BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
COAL COMBUSTION WASTE (CCW) ASH	)	R14-10
PONDS AND SURFACE IMPOUNDMENTS	)	(Rulemaking - Water)
AT POWER GENERATING FACILITIES:	)	
PROPOSED NEW 35 ILL. ADM. CODE 841	)	

NOTICE OF ELECTRONIC FILING

To: **Service List**

PLEASE TAKE NOTICE that on April 9, 2014, I electronically filed with the Clerk of the Pollution Control Board of the State of Illinois on behalf of the Environmental Law & Policy Center, Environmental Integrity Project, Sierra Club, and Prairie Rivers Network ("Environmental Groups"), **the Pre-Filed Testimony of Keir Soderberg and the Pre-Filed Testimony of Traci Barkley**, copies of which are attached hereto and herewith served upon you.

Dated: April 9, 2014

Respectfully submitted,

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PRE-FILED TESTIMONY OF KEIR SODERBERG, PH.D.

Qualifications

My name is Keir Soderberg. I am a Senior Project Scientist with S. S. Papadopulos & Associates, Inc. I have over 10 years of research and field experience in geochemistry and hydrology, and have been a consultant for more than 5 years. My areas of expertise include environmental geochemistry, hydrology and the analysis of geochemical fingerprints. I hold a Ph.D. degree in environmental science from the University of Virginia, a Master's degree in environmental geochemistry from the University of Cape Town, South Africa, and a Bachelor's degree in civil and environmental engineering from Princeton University. I have authored or co-authored several peer-reviewed publications and am a reviewer for academic journals as well as the National Science Foundation's Hydrologic Sciences Program. I was awarded a Fulbright scholarship for my Ph.D. research and was a postdoctoral scholar at Princeton University for two years. I am currently a member of the American Geophysical Union and the International Association of Geochemistry.

General Comments

The management of coal combustion waste is a critical issue for the protection of human health and the environment. The current efforts by the IEPA, the Board, and others participating in these hearings should be commended. There are many technical challenges involved, and the goal of my testimony on behalf of Environmental Groups is to improve the proposed rule, reducing uncertainty for generators, regulators, and the public.

I will provide testimony on several aspects of the proposed rule that relate to my expertise. These aspects include: applicability, monitoring, corrective action, closure, design criteria, and surface water impacts. My comments are organized here by section, and refer specifically to the Revised Proposed Part 841 dated March 25, 2014 (IEPA 2014a, Attachment 2).

Section 841.105 Applicability

This section on applicability requires clarification of three points: (1) the definition of "operated" in subsection 841.105(a); (2) the determination that the exemption stated in subsection 841.105(b)(5) applies; (3) the demonstration that an inactive impoundment is not impacting groundwater (i.e. that a unit is "outside the scope of application set forth in subsection (a)"

(IEPA 2014a, Attachment 2, page 3, "Board Note")); and (4) how and when any of the exemptions must be demonstrated.

First, the definition of "operated" with respect to subsection 841.105(a) has been discussed in the Agency comments as part of these hearings. In its response to Board questions, the Agency stated that "[t]he Agency will consider the unit in operation if it has stopped receiving CCW, but continues to receive stormwater or other waste streams" (IEPA 2014b, Attachment 1, page 9). In response to another Board question, the Agency stated that "[t]he Agency seeks to use the leachate definition to differentiate between stormwater that falls within the foot-print of a surface impoundment […] and stormwater that falls on a surface where CCW may be present from air deposition and be entrained in the storm water run-off" (IEPA 2014b, Attachment 1, page 14). From these two responses, one possible interpretation is that any uncapped impoundment that contains CCW would be within the implied definition of "operated" even if it is not receiving new CCW. Such impoundments receive stormwater both as direct precipitation and runoff. The inclusion of such impoundments is scientifically justified given that infiltrating stormwater will continue to leach chemical compounds from the CCW and therefore contribute to groundwater contamination. Nevertheless, this interpretation should be clarified in the proposed rules. A third Agency response stated that 58 of the 91 existing impoundments "can receive CCW" (IEPA 2014b, Attachment 1, page 1). Given the Agency's responses referenced above, the Board should include in the regulations a definition of "operated", and/or a clarification within (a), that includes all impoundments that can receive CCW and all impoundments that are open to stormwater either as direct precipitation or runoff.

Second, the exemption in subsection 841.105(b)(5) states that an impoundment is exempt if it "does not contain more than one cubic yard of CCW and is used to only collect stormwater runoff, which does not contain leachate." The language here is unclear on whether the Agency is stating that by definition stormwater runoff does not contain leachate or whether there is some demonstration required to show that stormwater runoff is not picking up some leachate prior to entering the impoundment. It is also unclear whether stormwater runoff that comes in contact with raw coal is considered as containing leachate.

Third, as stated in subsection 841.105(a)(2), the rule would apply to an impoundment that is not operated after the effective date but "[…]causes or contributes to an exceedence of groundwater quality standards[…]." Once again, it is unclear how and when the Agency will make this determination because the current monitoring requirements provided by the proposed regulations are inadequate to make this determination. In its responses to ELPC questions, the Agency states that it "cannot in all instances identify specific impoundments that are suspected of causing groundwater contamination" (IEPA 2014b, Attachment 4, page 2). Thus, for sites with groundwater exceedences, it could be warranted for the Agency to conclude that all impoundments at the site are contributing to exceedences. However, the proposed language and the Agency's responses to Board questions (IEPA 2014b, Attachment 1, pages 1-2) suggest that inactive impoundments that are not currently suspected of contributing to contamination, or that are not yet being monitored by the Agency for contributing to contamination, could be viewed as permanently not contributing to contamination. The result is that without monitoring at the units exempted from the rule, the rule will never capture failures at these units in the future, resulting in unabated groundwater contamination. Thus, there is a gap in the proposed rule with respect to the 33 impoundments that currently cannot receive CCW (IEPA 2014b, Attachment 1, page 1).

