA to approve as appropriate, a closure alternative that not only satisfies all applicable performance criteria of Part 845, but that is also cost effective. The importance of making this factor explicit is reflected by the substantial potential differences in cost associated with the available closure methods.

- Working with engineers at Geosyntec Consultants, I conducted a comparison of the cost and time duration to close a representative Illinois CCR surface impoundment using Closure by Removal and Closure with a Final Cover System. The representative impoundment is 60 acres in size and contains 2,700,000 CY of CCR. The final cover system considered in the comparison satisfies the prescriptive minimum design requirements of Part 845.[22] For Closure by Removal, CCR is trucked to a commercial MSW landfill 20 miles from the site.[23] The estimated cost and duration for Closure with a Final Cover System are $28 million and 20 months, respectively. The estimated cost and duration for Closure by Removal are $152 million and 140 months, respectively. Based on these estimates, the cost and duration for Closure by Removal are roughly five and seven times higher, respectively, than the cost and duration for Closure with a Final Cover System. These estimates are based on standard sources for construction cost estimating information (i.e., RS Means) and Illinois closure construction contractor bids received in 2019.

4. *ASSESSMENT, INSPECTION, AND REPORTING REQUIREMENTS (Part 845 Subpart D: Design Criteria and Subpart E: Operating Criteria)*

Opinion 10: Section 845.540(b) requires that a CCR surface impoundment undergo annual inspections by a qualified professional engineer. Unlike Section 845.540(a) that addresses annual inspections by a qualified person and requires regular inspections during the post-closure care period, Section 845.540(b) does not provide a clear statement as to whether the annual qualified professional engineer inspection requirement applies during the 30-year post-closure period. I suggest that Part 845 be clarified in this regard. Moreover, annual

[22]Low permeability layer is 36 inches thick; final protective layer is 36 inches thick.

[23]The tipping fee for off-site disposal is estimated to be $29/ton; this fee was obtained through a telephone survey of several landfill owners/operators and the first-hand knowledge of Geosyntec's solid waste professionals; CCR unit weight estimated as 90 pounds per cubic foot; daily off-site disposal rate estimated as 1,000 CY/day based on waste acceptance rate at off-site disposal facility.

inspections by a qualified professional engineer are not needed during the post-closure care period. Therefore, I suggest that Part 845 make it clear that annual qualified professional engineer inspections can cease at the initiation of closure. However, if IEPA retains a requirement in Part 845 that annual inspections by a qualified professional engineer must occur during the post-closure care period, I suggest they be conducted once every five years rather than annually. I note that the Federal CCR Rule does not contain any requirement for qualified professional engineer inspections during the post-closure care period.

- It could be inferred that Part 845 requires annual inspections of CCR surface impoundments by a qualified professional engineer during the post-closure care period. The inference is based on Section 845.540(b)(1)(A), which states that the annual inspection by the qualified professional engineer must include, among other things, "the results of inspections by a qualified person." Given that Part 845 requires regular qualified-person inspections throughout the duration of the post-closure care period, does this mean that the qualified professional engineer must conduct annual inspections for that same duration? I suggest that IEPA's intent with respect to annual post-closure care inspections by a qualified professional engineer be clarified.
- My opinion that annual inspections by a qualified professional engineer are unnecessary during the post-closure care period is supported by the fact that under Part 845, the CCR surface impoundment closure design will be prepared by a qualified professional engineer under an approved permit issued by IEPA. Further, closure construction will be conducted in accordance with the Construction Quality Assurance (CQA) Program requirements of Section 845.290. The CQA program must be led by a CQA Officer (who is also a qualified professional engineer) and conducted in accordance with an IEPA-approved CQA Plan. In summary, given the requirements placed on the design, construction, and CQA of a CCR surface impoundment closure, there is no need to require that qualified professional engineer inspections be conducted at some frequency throughout the closure and post-closure care periods.
- The configuration of a closed CCR surface impoundment should not change from year to year during the post-closure care period. Closed facilities are more stable than they were during their operating life due to the removal of standing water, CCR dewatering, final grading and capping of the CCR, installation of the final stormwater management system, and other engineering measures that may be implemented at the closure. Closed facilities are more like solid waste landfills than liquid-containing surface impoundments. This fact further supports my opinion that inspections by a qualified professional engineer are not needed during the post-closure care period.
- Based on Section 845.540(a), regular and storm-related post-closure inspections of CCR surface impoundments must be conducted by a qualified person. The inspections are required to look for "appearances of actual or potential structural weakness and other

conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR surface impoundment." Should either the storm-related or periodic inspections reveal damaged or deteriorated conditions, those conditions must be included in an inspection report that is recorded in the facility's operating record. This would trigger the owner or operator to investigate the conditions, likely engage the qualified professional engineer to evaluate the conditions, and result in maintenance and repairs to the CCR surface impoundment under the oversight of IEPA. This process further obviates the need to prescribe inspections by the qualified professional engineer during the post-closure care period.

Opinion 11: The Federal CCR Rule requires that hazard potential classification, structural stability, and safety factor assessments be performed at existing CCR surface impoundments at least once every five years. Part 845 requires that these assessments (i.e., Hazard Potential Classification Assessment [Section 845.440], Structural Stability Assessment [Section 845.450], and Safety Factor Assessment [Section 845.460]) be conducted annually. This annual frequency is five times greater than that required by the Federal CCR Rule; it is excessive and more than needed. Also, the Federal CCR Rule has no requirement to conduct these assessments during the closure or post-closure care periods. Part 845 is silent with respect to the need to conduct these assessments during the post-closure care period. Such assessments during the post-closure care period are not necessary. I suggest that Part 845 be clarified in this regard.

- I suggest that IEPA use the same frequency for these assessments as given in the Federal CCR Rule, plus whenever there is a change in the condition of the CCR surface impoundment that would warrant an updating of the assessments. Moreover, I recommend that Part 845 include clarifying language on the time period over which the assessments must be conducted and that they not be required during the closure and post-closure care period.
- The qualified professional engineer conducting the assessments required by Sections 845.440, .450, and .460 will (assuming he/she follows the standard of care for these types of evaluations) consider the conditions that exist in the CCR surface impoundment not only at the time of the assessments, but also the anticipated conditions (i.e., CCR levels and grades, water levels in the impoundment) in the years following the assessments. Analysis of the anticipated future conditions at a facility (based on a facility's phasing/development plans) is common to the analysis and design of virtually all types of waste containment systems. By analyzing the anticipated future conditions, the qualified professional engineer eliminates any need for annual analyses. USEPA chose a 5-year frequency for conducting the periodic assessments, and I suggest that IEPA consider a similar frequency for Part 845. IEPA can assure that the assessments are conducted for the range of anticipated conditions over the five-year periodic-assessment interval by

indicating in Part 845 that the assessments must consider the anticipated range of conditions at the facility over the assessment interval.