Last, it is unclear how and when the Agency will determine and/or the operator will demonstrate that a given unit is exempt from the proposed rule. For example, for the exemption stated in (b)(5), it is unclear how and when it will be demonstrated that a unit contains less than one cubic yard of CCW and whether this determination gets re-evaluated as part of an annual report. First, as described in section 841.210, the groundwater monitoring plan will include a description of each unit (subsection 841.210(b)(3)), as well as a schedule for submitting "annual reports" (subsection 841.210(b)(9)). However, these annual reports apparently refer only to the annual statistical analyses of monitored chemical constituents (section 841.235). Section 841.105 should state specifically that all units at a given site must be listed in the groundwater monitoring plan and in all annual reports along with descriptions following section 841.210(b)(3) as well as their status with respect to the rule. This annual listing would make it easier for the Agency to track the status of old units as well as any new units. Second, this section should state specifically what is required to verify that the inactive impoundments exempted from the proposed rule under section 841.105(a)(2) are not a threat to human health and the environment, including the level of detail required along with how and when such a demonstration would be reported to the Agency.

Alternatively, the rule could be applicable to all impoundments, active or inactive, for monitoring and corrective action and closure as needed. Including all impoundments would reduce confusion given that some of the provisions of the proposed rule apply to the entire site (e.g. section 841.200 "Hydrogeologic Site Characterization") and some to units (e.g. section 841.170 "Inspection").

Section 841.110 Definitions

In the "leachate" definition, "fugitive ash" is not defined. It is unclear whether fugitive ash refers to CCW outside of managed units. It is also unclear whether stormwater runoff that comes into contact with raw coal would be considered leachate.

The Board should include a definition of "operate" here and/or in subsection 841.105(a) as discussed above.

The Board should include a definition of "releases" here and/or in subsection 841.400(a)(1) as discussed below.

Section 841.170 Inspection

Various techniques and instruments are available for remote monitoring of parameters related to dam safety. This type of monitoring is now available at a reasonable cost, and is recommended by the U.S. EPA for tailings dams (U.S. EPA 1994). For example, the water content (or water potential) of earthen dams is a critical parameter in tracking slope stability, and could be monitored remotely in real-time. This kind of timely data could help guide the inspectors to trouble spots and possibly trigger inspections. Also, the Technical Support Document (IEPA

2013, Attachment A, page 10) indicated that two impoundments in particular have the potential to impact off-site drinking water – Havana East Pond and Edwards. Units of particular interest such as these should be given special inspection or monitoring status (e.g. inspections after every 10-year storm rather than every 25-year storm).

Subpart B: Monitoring (Sections 841.200 through 841.235)

There are numerous improvements that the Board should make to the subpart of the rule covering monitoring. First, the monitoring required by the rule should include monitoring of surface waters. I have provided additional testimony below on the need to address surface waters as a part of this rule. Leachate from CCW impoundments that enters the groundwater can be a threat to human health and the environment via two primary receptors: drinking water wells and surface water. These two source-to-receptor pathways were recognized in the U.S. EPA's risk assessment for CCW (U.S. EPA 2010a). The monitoring requirements in Subpart B address the drinking water well receptor, but not the surface water receptor. Although the proposed rule notes that distinct discharges to surface water will be regulated by NPDES permits, the discharge of contaminants to surface water via groundwater would not be regulated or even monitored. This type of discharge represents a gap in the proposed rule. The Agency should add requirements in Subpart B for characterizing and monitoring the groundwater-to-surface water pathway, including sampling of the hyporheic zone (USGS 2008; Environment Agency 2009; U.S. EPA 2013).

Second, the monitoring system should explicitly include measurement of water levels at each monitoring well on a quarterly basis. These measurements are necessary for understanding groundwater movement and for defining whether a monitoring well is upgradient or downgradient of a unit (e.g., subsection 841.220(c)). Water levels are the underlying data for building a map of the potentiometric surface as required in subsection 841.200(c)(14)(E) for the hydrogeologic site characterization, but this requirement would only produce a snapshot in time. The potentiometric surface can change on daily, seasonal and annual scales – and is likely to be especially dynamic in areas close to surface water, as is typical of CCW impoundment sites (U.S. EPA 2010b). In addition, groundwater mounding beneath CCW impoundments is one of the most critical processes affecting the movement of CCW leachate, and could be tracked with regular water level measurements. Seasonal variations in water levels that are potentially independent of CCW impoundments need to be accounted for when assessing the possibility of groundwater mounding due to infiltrating leachate. The minimum measurement frequency for tracking seasonal changes is quarterly. The Board should add a provision to subsection 841.205(c) to require that the monitoring system be adequate for assessing the overall groundwater flow and direction at the site as well as changes to the flow regime due to leachate from CCW impoundments. The Board should add a provision to subsection 841.210(b) to require water level measurements and a potentiometric surface map showing all units and monitoring wells. Section 841.235 should address the annual report referred to in subsection 841.210(b)(9), with subsections describing (a) the annual production of an updated potentiometric surface map and (b) the annual statistical analysis.