- Moreover, Section 845.540(b) requires that CCR surface impoundments be inspected annually during their operating lives by a qualified professional engineer. Part 845 requires the annual inspection to consider the previous hazard potential classification, structural stability, and safety factor assessments. If the qualified professional engineer finds that the facility conditions are deviating from the range of conditions used in the assessments, the engineer will be obligated to address them in the annual inspection report. The owner or operator and/or IEPA would initiate actions to address the deviations if they were judged to be significant and updated assessments could be prepared at that time. This process further supports the adequacy of a five-year frequency for the three assessments.
- As stated in my opinion, I recommend that Part 845 provide clarifying language that the hazard potential classification, structural stability, and safety factor assessments are not required during the closure and post-closure care periods. While it might be inferred that they are not required during the post-closure care period because all three assessments are addressed in Part 845 Subpart D: Design Criteria, there is no statement to this effect. The only statement made (using the Hazard Potential Classification Assessment, Section 845.440, as an example) is "The owner or operator of the CCR surface impoundment must conduct an initial and annual hazard potential classification assessment of the CCR surface impoundment." The rule doesn't state when the assessments can be stopped. As previously described, based on Section 845.540(a), inspections of the closed CCR surface impoundment will be conducted during the post-closure care period by a qualified person. Should the inspections reveal damage or deteriorated conditions, those conditions must be included in an inspection report that is recorded in the facility's operating record. This would trigger the owner or operator to investigate the conditions, likely engage the qualified professional engineer to evaluate the conditions, and result in maintenance and repairs to the CCR surface impoundment under the oversight of IEPA. This process eliminates any need to prescribe hazard classification, structural stability, or safety factor assessments during the post-closure care period unless there is a change in the site conditions that warranted such.
- Finally, I reiterate that during the post-closure care period, a CCR surface impoundment is in many ways more akin to a landfill than a liquid impoundment. With this thought in mind, I note that 35 Ill. Adm. Code 811 (Standards for New Solid Waste Landfills) does not require hazard potential classification, structural stability, or safety factor assessments.

Opinion 12: The Federal CCR Rule requires that groundwater monitoring (i.e., detection and assessment monitoring per 40 CFR §257.94 and .95) be conducted semi-annually during

the active life and post-closure care period of a CCR surface impoundment. The federal rule allows the owner or operator to propose an alternative monitoring frequency, up to annually, for limited site-specific conditions. Part 845 requires that groundwater monitoring be "at least quarterly during the active life of the CCR surface impoundment and the post-closure care period or period specified in Section 845.740(b) when closure is by removal." There is no provision in Part 845 for an alternative monitoring frequency. I suggest that IEPA consider provisions for allowing an alternative monitoring frequency in Part 845 when a technical demonstration (certified by a qualified professional engineer and approved by IEPA) shows that the alternative frequency satisfies applicable performance criteria (to also be added to Part 845). This suggestion can be considered separately for both the operating life of the CCR surface impoundment and the post-closure care period.

- There may be sites where groundwater flow velocity is so slow, and the site so well characterized, that quarterly groundwater monitoring data are not needed to be protective of human health and the environment. In those cases, semi-annual monitoring may be adequate based on a technical demonstration using factors such as those defined in the Federal CCR Rule or developed specifically for Part 845.
- While the protectiveness of semi-annual groundwater monitoring may be demonstrated at both active and closed facilities, it is likely to be achieved more frequently at closed facilities during the post-closure care period. During this period, water infiltration into, and leachate seepage through, the CCR surface impoundment are substantially reduced compared to rates during active operation of the impoundment. There may thus be less groundwater mounding beneath the surface impoundment, and consequently, slower groundwater velocities. There will also often be decreasing concentrations of regulated groundwater parameters.
- Given the long duration of the post-closure care period (30 year minimum), a reduction in groundwater monitoring frequency from quarterly to semi-annually, at sites where an adequate technical demonstration can be made, has the potential to conserve considerable resources and substantially reduce the cost of post-closure care without compromising the ability to evaluate potential changes to groundwater quality.

Rudolph Bonaparte - Background and Qualifications

I am a Senior Principal at Geosyntec Consultants ("Geosyntec"), a national professional services firm specializing in the earth and environmental sciences, engineering analysis and design, and construction management and quality assurance. I have been employed by Geosyntec for nearly 34 years, since 1986. I work out of the firm's Brookhaven, Georgia office, near Atlanta. In addition to my position at Geosyntec, I am also a Professor of the Practice in the School of Civil and Environmental Engineering at the Georgia Institute of Technology.