Third, the rules require more detailed guidance on statistical comparisons to numerical groundwater standards and background values (Sections 841.220, 841.225, 841.230 and

841.235). To begin with, comparing potentially impacted groundwater to background groundwater will be heavily dependent on the number of data points used to characterize each statistical population. The proposed rules state that an increase in chemical concentration has to be statistically significant in order to trigger a preventive response (IEPA 2013, Attachment A, page 34). The rules reference the U.S. EPA's Unified Guidance, which recommends that a minimum of 8 data points be used to establish background (U.S. EPA 2009). In its response to pre-filed questions, the Agency does not specifically acknowledge that a minimum of 8 data points will be required for a given comparison to provide a statistically significant result (IEPA 2014b, Attachment 3, page 31). Presumably the Agency was vague in its response to allow for flexibility in applying the requirement of statistical significance. Some tests, such as the non-parametric Mann-Kendall trend test, could be performed on as few as four data points. However, the Unified Guidance suggests a minimum of 8 data points to reduce the error rate for such tests. Under the proposed rules, it would take four years of semi-annual monitoring to generate 8 data points. To be most protective of human health and the environment, the Board should require a period of more frequent monitoring when a new well is installed or for instances where a new background value has to be established. For example, monthly monitoring for one year (IEPA 2014b, Attachment 3, page 31) would provide, in a timely manner, enough data points for statistical tests and a sense of any seasonal variations to consider for the long-term semi-annual monitoring. The rule should also specify what to do when very few data points are available to characterize site-specific background concentrations and/or the potentially impacted groundwater concentrations. For example, the state-wide background data set for the relevant aquifer system, as established in the Technical Support Document (IEPA 2013, Attachment A, pages 4-18), could be used to establish an Upper Tolerance Limit (UTL) or Upper Prediction Limit (UPL) to which a single compliance well sample result could be compared. Then, once enough data has been collected to establish a site-specific background, a new UTL or UPL would be used (or a different approved statistical comparison).

Fourth, the use of the term "increase" regarding chemical concentrations in section 841.235 "Statistical Analysis" is unclear. Instead of simply using the term "increase", the rules should specifically and consistently reference the various statistical comparisons and trend tests. For example, the Technical Support Document refers to a "statistically significant increasing concentration" (IEPA 2013, Attachment A, page 32), which could refer to an intrawell trend over time or to a comparison between a single well and background. The next paragraph is more specific, "the concentration of a chemical constituent in a down gradient well differs to a statistically significant degree from the concentration detected in an upgradient well" (IEPA 2013, Attachment A, page 33). Such a comparison would require a certain amount of data as discussed above. To reduce confusion and to have a more uniform set of statistics for each facility, the rule needs to define four comparisons at each compliance well: (1) whether a reported concentration is above the relevant numerical standard; (2) whether there are any trends over time at a given well; (3) whether a reported concentration is above the relevant state-wide background concentration (IEPA 2013, Attachment A, pages 4-18); (4) whether a reported concentration is above the relevant site-specific background criterion.

Establishing a site-specific background distribution can be difficult based on the fact that in many cases monitoring wells are only available on-site, and the on-site hydrology can be dominated by the groundwater mound created by an impoundment. In this situation, a comparison to the state-wide background statistics would be necessary. This comparison would give the Agency necessary information, for instance, with respect to alternative cause demonstrations. This is also the type of comparison the Agency would need "to be satisfied that the groundwater data used to establish the background (baseline) value is not already contaminated" (IEPA 2014b, Attachment 3, page 23). The Agency leaves the site-specific background comparison criterion open to the various possibilities described in the Unified Guidance. These possibilities include prediction limits, tolerance intervals and control charts. However, the Unified Guidance was written to encompass groundwater monitoring statistics at all types of RCRA sites, not only surface impoundments. Given the differences among the criteria presented as options in the Unified Guidance, the rule should provide a set of preferred background comparison tools as a starting point or rank the various options in order of preference based on the Agency's experience with monitoring at surface impoundment sites. For example, the Agency could indicate that interwell comparisons are preferable to intrawell comparisons, as long as unimpacted background wells can be established. Another example would be to state that the Upper Prediction Limit is typically appropriate for evaluating background exceedences at surface impoundment sites. Both of these recommendations would potentially affect the monitoring program design. This guidance would help make evaluating the statistics more manageable and more comparable across different sites and units.

Further, the rule requires a statistically significant increase in concentration to trigger a preventive action, corrective action, or further investigation (e.g., subsection 841.235(c)). If two different statistical procedures are used, however, it could lead to a conflict. The rule therefore should provide what will happen when two viable statistical procedures disagree. For example, it is often the case that a parametric and a non-parametric approach are both applicable for determining the upper prediction limit of a set of background concentration data. A parametric procedure such as a lognormal Regression on Order Statistics can produce a substantially different upper prediction limit than a non-parametric procedure such as Kaplan-Meier, especially when only a small number of background data points are available. Resolving this type of discrepancy will fall to the Agency, but the rule could outline a set of preferences to reduce the number of disputes that may arise. For example, the Board could state that parametric tests are preferable due to their higher statistical power than non-parametric tests, but only when all of the relevant assumptions are satisfied. Another example would be that non-parametric tests are preferred when the data set contains a certain frequency of non-detect data. Alternatively, the Board could require that several statistical tests be performed – a task that is trivial for most statistical software. The comparison of several tests can often provide information on the robustness of a single test result.

Fifth, under section 841.215, the Agency excludes radium-226 and radium-228 from the list of chemical constituents to be monitored. These radioactive constituents are not present in very high concentrations in CCW leachate, and their transport via groundwater can be retarded relative to constituents such as boron. However, in sample results presented by the Agency as part of these hearings (IEPA 2014a, Attachment 4, pages 493 and 517), concentrations were reported that exceeded the federal MCL for drinking water of 5 pCi/L (for the combined Ra-226 + Ra-228) in two locations (City Power & Light sample AP-2 at 10.2 pCi/L, and City Power & Light sample AP-5 at 12.2 pCi/L). Although the Illinois numerical groundwater standards allow for higher concentrations (20 pCi/L for Ra-226 and 20 pCi/L for Ra-228), the Illinois surface water standards are much lower (3.75 pCi/L for Ra-226+Ra-228). Given that elevated concentrations exist, and that leachate would not have to travel far to reach surface water in many CCW impoundment scenarios, these constituents should be monitored. At a minimum, Gross Alpha and Gross Beta activity could be monitored if the cost of Ra-226 and Ra-228 determinations is a concern for the Board or Agency.

Sixth, the Agency's March 25, 2014 revision to subsection 841.230(c) allows for the reduction in monitoring frequency for certain monitoring wells. This subsection includes a prohibition on reduced monitoring. However, the prohibition, "[r]educed monitoring is prohibited when the unit or units associated with monitoring well does not have a liner…," assumes that a given monitoring well can be associated with a specific unit. As mentioned above, the Agency has stated that it "cannot in all instances identify specific impoundments that are suspected of causing groundwater contamination" (IEPA 2014b, Attachment 4, page 2). The language in this subsection should be clarified to reflect that a monitoring well may receive leachate from multiple impoundments, and that one unit cannot always be associated with a specific monitoring well being considered for reduced monitoring. A better provision would be to prohibit a reduction in monitoring for any facility with unlined impoundments that are subject to the proposed rule.

Last, subsections (c)(1) and (c)(2) allow for reduced monitoring once every five years in upgradient and downgradient wells for a chemical constituent that has not been detected in five years. These changes to monitoring frequency would represent a drastic reduction in frequency from the proposed semi-annual monitoring. One sample every five years is insufficient for several reasons. First, if a constituent is only monitored once every five years in an upgradient well, and it is subsequently detected in a downgradient well, alternative causes would be much more difficult to demonstrate and evaluate compared to having semi-annual monitoring. Second, late detection of contamination will make remediation more difficult and costly, and will unnecessarily threaten human health and the environment. Third, monitoring once every five years would place a large amount of statistical weight on one individual sample. Individual samples can be affected by seasonal variations, sampling errors, and analytical problems such as matrix interference. Fourth, it is likely that CCW leachate plumes will have multiple concentration fronts based on variability in infiltration due to the use of different impoundments at different times, precipitation pulses, and changes to the type of waste deposited in a given impoundment. Sampling once every five years is insufficient to capture these variabilities. Fifth, chemical constituents in CCW leachate travel at different rates in the subsurface due to conditions in the groundwater (pH, redox potential) and the type of soil or aquifer material to which they are exposed. Thus, the first rise in concentration and the peak concentration will be seen at different times for different chemical constituents (e.g. Zheng and Bennett 2002). Reduced sampling due to a series of non-detects could be premature due to a delayed rise in or peak concentration of a contaminant, and subsequent sampling once every five years could similarly miss the peak concentration of this contaminant. Given these concerns with a five year sampling frequency, the Board should require no less frequent than annual monitoring[1]. Further,

[1] The Technical Support Document stated that "the lowest frequency for monitoring will be semi-annually." (IEPA 2013, Attachment A, page 32). If any reduction in monitoring frequency is to allowed under the proposed rules, the Agency should supply additional justification of why it has departed from the position in its Technical Support Document.

the Board should allow this only after general seasonal variations in detected constituents are characterized so that samples will be collected during an appropriate season. Finally, the Board should prohibit reduced monitoring for a core set of chemical constituents that are known to leach from CCW. For example, the U.S. EPA's 2010 CCW risk assessment identified 24 constituents of concern for CCW leachate with human health benchmarks, including: arsenic, beryllium, boron, cadmium, chromium, lead, mercury, molybdenum, and thallium. Studies of CCW leachate have confirmed the presence of these constituents in leachate (EPRI 2006; U.S. EPA 2009).

Subpart C: Corrective Action (sections 841.300 through 841.325)

The Board should make a number of changes to improve the provisions on corrective action. First, if corrective action establishes additional compliance points, these should be targeted at evaluating off-site migration toward both groundwater receptors and surface water receptors, as described above under Subpart B and in my testimony on groundwater-surface water interaction below.

Second, section 841.305 needs to be more specific with respect to the level of detail required in an alternative cause demonstration. In order for an alternative cause to be plausible, the demonstration must describe and justify a specific cause with documentation. The current language allows for three types of alternative causes: (1) an error in sampling, analysis or evaluation; (2) natural causes; (3) a source other than the unit. The Board should require the alternative cause demonstration to identify at least one of these causes, and to provide a documented justification. For example, Ameren provided the following explanation as an alternative cause for arsenic at its Venice facility: "Arsenic is present inside and outside of the boron plume at levels above the Class I standard. These data suggests [sic] that the ash pond system does not contribute a significant source of arsenic to groundwater" (Ameren 2010, page 9). This explanation is not sufficient to demonstrate an alternative cause. First, there is no suggested alternative cause or source of arsenic (e.g. natural conditions or another industrial source). Second, there is no documentation for the existence of such a cause or source. Third, the lack of correspondence between arsenic and boron concentration patterns in the groundwater could potentially be explained in other ways, rather than solely by an alternative cause. This lack of correspondence could also be caused by the type of CCW in each pond, the hydrogeology of each pond, and the geochemical conditions in the subsurface. None of these conditions were mentioned as part of the alternative cause demonstration, highlighting the need for specific requirements in the rule.