I obtained my B.S. in civil engineering in 1977 from the University of Texas at Austin. I received M.S. and Ph.D. degrees in civil (geotechnical) engineering from the University of California, Berkeley in 1978 and 1981, respectively. My post-academic career spans nearly 40 years of professional practice experience in the areas of geoenvironmental and geotechnical engineering applied to waste management, environmental remediation, and civil infrastructure projects. This experience includes site investigations, laboratory testing, feasibility studies, engineering analyses, conceptual and detailed design, construction oversight, and performance monitoring. I am a registered professional civil engineer in Illinois and 17 other states. I am an elected member of the U.S. National Academy of Engineering. I am also a Fellow of the American Society of Civil Engineers.

I am experienced in the design, construction, and performance assessment of solid, hazardous, industrial (including CCR), and low-level radioactive (LLRW) landfills and surface impoundments. I am also experienced in the design, construction, and performance assessment of projects involving contaminated soil excavation and disposal, subsurface hydraulic barrier walls, subsurface leachate and groundwater interceptors, and contaminated sediment remediation. I have been the engineer-of-record for the design and/or construction quality assurance (CQA) on more than twenty RCRA Subtitle C or D waste disposal facility projects and three major CERCLA site remediation projects. I have also been involved in a variety of capacities (other than as engineer-of-record) in more than 100 RCRA, CERCLA, and state-led waste management and/or environmental assessment and remediation projects. I am the lead co-author of several technical resource and guidance documents on the design, construction, and performance of waste containment systems for landfills, waste piles, and surface impoundments published by the U.S. Environmental Protection Agency (USEPA).

My experience with the permitting and engineering of CCR landfills and impoundments goes back more than 25 years, to when I served as the engineer-of-record for the expansion of CCR landfills in Virginia and Ohio, and the development of groundwater monitoring programs for each. I have also been involved in the permitting, design, closure, and/or evaluation of CCR landfills or impoundments in Alabama, Florida, Georgia, Iowa, North Carolina, and Tennessee. I am familiar with the physical and chemical characteristics of CCRs as well as the USEPA (RCRA) CCR Rule contained in 40 CFR §257 and the USEPA (Clean Water Act [CWA]) Effluent Limitation Guidelines contained in 40 CFR §423. I am also familiar with historical practices for managing CCRs at coal-fired power plants and how those practices have evolved in recent years in response to promulgation of state and federal CCR rules, most notably the 2015 USEPA CCR Rule.

* * * * * * * * * *

CERTIFICATE OF SERVICE

I, the undersigned, certify that on this 27th day of August, 2020, I have served electronically the attached **Dynegy's Prefiled Testimony**, upon the individuals on the attached service list. I further certify that my email address is rgranholm@schiffhardin.com; the number of pages in the email transmission is 278; and the email transmission took place before after 5:00 p.m.

Respectfully submitted,

/s/ Ryan C. Granholm
Ryan C. Granholm

SCHIFF HARDIN LLP
Joshua R. More
Stephen J. Bonebrake
Ryan C. Granholm
233 South Wacker Drive,
Suite 7100
Chicago, Illinois 60606
(312) 258-5633
rgranholm@schiffhardin.com

Michael L. Raiff
GIBSON, DUNN & CRUTCHER LLP
2001 Ross Avenue, Suite 2100
Dallas, TX 75201-6912
(214) 698-3350
mraiff@gibsondunn.com