Third, section 841.310 should include requirements for source characterization and source control as part of a corrective action plan. As written, the proposed rule does not provide meaningful requirements that assure long-term control of releases. If a corrective action is triggered, a unit or units are known to be causing contamination of groundwater. Any corrective action plan needs to include both short-term solutions, such as a groundwater collection system, and long-term solutions such as source control. The proposed section regarding groundwater collection systems (section 841.315) is unclear about when such a system would be required by the Agency, and where the system would be located with respect to compliance points. Section 841.310 should be revised to state that a groundwater collection system is one possible type of short-term solution that would be a necessary part of the overall corrective action. It is also unclear how long-term compliance is going to be established: "Once compliance with the groundwater quality standards [… has] been achieved, the owner or operator of the unit may discontinue operation of the groundwater collection system" (section 841.315(c)). Given this language, it is likely that without any source control, a groundwater collection system will only be a temporary solution. That is, once the pumps are turned off, migration of the leachate plume will continue as before. The Board should revise the corrective action plan requirements (section 841.310) to include a requirement for long-term source control, such as permanent removal of CCW from the impoundment or relining with a liner that meets U.S. EPA design criteria for a double walled liner and leachate collection system (U.S. EPA 2010b).

Fourth, the corrective action provisions should also contain a requirement that triggers closure of a unit that remains out of compliance after an attempt to meet corrective action requirements. Failure of corrective action, either through non-compliance with a corrective action plan or through compliance with a plan that is unsuccessful in addressing exceedances, results in a continuing threat to public health and the environment. The rule therefore should require that a unit that is out of compliance after an attempt at corrective action be closed pursuant to Part 841, Subpart D, because of this ongoing threat.

Subpart D: Closure (sections 841.400 through 841.450)

There is currently no language in the rules that would trigger closure of an impoundment. The rules should include language, for instance as part of section 841.405, that gives the Agency the authority to mandate closure of a unit, and the disposition of CCW and its leachate.

Closure by removal (section 841.400(b)) is a technically feasible alternative. The Board should consider closure by removal to be the best practice with respect to protecting groundwater and surface water from CCW impacts. Responses to the U.S. EPA's 2010 "Questionnaire for the Steam Electric Power Generating Effluent Guidelines" (U.S. EPA 2010c) provide evidence that closure by removal is technically and economically feasible. The responses included detailed descriptions of closure activities for 21 impoundments. Of these, 14 impoundments were closed by removal, and the remaining 7 were capped or re-graded with fill. The 14 impoundments reportedly closed by removal were located at 7 facilities in 6 states (NV, CO, MA, MN, MO, WV). For example, the Brayton Point facility in Massachusetts closed four impoundments containing fly ash and bottom ash by removal. The Grainger facility in South Carolina is another example of impoundment closure by removal. At the Grainger facility, Santee Cooper has pledged to remove 1.3 million tons of CCW as part of closure (SELC 2013), demonstrating the technical and economic feasibility for even very large volumes of CCW.[2]

The March 25, 2014 revised language in subsection 841.400(b) covering closure by removal does not require the removal of the containment system. The rules should require that any

[2] Removal costs can vary greatly depending on the distance to the landfill, the type of waste and the location of the impoundment. The U.S. EPA's 2010 proposed rule listed a range of $2 to $80 per ton of CCW (U.S. EPA 2010b). Costs of removal were only reported in the U.S. EPA's 2010 questionnaire for one impoundment, the "Supplemental Hold-up Pond" at the Allen S King facility in Minnesota, and costs of closure by removal were around $80,000, but size information was redacted (U.S. EPA 2010c).

containment system components that are left in place be cleaned to certain specifications, however, and punctured in a manner that allows for stormwater to cross through the barrier.

Section 841.415 Final Slope and Stabilization should include a prohibition on using CCW to establish the final grade and slope of the impoundment. As written, subsection 841.415(d) could be interpreted to allow for CCW to be exposed on the earthen berms surrounding the unit. CCW exposed in this way would come into contact with stormwater and become part of eroded sediment transported away from the closed unit. Subsection 841.415(d) should be clarified to prevent this exposure.

Section 841.420 describes the final cover system, and specifies permeability requirements for both the cover and any liner system. There should be a reference here as to how the permeability should be demonstrated. There are standard methods available, but the Agency should specify whether a field demonstration or laboratory demonstration is sufficient. In addition, subsection 841.420(a)(1) requires that the cover "provide long-term minimization of the migration of liquids through the closed impoundment unit". This language is too subjective to provide adequate guidance and protection. The U.S. EPA's proposed rule requires monitoring for 30 years post-closure (U.S. EPA 2010b). Modeling of contaminant transport for U.S. EPA's risk assessment predicted even longer timeframes for peak concentrations to appear in drinking water wells off-site (e.g. the median time to peak boron concentration was 74 years from unlined impoundments and 90 years from clay-lined impoundments) (U.S. EPA 2010a). The Board should define "long-term" in the rule, consistent with U.S. EPA's post-closure monitoring and risk assessment, and the Board should include in the rule requirements for leakage detection. These requirements could be listed in section 841.430, specifying how the owner or operator will demonstrate that there are no "tears, rips, punctures, and other damage to the geosynthetic membrane" (subsection 841.430(f)), and that there has been no "disturbance of the final cover, liner or any other components of the containment system" (subsection 841.430(i)).

Surface Water

Groundwater and surface water interact, and this interaction should be reflected in the siting, design, monitoring, remediation, and closure of CCW impoundments. The exchange between groundwater and surface water occurs in riverbanks and sediments, collectively termed the "hyporheic zone". Although the amount of water and chemical constituents exchanged can be difficult to quantify, various modeling and measurement techniques are available. Hyporheic exchange is a widely recognized process (USGS 2008, Environment Agency 2009), and is particularly important for tracking the movement of groundwater contamination that occurs near surface water. For example, this process was considered as part of the closure of impoundments at Ameren's Venice facility in Illinois (Natural Resource Technology 2010). The conclusion reached by National Resource Technology in this case was that the flux of boron from groundwater to surface water would be sufficiently diluted by the large volume of water in the Mississippi River. There are some issues with this first-order analysis (e.g. the dilution volume includes an arbitrary distance from shore and assumes a uniform channel depth), but importantly, the groundwater-surface water exchange process at least was considered. This evaluation also involved several assumptions that could be vastly improved if monitoring data were available for the hyporheic zone (USGS 2008, Environment Agency 2009, U.S. EPA 2013).