Attorneys for Dynegy

SERVICE LIST	
Vanessa Horton, Hearing Officer Vanessa.Horton@illinois.gov Don Brown, Assistant Clerk Don.brown@illinois.gov Illinois Pollution Control Board James R. Thompson Center Suite 11-500 100 West Randolph Chicago, Illinois 60601	Rex L. Gradeless Rex.Gradeless@illinois.gov Stephanie N. Diers Stefanie.Diers@illinois.gov Christine M. Zeivel Christine.Zeivel@illinois.gov Illinois Environmental Protection Agency 1021 N. Grand Ave., East, P.O. Box 19276 Springfield, Illinois 62794-9276
Virginia I. Yang - Deputy Counsel virginia.yang@illinois.gov Nick San Diego - Staff Attorney nick.sandiego@illinois.gov Robert G. Mool bob.mool@illinois.gov Paul Mauer - Senior Dam Safety Eng. Paul.Mauer@illinois.gov Renee Snow - General Counsel renee.snow@illinois.gov Illinois Department of Natural Resources One Natural Resources Way Springfield, IL 62702-1271	Matthew J. Dunn mdunn@atg.state.il.us Stephen Sylvester ssylvester@atg.state.il.us Andrew Armstrong aarmstrong@atg.state.il.us Kathryn A. Pamenter KPamenter@atg.state.il.us 69 West Washington Street, Suite 1800 Chicago, IL 60602
Deborah Williams Deborah.Williams@cwlp.com City of Springfield Office of Utilities 800 E. Monroe, 4th Floor Municipal Building East Springfield, IL 62757-0001	Kim Knowles Kknowles@prairierivers.org Andrew Rehn Arehn@prairierivers.org 1902 Fox Dr., Ste. 6 Champaign, IL 61820
Jennifer Cassel jcassel@earthjustice.org Thomas Cmar tcmar@earthjustice.org Mychal Ozaeta mozaeta@earthjustice.org Melissa Legge mlegge@earthjustice.org Earthjustice 311 South Wacker Drive, Suite 1400 Chicago, IL 60606	Jeffrey Hammons JHammons@elpc.org Kiana Courtney KCourtney@elpc.org Environmental Law & Policy Center 35 E. Wacker Dr., Suite 1600 Chicago, Illinois 60601

Faith Bugel fbugel@gmail.com 1004 Mohawk Wilmette, IL 60091	Michael Smallwood Msmallwood@ameren.com 1901 Choteau Ave. St. Louis, MO 63103
Mark A. Bilut Mbilut@mwe.com McDermott, Will & Emery 227 W. Monroe Street Chicago, IL 60606-5096	Abel Russ aruss@environmentalintegrity.org Environmental Integrity Project 1000 Vermont, Ave NW, Ste. 1100 Washington, DC 20005
Susan M. Franzetti Sf@nijmanfranzetti.com Kristen Laughridge Gale kg@nijmanfranzetti.com Vincent R. Angermeier va@nijmanfranzetti.com Nijman Franzetti LLP 10 S. Lasalle St., Ste. 3600 Chicago, IL 60603	Alec M Davis adavis@ierg.org Kelly Thompson kthompson@ierg.org Illinois Environmental Regulatory Group 215 E. Adams St. Springfield, IL 62701
Jennifer M. Martin Jennifer.martin@heplerbroom.com Melissa Brown Melissa.brown@heplerbroom.com Heplerbroom, LLC 4340 Acer Grove Drive Springfield, Illinois 62711	Cynthia Skrukrud Cynthia.Skrukrud@sierraclub.org Jack Darin Jack.Darin@sierraclub.org Christine Nannicelli christine.nannicelli@sierraclub.org Sierra Club 70 E. Lake Street, Ste. 1500 Chicago, IL 60601-7447
Amy Antoniolli aantoniolli@schiffhardin.com Schiff Hardin, LLP 233 S. Wacker Dr., Ste. 7100 Chicago, IL 60606-6473	Walter Stone Water.stone@nrgenergy.com 8301 Professional Place, Suite 230 Landover, MD 20785
Alisha Anker aanker@ppi.coop Prairie Power Inc. 3130 Pleasant Runn Springfield, IL 62711	Chris Newman newman.christopherm@epa.gov U.S. EPA, Region 5 77 West Jackson Blvd. Chicago, IL 60604-3590

Keith Harley kharley@kentlaw.iit.edu Daryl Grable dgrable@clclaw.org Chicago Legal Clinic, Inc. 211 W. Wacker Dr. Ste. 750 Chicago, IL 60606	Claire Manning cmanning@bhslaw.com Anthony Shuering aschuering@bhslaw.com Brown, Hay & Stephens, LLP 205 S. Fifth Street, Suite 1000 P.O. Box 2459 Springfield, IL 62705-2459