The rule should include requirements to assess groundwater flow to surface water. This assessment should be part of the hydrogeologic site characterization (section 841.200), and any updates to this characterization. In addition, the monitoring system (section 841.205) should include requirements to provide monitoring data in support of this type of assessment. This monitoring should include conventional monitoring wells sufficient to establish the hydraulic gradient between CCW impoundments and areas where groundwater may discharge to surface water. If groundwater discharge to surface water is considered possible by the Agency at a given site, then mini-piezometers (or similar) to assess the hydrology of the hyporheic zone should be included in the groundwater monitoring system. The Board should include this type of information under section 841.400 so that an adequate assessment of non-point surface water impacts can be included when closure options are being considered.

Design Criteria

The Board inquired about including a section on impoundment design criteria in the rule (IEPA 2014b, Attachment 1, page 5). The proposed rule should include provisions specifying adequate design criteria for impoundments. Such provisions would help prevent additional impoundment failures and the associated contamination of groundwater and surface water. Appropriate design criteria would, in helping to prevent impoundment failure, be likely to conserve resources for both the State of Illinois in avoiding enforcement action costs and for the generators in avoiding corrective action costs. The proposed rule could include provisions addressing siting, liners, leachate collection systems and integrated safety monitoring systems. First, as to siting, design criteria provisions should enable the Agency to protect both surface water and groundwater. Impoundments should be sited to avoid direct contact with groundwater and to minimize potential impacts to surface water from leachate or dam failure. Even with a very protective liner, surface water is at risk through structural failure. Thus, the sites selected for temporary and permanent disposal of CCW should account for and minimize this risk. Second, as to liners, the design criteria should adopt the same liner requirements as the U.S. EPA proposal (U.S. EPA 2010b). The double liner systems proposed by the U.S. EPA have a much lower failure rate than single liner systems, and should be adopted here as the best practice for both any new impoundments and the re-lining of existing impoundments (U.S. EPA 2010b, Reddy and Butul 1999). Three liner types were considered as part of the U.S. EPA's 2010 risk assessment: unlined, clay lined, and composite lined. As an example, the median model results indicated peak boron concentration to reach a receptor well in 74 years for an unlined impoundment, 90 years for a clay lined impoundment, and 4,400 years for a composite lined impoundment (U.S. EPA 2010a). Thus, the compacted clay liner provided some additional protection, but the composite liner provided dramatically more protection compared to either the unlined or clay lined scenarios. Finally, the design criteria should require a leachate collection system. All impoundments contain fluids, and the presence of these fluids represents a potential threat to human health and the environment through seepage, liner failure or structural failure. That is, the fluids contain leached chemicals, and are therefore a potential threat through seepage in addition to increasing hydrostatic pressure that can raise the risk of liner or structural failure (U.S. EPA 1994). A leachate collection system would help to minimize each of these risks by reducing the fluid pressure in the system. Once again, the U.S. EPA proposal requires a leachate collection system at all new impoundments (U.S. EPA 2010b). In order to be most protective, the Board should adopt the same leachate collection system provisions as the U.S. EPA.

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Dated: April 9, 2014

Respectfully submitted,

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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
COAL COMBUSTION WASTE (CCW) ASH	)	R14-10
PONDS AND SURFACE IMPOUNDMENTS	)	(Rulemaking - Water)
AT POWER GENERATING FACILITIES:	)	
PROPOSED NEW 35 ILL. ADM. CODE 841	)	

PRE-FILED TESTIMONY OF TRACI BARKLEY

Qualifications and Introduction

My name is Traci Barkley and I am a Water Resources Specialist for Prairie Rivers Network. I have nineteen years of water resources-related professional and research experience with responsibilities in ecosystem monitoring and assessment, regulatory and policy analysis, technical report writing, and public outreach. I received a Master's of Science in Natural Resources and Environmental Science from the University of Illinois, with a concentration in Aquatic Ecology. In addition, I have completed some coursework towards a Doctoral Degree in Ecology and Evolutionary Biology.

Coal ash impoundments left in place without proper closure pose an unreasonable risk to Illinois residents and the ecosystems they rely on for their health, welfare and recreation. Coal ash impoundments leach contaminants into both groundwater and surface water, release ongoing pollution discharges into surface waters, and pose a looming risk of dramatic structural failure.

Because the rules being considered by the Board in this proceeding will be the only rules in Illinois to specifically address the closure of coal ash impoundments, the Board must consider that the long-term coal ash impoundment management decisions that flow from these rules will have effects that reach beyond the narrow scope of groundwater impacts IEPA has identified in its proposal. For example, following the proposed rules, IEPA could approve a closure plan that allows a structurally unsound unit to leave coal combustion waste ("CCW") in place, which could lead to a coal ash disaster in Illinois as high-profile as the 2009 TVA coal ash spill into the Emory River in Kingston, Tennessee or the 2014 Duke Energy coal ash spill into the Dan River in North Carolina.

IEPA's proposed rule does not go far enough to protect the health & welfare of Illinois citizens in a number of ways. These shortcomings include that:

- Closure is voluntary, even for units that are leaking or pose other threats
- Closure standards are insufficient, as they allow unacceptable conditions to persist like a ticking time bomb
- Corrective action plans as proposed by IEPA are insufficient to address pollution problems
- New coal ash pits can be constructed and existing units can be expanded without meeting any design standards

Below, I identify specific examples of the risks presented by coal ash contamination that already exist throughout the State.

The hazards and high risk of coal ash storage

Coal combustion waste, or coal ash, is the solid by-product that is left over after coal is burned for electricity. Coal ash contains toxic elements such as mercury, selenium, arsenic, chromium, and cadmium and numerous other dangerous contaminants.[1] More recently, coal ash contains particles captured by air pollution control devices that have been installed to prevent air emissions of particulate matter and other gaseous pollutants from power plant smokestacks. As new technologies are installed to filter additional hazardous air pollutants from power plants, cleaning the air we breathe of smog, soot and other harmful pollution, the quantity of dangerous chemicals in coal ash increases.[2] The hazardous substances found in coal ash can cause cancer and damage the nervous system and other organs, especially in children. According to the Human Health and Ecological Risk Assessment completed by U.S. EPA in 2010, the excess cancer risk for people drinking groundwater contaminated with arsenic from unlined coal ash ponds is estimated to be as high as 1 in 50.[3] For context, U.S. EPA in its Assessment viewed cancer risk as significantly high when environmental exposures resulted in more than one additional cancer per 100,000 people.[4] Consequently, a lifetime cancer risk of 1 in 50 represents a risk 2000 times U.S. EPA's level of significance. This is an especially high risk when the impoundment is located in a shallow aquifer recharge area such as at Will County, Joliet 9, Joliet 29, Powerton, Meredosia, Venice, and Wood River facilities.

The research done so far on the effects of coal ash pollution on aquatic ecosystems has produced alarming results.[5] Dr. Dennis Lemly, Ph.D., U.S. Fish and Wildlife Service Biologist, recently submitted a report that discloses $2.3 billion in monetary damages from coal ash to the sports recreation industry at 22 waterways due to the absence of the safeguards needed to protect the adjacent game fish habitat at these impoundment sites.[6] Dr. Lemly concludes that a "surface impoundment of coal combustion waste unnecessarily jeopardizes fish and wildlife populations, causes significant long-term environmental damage, and results in high economic costs that could be avoided or minimized if other disposal practices were used."[7] Specific impacts of coal ash pollution to fish and wildlife include widespread sterility of fish, selenium poisoning of waterfowl, deformities and reproductive failure in game fish species, reduced populations, and fish kills. Further, a series of recent studies by Duke University scientists identified the long-

[1] Office of Solid Waste & Emergency Response, U.S. Envtl. Prot. Agency, Report to Congress: Wastes from the Combustion of Fossil Fuels (Mar. 1999).
[2] See, e.g., Office of Research & Dev., U.S. Envtl. Prot. Agency, Characterization of Coal Combustion Residues from Electric Utilities Using Wet Scrubbers for Multi-Pollutant Control (July 2008) and Office of Research & Dev., U.S. Envtl. Prot. Agency, Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control (Feb. 2006).
[3] U.S. Envtl. Prot. Agency, Human and Ecological Risk Assessment of Coal Combustion Wastes (April 10, 2010) (draft) (hereinafter U.S. EPA Risk Assessment), at 4-57-58.
[4] *Id*. at 4-1-4-2.
[5] *See id*. at 4-33 ("Cases of damage to terrestrial and aquatic organisms from improperly managed CCW are common in the literature.").
[6] Letter to the Office of Management and Budget, A. Dennis Lemly, Ph.D., Research Fish Biologist USDA-Forest Service, Southern Research Station Piedmont Aquatic Research Laboratory, January 8, 2010.
[7] *Id*.

term ecological threat to the waterways impacted by the 2008 TVA spill and to numerous lakes and rivers throughout North Carolina by the ongoing discharge of prodigious volumes of heavy metals from coal ash ponds. [8]

> Biological effects studies are key to determining what the impacts of coal ash really are on fish and wildlife. While chemical monitoring can tell us what concentrations of chemicals are present, biological effects studies range from on-site physical evaluations and/or laboratory toxicity tests with groups of individuals to population-level evaluations in the field that determine whether there has been a depletion of animal numbers.[9]

While concentrations of particular coal ash pollutants may be low in some cases, those numbers belie the effect of cumulative loading of pollutants into a waterbody and accumulation in aquatic organisms and community food webs. Of particular concern is build up of heavy metals such as mercury and selenium in sediments that settle to the bottom of receiving streams or reservoirs and allow for release and cycling of pollutants within the waterbody, increasing bioavailability under dynamic conditions such as flood events, spring and fall turnovers and anoxic conditions during times of drought or extreme heat events. This is of particular concern at power plant facilities such as Newton facility where coal ash pollution enters Newton Lake, a state fish and wildlife area used for fishing and fish consumption.

The rules proposed by IEPA would allow this situation to continue indefinitely, continually increasing the load of mercury and other metals in these reservoirs.

Shortcomings in the data

I have reviewed groundwater and surface water data generated by IEPA personnel and data submitted to IEPA by dischargers and their consultants. Two important points stand out: 1) for most sites, IEPA only has about 2 years of data upon which it has based its regulatory proposal and 2) even looking at only these limited data, contamination by coal ash pollutants has been demonstrated at every coal-fired power plant in Illinois.

The data that IEPA have reviewed do not present an accurate characterization of how leaching progresses over time. According to the Human Health and Ecological Risk Assessment completed by the EPA in 2010, peak pollution from dump sites can occur long after the waste is placed. For example, peak exposures from unlined coal ash ponds are projected to occur

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[8] See Laura Ruhl, Avner Vengosh, Gary S. Dwyer, Heileen Hsu-Kim, Amrika Deonarine, Mike Bergin, and Julia Kravchenko, Survey of the Potential Environmental and Health Impacts in the Immediate Aftermath of the Coal Ash Spill in Kingston, Tennessee, Environ. Sci. Technol., 2009, 43 (16), pp 6326–6333, May 4, 2009. See also, Laura Ruhl, Avner Vengosh, Gary S. Dwyer, Heileen Hsu-Kim, Grace Schwartz, Autumn Romanski, and S. Daniel Smith. [9]The Impact of Coal Combustion Residue Effluent on Water Resources: A North Carolina Example, Environ. Sci. Technol., 2012 Nov 6;46(21):12226-33.

[9] See Laura Ruhl, Avner Vengosh, Gary S. Dwyer, Heileen Hsu-Kim, Amrika Deonarine, Mike Bergin, and Julia Kravchenko, Survey of the Potential Environmental and Health Impacts in the Immediate Aftermath of the Coal Ash Spill in Kingston, Tennessee, Environ. Sci. Technol., 2009, 43 (16), pp 6326–6333, May 4, 2009. See also, Laura Ruhl, Avner Vengosh, Gary S. Dwyer, Heileen Hsu-Kim, Grace Schwartz, Autumn Romanski, and S. Daniel Smith. The Impact of Coal Combustion Residue Effluent on Water Resources: A North Carolina Example, Environ. Sci. Technol., 2012 Nov 6;46(21):12226-33.

approximately 70 to 76 years after the ponds first began operation—thus retired sites still pose very significant threats.[10] IEPA's confidence that its proposal will protect groundwater based on only two years of data, in some instances with only a couple of data points, is misplaced - especially when those data have shown contamination progressing in nearly every instance.

Surface water risks

As mentioned above, coal ash impoundments pose three principal risks to humans and the environment: 1) risks to groundwater, 2) risks to surface water, and 3) risks of structural failure. IEPA has focused the substance of its rule exclusively on groundwater pollution. Here I will discuss the potential surface water impacts that factor into corrective action and closure decisions and then discuss the structural safety concerns that should also be taken into account in the rule.

Because coal plants need water to operate, most coal ash pits are located in close proximity to Illinois rivers and lakes. This means that coal ash contamination can reach the surface waters through groundwater flow, during storm and flood events, by direct discharges or by structural failure.

When coal ash contamination leaches into groundwater, it is not uncommon for that pollution to reach nearby surface water. This has happened at the Duck Creek, Marion, and Vermillion plants, where pollutants have leached through groundwater into adjacent waterways.

Again, because of the need for coal plants to be located near surface waters, many coal ash impoundments are located in floodplains along rivers. Some plant operators routinely pump excess water into the nearby surface water, especially during storm events. For example, the E.D. Edwards plant pumps into the Illinois River.[11] Stormwater also routinely flows through the coal ash impoundments at the Meredosia Plant into the Illinois River. The ash pits at the Vermilion facility are located in the floodplain of the Middle Fork of the Vermilion River. The two older pits are hydrologically connected to the river during times of flood, through both groundwater and surface water connections. Flood events can exacerbate coal ash pollution in a number of ways, including: 1) river water backing up into the floodplain and into coal ash pits, mingling with and mobilizing coal ash pollutants, 2) river water backing up through the water table and into unlined ash pits from below, mingling with and mobilizing coal ash pollutants, and 3) wear and tear from flood waters' erosional forces on the coal ash impoundment walls, decreasing structural stability.

Structural integrity

Finally, the rules proposed by IEPA do not account for the risk of a disaster from an impoundment structural failure when making the decision of whether and how a coal ash impoundment will be closed. The recent coal ash disasters in Tennessee and North Carolina illustrate the enormous cost of inaction with regard to coal ash impoundments. Proper closure by removal of coal ash when structural integrity is poor or site specific conditions predict declining

[10] U.S. EPA Risk Assessment, table 4-7 at 4-11-4-12.
[11] Ameren Edwards Hearing Transcript, p. 35, 36 (August 7, 2013) available at http://www.epa.state.il.us/public-notices/2013/ameren-edwards/hearing-transcript.pdf.

stability can defuse the "ticking time bomb" problem that many impoundments present. As discussed above, most coal ash impoundments are located near surface water sources because the plants producing the ash need to be located near a water source. However, successful long-term disposal of coal ash does not require a water source. To the contrary, allowing a coal ash impoundment to remain next to a water source significantly increases the risks posed by that waste. Closure by removal can move the looming threat away from our critical water sources, and away from places where they pose a hazard to humans and the environment.

According to U.S. EPA, there are two impoundments (at Havana and Wood River) in Illinois that are designated "high hazard," and are likely to cause loss of human life if the impounding structure holding the coal ash waste fails. In U.S. EPA's structural integrity assessments of the surface impoundments containing coal combustion residuals and with maximum embankment heights of six (6) feet at electric utilities in Illinois, 16 of the 38 impoundments received a rating of "poor." Another 16 impoundments received a rating of "fair", only four (4) were rated as "satisfactory" and one (1) evaluation is still "in progress".[12] In addition, several more have not been inspected for structural integrity and stability. A coal ash impoundment rule should explicitly consider these risks as a factor in making closure decisions; otherwise, we are courting disaster.

Dated: April 9, 2014

Respectfully submitted,

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[12] http://www.epa.gov/osw/nonhaz/industrial/special/fossil/surveys2/statelet/il_epa_let.pdf

CERTIFICATE OF SERVICE

I, Andrew Armstrong, hereby certify that I have served the attached **Notice of Filing, Pre-Filed Testimony of Keir Soderberg and Pre-Filed Testimony of Traci Barkley** on behalf of the Environmental Law & Policy Center, Environmental Integrity Project, Sierra Club, and Prairie Rivers Network in R14-10 upon the attached service list by depositing said documents in the United States Mail, postage prepaid, in Chicago, Illinois on April 9, 2014.

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